RIO GRANDE WILD TURKEY HEN SURVIVAL AND HABITAT SELECTION IN SOUTH CENTRAL KANSAS

by

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ABSTRACT

Rio Grande wild turkey (Meleagris gallopavo intermedia) hen survival and habitat selection were studied in south central Kansas using radio-telemetry during the reproductive season (15 March to 15 August) in 1991 and 1992. Dispersal distances did not differ ($P > 0.05$) between years, but were larger ($P < 0.05$) for juveniles than adults. Juveniles that dispersed long distances had a higher probability ($P = 0.07$) of survival than short-dispersing juveniles.

The reproductive season survival rate was 0.621. No difference ($P > 0.05$) in survival rate was detected for age classes or years. Survival was lowest during the 1 April to 31 May period, and mammalian predators were responsible for 83% of the mortality. Renesting hens had a higher probability ($P < 0.01$) of survival than hens attempting their first nests of the year.

The average reproductive season home range size was 2,879 ha. Home range size did not differ ($P > 0.05$) between age classes or years.

Adult hens were more consistent than juveniles for their selection of cover-types in 50% and 85% core areas. Adults at the EAST (Bell and Dunn trapsites) and WEST (Haas and Woolfolk trapsites) sites selected against ($P < 0.05$) cropland and CRP fields. EAST adults selected for ($P < 0.05$) rangeland in their 50% and 85% core use areas, but WEST adults did not ($P > 0.05$). Juvenile core area selection was not only variable between years, but also between sites.

Nesting hens selected for ($P < 0.05$) the CRP cover-type for first nesting attempts. Hens shifted cover-type use during renesting attempts. The CRP cover-type was used less frequently, and the rangeland cover-type was used more frequently for renesting attempts.

Brood-rearing hens selected for ($\underline{P}$ < 0.05) riparian and treerow cover-types and against ($\underline{P}$ > 0.05) cropland and CRP fields at the Woolfolk trapsite. Cover-types were used in proportion to their availability by broods at the Dunn trapsite.

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CHAPTER I
INTRODUCTION

Historically, the Rio Grande wild turkey (*Meleagris gallopavo intermedia)* occupied much of the Great Plains region of the U.S. (Johnsgard 1979). The Rio Grande wild turkey was an abundant resident during the early settlement of Kansas; however, populations were extirpated from most of the state during the early 20th century, with the exception of southern Kansas (Johnsgard 1979). Both indiscriminate hunting during the late 1800s and habitat loss during the early 1900s have been blamed for this decline (Beasom and Wilson 1992).

Rio Grande turkeys began to emigrate into Kansas from newly established populations (Beasom and Wilson 1992) in northern Oklahoma during the late 1950s (Capel 1973). The natural movement of birds into the state inspired a tranplanting program that would continue for the next 25 years (Beasom and Wilson 1992). This program produced stable turkey populations in parts of southwest and south central Kansas, that eventually led to the establishment of a spring gobbler season for 25 southwestern counties in 1974 (Sexson 1990). Permits were issued for the spring gobbler season annually until biologists recorded declining wild turkey populations in the western 15 counties of this management unit (Sexson 1990). The reasons for this decline were unknown.

Although the wild turkey is an important game species and is relatively abundant in Kansas, it has received little or no research attention. The Kansas Department of Wildlife and Parks and the National Wild Turkey Federation funded this research to determine the factors limiting Rio Grande turkey populations in agricultural landscapes in Kansas. More specifically, my study was designed to provide survival and habitat selection information for understanding the factors regulating Kansas Rio Grande turkey populations during the reproductive season (15 March to 15 August).

Data on wild turkey survival and cause-specific mortality rates are scarce in the Great Plains region. March through August survival rates and cause-specific mortality rates were calculated for Rio Grande turkey hens in Texas (Blair, unpubl. data). However, differences in climate, predator community composition, and vegetation types make comparisons between Texas and Kansas difficult. The most detailed wild turkey survival study, to date, was conducted on the eastern subspecies (M. g. silvestris) in Missouri (Kurzejeski et al. 1987). Survival and cause-specific mortality rates are presented in Chapter II. The hypothesis that dispersal is a risky endeavor, leading to higher mortality rates for long distance dispersers is also discussed.

Information on wild turkey habitat selection offers biologists insight on the habitat components neccessary to sustain populations and the factors responsible for shifts in selection over time. Both Speake et al. (1975) and Porter (1992) discuss shifts in turkey seasonal habitat selection. Shifts in the use of habitat types for nesting have been reported for eastern turkey hens (Lazarus and Porter 1985) and Rio Grande turkey hens (Schmutz et al. 1989). Differences in habitat selection by juvenile and adult eastern wild turkey hens were reported in Arkansas (Wigley et al. 1985). Reproductive season habitat selection is presented at 2 levels of resolution in Chapter III.

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CHAPTER II

SURVIVAL OF RIO GRANDE WILD TURKEY HENS DURING THE REPRODUCTIVE SEASON IN SOUTH CENTRAL KANSAS

Introduction

Wild turkeys commonly disperse from wintering areas to spring breeding and nesting areas (Ellis and Lewis 1967, Fleming and Webb 1974, Speake et al. 1975, Porter 1977, Hoffman 1991). Dispersal may be a mechanism for redistributing individuals over available habitats (Brown 1980), dispersing possible predators during the nesting period, decreasing intrasexual competition for resources (Dobson and Jones 1985), or increasing genetic variation in wintering flocks (Dobson and Jones 1985, Buford 1993). Murray (1967) believed that vertebrate reproduction is dominated by adults that occupy the suitable breeding sites (nearby), while passive individuals (juveniles) maximize their chance of reproduction by dispersing.

Data on Rio Grande wild turkey survival and sources of mortality are lacking for the Great Plains region. Survival estimates are useful in providing information on seasonal and cause-specific mortality, as well as contributing information to produce projections for population size and age structure. The survival of wild turkey hens has been influenced by environmental factors (Healy 1992), age class (Vander Haegen et al. 1988, Schmutz and Braun 1989), predators (Kurzejeski et al. 1987), and hunting (Kurzejeski et al. 1987).

Few studies of Galliformes have investigated the possible relationship between dispersal/migration distance and survival. Much speculation surrounds the hypothesis that dispersal is a risky endeavor, leading to high mortality rates for birds dispersing long distances. Beaudette and Keppie (1992) investigated the survival rates of spruce grouse that dispersed short and long distances and found no link between distance and mortality rate.

The objectives of this aspect of my study were to calculate turkey hen dispersal distances, estimate wild turkey survival and cause-specific mortality rates for the reproductive season, and determine if a relationship existed between dispersal distance and survival.

Study Area

This study was conducted on a 242,895 ha site located in Barber, Comanche and Clark Counties in south central Kansas, and small areas of Woods and Harper Counties in northern Oklahoma. The study area was located in the Central Rolling Red Plains major land resource area (Austin 1965) with elevations ranging from 382 m in Barber County to 673 m in Comanche County. The following climatological information was obtained from soil surveys for Barber and Comanche Counties (U.S. Soil Cons. Serv. 1977 and 1989, respectively). The average winter temperature is 1.8 °C, with an average daily minimum of -5.2 °C. In summer the average temperature is 26.2 °C, with an average daily maximum of 33.9 °C. The average annual precipitation is 60 cm, with 73% occurring April through September. Annual snowfall averages 43 cm.

Farming, ranching and oil production are the main land uses in this area. Approximately two-thirds of the study area is rangeland and riparian, and one-third is cropland. The abundant crop is winter wheat (55%) with grain sorghum, corn, alfalfa, oats and soybeans making up the remainder. Most of the ranches are feeder-stocker or cow-calf operations.

Rangeland plant communities were characterized by 75 percent climax vegetation and were dominated by big bluestem (*Andropogon gerardi*), little bluestem (*Andropogon scoparius*), switchgrass (*Panicum virgatum*), sideoats grama

(Bouteloua curtipendula), sand sagebrush (Artemisia filifolia) eastern redcedar (Juniperus virginiana), and sandhill plum (Prunus angustifolia). Wooded areas along streams and drainages contained eastern cottonwood (Populus deltoides), american elm (Ulmus americana), hackberry (Celtis occidentalis), and sandhill plum. CRP fields were planted with 5 main species of grasses: Big bluestem, little bluestem, switchgrass, sideoats grama, and indiangrass (Sorghastrum nutans). Treerows were planted mainly with siberian elm (Ulmus pumila), catalpa (Catalpa speciosa), and eastern redcedar.

Methods

Drop nets and rocket nets were used to capture turkey hens at 4 sites (Bell, Haas, Dunn, and Woolfolk) in south central Kansas from January through March in 1991 and 1992. Captured hens were sexed, aged, weighed, and fitted with aluminum leg bands and radio transmitters. Sex of the birds was determined by characteristics of the head and the shape and coloration of the breast feathers. Age was determined by the characteristics of the primaries IX and X and by tail feather replacement (Larson and Taber 1980).

Each hen was fitted with a Telonics (Mesa, Arizona), lithium-powered radio transmitter that operated on the 150-152 MHz band. Each transmitter weighed approximately 105 g, included a mortality-mode sensor, and had an approximate lifespan of 24 months. Transmitters were attached to the hens in a backpack fashion (Kurzejeski et al. 1987) and were fastened by nylon-coated rubber harness looped under each wing (Kenward 1987;104). After instrumentation, birds were released at the capture site. Turkey hens were not included in the sample until 7 days after release so that capture related bias would be reduced (Bidwell et al. 1989).

Transmitter signals were received by a Telonics TR-2 receiver and a hand-held antenna or a user-constructed retractable mobile antenna tower (Pollock et al. 1990) with dual antenna arrays. All individuals were located at least once, but usually twice, weekly from time of capture until 15 August in 1991 and 5 September in 1992. When a mortality signal was received, the site of the mortality was investigated immediately, and the evidence recovered was used to determine the cause of death. Mortalities were classified to 1 of 4 outcomes: mammalian predation, avian predation, poaching, or unknown. Hens were censored on the last date found alive when loss of transmitter or transmitter failure occurred.

Survival and cause-specific mortality rates were estimated for the 15 March to 15 August period (reproductive season) using a modified Mayfield method (Heisey and Fuller 1985). Z-tests were used to identify 3 intervals where daily rates were constant. A chi-square test for homogeneous survival rates (Sauer and Williams 1989) was used to test the following hypotheses:

$$Ho: J_1 = J_2 = A_1 = A_2$$

where: J_1 = Juvenile survival rate in 1991,
J_2 = Juvenile survival rate in 1992,
A_1 = Adult survival rate in 1991,
A_2 = Adult survival rate in 1992.

$$Ho: T_1 = T_2 = T_3 = T_4$$

where: T_1 = Hen survival rate at trapsite 1,
T_2 = Hen survival rate at trapsite 2,
T_3 = Hen survival rate at trapsite 3,
T_4 = Hen survival rate at trapsite 4.

If one of the hypotheses was rejected, then individual comparison-wise testing (Z-tests) was conducted at a level of α/number of possible comparisons.

The staggered entry approach to the Kaplan-Meier product limit method was used to estimate hen survival from 8 January to 5 September (Kaplan and Meier 1958, Pollock et al. 1989). While the modified Mayfield estimator proposed by Heisey and Fuller allows animals to exit the sample at any time (censoring), the staggered entry approach allows radio-tagged animals to enter <u>and</u> exit the sample during the period of survival estimation. Therefore, the same initial starting date for all individuals contributing to the estimate is not required. This method allowed me to estimate survival for the population beginning on 8 January, although some individuals were captured as late as 15 March. Both the Heisey-Fuller and Kaplan-Meier methods avoid the biases associated with survival rates that are based on simple percentages (Heisey and Fuller 1985).

Survival rates specific to nesting and renesting activities were estimated using the Kaplan-Meier product limit method for a single 28-day (nest incubation period) time interval. Z-tests were used to detect survival rate differences between CRP and rangeland nesters, as well as, the hens attempting first nests of the year and renesting hens.

To obtain a reasonable estimate of annual hen survival, I calculated a daily mortality rate using the average of the Kaplan-Meier survival rates of late summer (8/15-9/5) and late winter (1/9-2/28). The average rate was applied to the 123 day period beginning on 6 September and ending on 9 January (when no monitoring of hens was conducted).

Dispersal distance was the straight-line distance between the winter roost site and the location of the first nesting attempt. No dispersal distance was calculated for hens that failed to survive until the mean dispersal date occurred or for hens that survived, but did not attempt a nest. Dispersal date data were non-normal, so the Kruskal-Wallis test was utilized to detect if mean dispersal date was related to year of capture. An analysis of variance (ANOVA) was used to investigate the possibility that dispersal distance was age related or year related. I also investigated the possibility that survival was related to dispersal distance by classifying individuals as long or short dispersers and calculating survival rates for each dispersal class. Hens were classified as long dispersers if they dispersed farther than the mean dispersal distance and were classified as short dispersers if they dispersed a distance less than the mean. Z-tests were utilized to detect differences in survival between long and short dispersing adults and juveniles.

In addition, some simple population modelling was performed to better understand the role of reproduction and hen survival in maintaining stable turkey populations in south central Kansas:

$$A = B / (C * D)$$

where: A = Number of poults produced/<u>successful</u> hen,
B = Annual hen mortality rate * 2,
C = Hen survival rate (1 January to 1 April),
D = Hen success rate.

Results

A total of 130 wild turkey hens were captured and instrumented during 1991 and 1992 (Table 2.1). Twenty-four hens were censored during the 8 January to 5 September period due to loss of transmitter (8), transmitter failure (5), and death or failure\loss of transmitter before 7 days had elapsed from capture date (11). Survival data were obtained from 118 hens for the 8 January to 5 September period and from 115 hens for the 15 March to 15 August period (reproductive period).

Seventy-six dispersal distances (27 in 1991, 49 in 1992, 44 juveniles and 32 adults) were recorded for hens

Table 2.1. Sample Sizes for Rio Grande wild turkey hens radio-tagged in south central Kansas, 1991 and 1992.

		Sample Size		
Year	Variable	Juvenile	Adult	Total
1991	Instrumented	31	11	42
	Censored[a]	3	4	7
	Monitored[b]	29	11	40
1992	Instrumented	55	33	88
	Censored[a]	14	3	17
	Monitored[c]	44	31	75

[a] Fate of hen unknown due to loss or failure of transmitter.
[b] Number of hens available for monitoring on 15 March 1991.
[c] Number of hens available for monitoring on 15 March 1992.

dispersing from the winter roost sites to nest sites in years 1991 and 1992. Dispersal distances did not differ (F = 2.05, P > 0.05) between 1991 (11.26 km) and 1992 (8.16 km), but were larger (F = 6.40, P < 0.05) for juveniles (11.51 km) than adults (6.16 km). No difference in survival was detected (F = 0.12, P = 0.48) between adult hens dispersing long and short distances; however, juveniles that dispersed long distances had a higher probability of survival (P = 0.069) than juveniles dispersing short distances.

No survival rate difference (X^2 = 0.424, P > 0.05, df = 3) was detected among 1991 juveniles (0.598 ± 0.009), 1992 juveniles (0.594 ± 0.006), 1991 adults (0.695 ± 0.019), and 1992 adults (0.616 ± 0.007). There were also no differences (X^2 = 3.614, P > 0.05, df = 3) detected among the Bell (0.654 ± 0.004), Haas (0.699 ± 0.015), Dunn (0.408 ± 0.016), and the Woolfolk (0.613 ± 0.013) trapsites. Therefore, individuals were pooled to estimate the survival rate and the cause-specific mortality rates during the reproductive season and the survival rate of the 8 January to 5 September period.

The modified Mayfield survival rate for hens during the reproductive period was 0.621 (Table 2.2). Survival probabilities were lowest in the second interval, 1 April to 31 May. The Kaplan-Meier survival estimate for the reproductive season was also 0.621. The Kaplan-Meier survival rate for hens during the 8 January to 5 September period was 0.547 (Table 2.3). These biweekly rates indicated that survival probabilities were lowest during the 1 May to 15 May period. The estimated annual survival rate was 0.449.

Forty-two of the 115 hens (37%) died during the reproductive period. Mammalian predators (83.4%), poaching (7.0%), and avian predators (4.9%) accounted for the

Table 2.2. Heisey-Fuller interval survival rates for radio-marked Rio Grande turkey hens ($\underline{n}$ = 115) during the reproductive season (15 Mar - 15 Aug) in south central Kansas, 1991 and 1992.

Interval	N days in interval	N turkey days	Interval survival rate	Variance
15 Mar-31 Mar	16	1800	0.9823	0.0002
1 Apr-31 May	61	5707	0.7317	0.0018
1 June-15 Aug	76	5240	0.8639	0.0016
15 Mar - 15 Aug survival rate:			0.6209	
Lower 95% C.L.:			0.5377	
Upper 95% C.L.:			0.7210	

Table 2.3. Kaplan-Meier survival estimates for radio-marked Rio Grande turkey hens in south central Kansas, 8 Jan - 5 Sept, 1991 and 1992.

Dates	N risk	N deaths	N censored	Survival	95% CI
1/8-1/15	27	0	0	1.0000	1.0000-1.0000
1/16-1/31	32	1	0	0.9688	0.9094-1.0281
2/1-2/15	56	2	1	0.9342	0.8714-0.9969
2/16-2/28	61	1	1	0.9188	0.8531-0.9845
3/1-3/15	115	1	1	0.9108	0.8611-0.9606
3/16-3/31	116	4	2	0.8794	0.8239-0.9350
4/1-4/15	110	5	2	0.8395	0.7766-0.9023
4/16-4/30	103	6	1	0.7906	0.7207-0.8604
5/1-5/15	96	16	0	0.6588	0.5818-0.7358
5/16-5/31	80	1	0	0.6506	0.5663-0.7348
6/1-6/15	79	3	1	0.6259	0.5414-0.7103
6/16-6/30	75	2	3	0.6092	0.5230-0.6954
7/1-7/15	70	2	0	0.5918	0.5032-0.6803
7/16-7/31	68	1	1	0.5831	0.4936-0.6726
8/1-8/15	66	2	1	0.5654	0.4755-0.6553
8/16-8/31	63	0	0	0.5654	0.4734-0.6574
9/1-9/5	63	2	0	0.5474	0.4565-0.6384

mortalities (Table 2.4). Twenty-eight of the 42 deaths (66.7%) occurred during the months of April and May, coinciding with the peak initiation dates for first nesting attempts in 1991 ($\bar{x}$ = 4 May, SE = 2.97 days) and 1992 ($\bar{x}$ = 23 April, SE = 2.31 days).

The mortality rate of hens during the incubation stage of the first nesting attempt was 0.187 (14/75), while the mortality rate of renesting hens (after a failed nesting attempt or loss of brood) was 0.038 (1/26). Renesting hens had a higher probability of survival (Z = 2.71, P = 0.003) than hens attempting their first nests of the year. The mortality rate of nesting hens that selected CRP fields for nesting cover (0.15, n = 20) was not different (Z = 0.598, P > 0.05) than hens that selected rangeland for nesting cover (0.205, n = 44).

My estimate of hen success (46%) and annual hen survival (45%) indicted that 2.72 poults/successfully nesting hen (poult-to-hen ratio of 1.25:1) have to be produced in order to sustain the current population size. However, if annual survival of hens improved to 55%, only 2.17 poults/successfully nesting hen (poult-to-hen ratio of 1.1:1) would be necessary to maintain a stable turkey population. When annual hen survival remains at 45%, but hen success increases to 56%, 2.23 poults need to be produced by each successfully nesting hen (poult-to-hen ratio of 1.25:1). If both hen survival and hen success improve to 0.55 and 0.56, respectively, then 1.78 poults need to be produced by each successful hen (poult-to-hen ratio of 1:1).

Discussion

Juvenile turkey hens in south central Kansas dispersed longer distances than adults. Schmutz and Braun (1989) also found the same results for Rio Grande wild turkey hens in Colorado. They found their results to be consistent with

Table 2.4. Cause-specific mortality rates for radio-marked Rio Grande turkey hens during the reproductive season (15 Mar - 15 Aug) in south central Kansas, 1991 and 1992.

Source of Mortality	N	Estimate	Variance
Mammalian	35	0.3202	0.00199
Poaching	3	0.0270	0.00024
Avian	2	0.0186	0.00017
Unknown	2	0.0180	0.00016

the interfemale aggression hypothesis of delayed yearly breeding suggested by Hannon et al. (1982) for blue grouse (Dendragapus obscurus). However, it is unclear in this study why the age classes exhibited a difference in dispersal distances, since Buford (1993) did not find delayed breeding of juvenile hens. Juvenile hens may have maximized their chance of reproduction by dispersing to their birthplace and away from heavily populated nesting areas that were dominated by adult hens (Murray 1967).

In addition, no evidence of long dispersal distances leading to higher incidence of mortality was found. However, I did discover juveniles dispersing long distances had a higher probability of survival than juveniles dispersing short distances. Murray (1967) mentioned nothing about the impacts of dispersal on survival.

No difference in survival rates was detected between years and ages during the reproductive season. Therefore, these data were pooled to estimate survival during the reproductive period, and the longer 9 January to 5 September period. Both Porter (1977) and Vander Haegen et al. (1988) found that yearling eastern wild turkey females experienced higher mortality than adult females, while Kurzejeski et al. (1987) detected no differences in survival between subadult and adult eastern wild turkey hens. However, their (Kurzejeski et al. 1987) sample of subadult hens was low (n = 8). The lack of difference in survival rates between years for this study was a little surprising, since variation in annual rates among years for other studies was quite high (Vangilder 1992).

Both survival estimates (Heisey-Fuller and Kaplan-Meier) indicated that hen survival was the lowest during the spring (April and May) when the first nesting attempts were most common. Several authors have documented substantial hen mortality during the nesting period (Speake 1980, Vangilder et al. 1987, Vander Haegen et al. 1988). On the west Texas Rolling Plains, Rio Grande turkey hens had a March through August survival rate of 0.52 in 1991 and 0.543 in 1992, and the highest mortality occured in May for both years (Blair, unpubl. data).

The mortality rate of hens attempting a second or third nest was significantly lower than that of hens attempting first nests. No mention of this type of information was found in the existing wild turkey survival and productivity literature. I believe this type of relationship is commonplace for wild turkeys living in the Great Plains region of the U.S. because the summer rains provide a boost to vegetative growth, which in turn provides taller and denser screening cover for later nesting attempts. This increased vegetative screening cover is associated with higher nesting success (Buford 1993), and hence, could lead to a higher probability of survival. Another possible explanation for this phenomenon is that there were fewer nests later in the nesting season, and therefore, predators were not locating nests as efficiently as they were earlier in the season. One can even speculate that renesting hens were "better" survivors than the group of hens that attempted first nests.

Mammalian predators were responsible for 83% of the hen mortalities during the reproductive periods in 1991 and 1992. On the west Texas Rolling Plains, predators were responsible for all mortalities from March through May (Blair, unpubl. data). The 2 major predators on adult Rio Grande turkeys in south Texas were bobcats (<u>Felis rufus</u>) and coyotes (<u>Canis latrans</u>) (Ransom et al. 1987). Predation also accounted for 55% of the hen mortalities of eastern turkeys in Missouri (Kurzejeski 1987). The major predator on my study area was the coyote, with the bobcat a very distant second.

In Texas, wild turkey productivity was higher in areas where predators were controlled than on uncontrolled areas

(Beasom 1974). However, one must remember that wild turkeys coevolved in the constant presence of predators and "quick fix" solutions for increasing turkey numbers such as predator control must be used with caution. Predator control may be warranted in situations where turkeys are being reintroduced to a former range (Ligon 1946); however, it has been found to be ineffective and expensive (MacDonald and Jantzen 1967, Williams et al. 1980) in other situations.

Logan (1970) believed that the most serious predator of the Rio Grande turkey in western Oklahoma was the poacher. Mortality attributed to poaching accounted for 39% of the hen deaths in Missouri, with 42% of those occurring during the spring gobbler season (Kurzejeski 1987). When compared to the results of Kurzejeski (1987), poaching was not a major source of hen mortality during my 2-year study: 3 hens (7%) were killed by poachers. However, all of the poaching incidents occurred during 1991, and I felt that people were more aware of my presence (monitoring of the turkeys, vegetation sampling, etc.) in the area for the second field season, which helped to deter poaching activity in 1992.

The estimated annual survival rate for turkey hens during 1991 and 1992 was 0.449. Annual survival (73%) was relatively high for Rio Grande turkey hens in south Texas (Ransom et al. 1987). Kurzejeski et al. (1987) reported an annual survival rate of 0.435 for eastern wild turkeys in Missouri, with the highest incidence of mortality occurring during the spring. Their data indicated that high density turkey populations could be maintained with this high rate of mortality if hen success averaged 35-40%. Hen success in south central Kansas was 46%, and population size seemed to be relatively stable after observing about the same number of birds at the 1992 winter roost sites that were seen at the 1991 winter roost sites. The lack of difference in survival rates between years also indicated population stability.

By performing some simple population modelling, I found that wild turkey numbers are more easily influenced by changing the annual survival rate than changing the rate of reproduction. By increasing hen success from 46% to 56%, and keeping the annual survival at 45%, 4 more hens (in a fictitious population of 100 birds) are contibuting to poult production (successful hens increased from 45 to 49). However, increasing survival from 45% to 55% not only increased the number of hens available for nesting (increased from 88 to 91), which produced a greater number of successful hens (increased from 40 to 42), but also decreased the number of hens that need to be replaced because of mortality (reduced from 55 to 45).

Management Implications

My calculations indicated that an increase in hen survival was more productive than an increase in hen success. However, it would be most effective to focus management efforts on production of proper nesting cover in south central Kansas, which would increase productivity (Buford 1993) and may increase survival. Survival probabilities were lowest during the spring when the first nesting attempts were most common, and higher for renesting hens later in the reproductive season after the influence of spring and early summer rains on the vegetative communities. Therefore, managing for higher levels of grass and total herbaceous cover for first nesting attempts not only increases nest success (Buford 1993), but may also increase chance of hen survival.

Predation was the major source of hen mortality in south central Kansas. Predator control would probably be an expensive and ineffective method of increasing wild turkey numbers. It may only be warranted in situations where turkeys are reintroduced to their former range, and need protection until a viable population is established.

Concerns about long dispersal distances leading to increased mortality need not be expressed in management plans for the wild turkey in south central Kansas, since dispersal did not have a negative impact on survival. The increased survival of long-dispersing juveniles over short-dispersing juveniles even suggests that these individuals had something to gain by their long distance movement. Dispersal distances of juvenile hens may be valuable to managers, who could use this information to more accurately identify management unit boundaries.

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CHAPTER III
HABITAT USE BY RIO GRANDE WILD TURKEY HENS DURING THE REPRODUCTIVE SEASON IN SOUTH CENTRAL KANSAS

Introduction

Habitat selection is variable for wild turkeys, reflecting changes in resource availability (Porter 1977, Zwank et al. 1988), shifts in specific seasonal requirements (Speake et al. 1975, Porter 1992), and selection differences between age classes (Wigley et al. 1985). Juvenile eastern wild turkey (*Meleagris gallopavo silvestris*) hens displayed highly variable habitat selection patterns during the spring and summer seasons in Arkansas, and used all forest types in proportion to their availability (Wigley et al. 1985). On the other hand, adult hens were more consistent in their selection of forest types, preferring natural pine stands (> 40 years old) and avoiding young pine plantations (< 4 years old). The authors offered no explanation for the selection diffences between age classes, but concluded that the variable selection patterns accentuated the need to maintain a diversity of habitats for wild turkeys.

Several researchers have found the selection of nesting habitat to be dependent on the availability of dense herbaceous or woody vegetation (Lazarus and Porter 1985, Wertz and Flake 1988, Schmutz et al. 1989, Buford 1993). Lazarus and Porter (1985) noticed a shift in preference of eastern wild turkey nesting sites from deciduous habitats to open habitats as the spring and summer progressed in southeastern Minnesota. The explanation for the phenomenon was that the deciduous habitat type provided the only source of adequate nesting cover during the early months of nest initiation. As the nesting season progressed, increased availability of dense herbaceous vegetation in the open habitats resulted in the preference of these habitats for renesting.

Understanding the habitat needs of brood-rearing hens is necessary, since the highest turkey mortality occurs during the brood-rearing stage (Porter 1992). Agricultural habitats received little use by Rio Grande turkey (M. g. intermedia) broods in Colorado (Schmutz et al. 1990), and Rio Grande-Merriam's (M. g. merriami) hybrid turkey broods in South Dakota (McCabe and Flake 1985). Several authors have documented the importance of wooded habitats for Rio Grande turkey brood-rearing hens (Logan 1970, Baker 1979, Schmutz et al. 1990).

The purpose of this chapter is to describe and evaluate the Rio Grande wild turkey hen's selection of habitats during the reproductive season in an agricultural landscape. At a coarse level of resolution, habitat use within core use areas is evaluated. At a finer level of resolution, hen selection of nesting and brood-rearing habitats within home ranges is evaluated.

Study Area

The study site encompassed 242,895 ha in Barber, Comanche and Clark Counties in south central Kansas, and Woods and Harper Counties in northern Oklahoma. The site was located in the Central Rolling Red Plains land resource area (Austin 1965) and elevations ranged from 382 m to 673 m. The following climatological information was obtained from soil surveys for Barber and Comanche Counties (U.S. Soil Cons. Serv. 1977 and 1989, respectively). During winter the average temperature is 1.8 °C, with an average daily minimum of -5.2 °C. The average summer temperature is 26.2 °C, with an average daily maximum of 33.9 °C. Annual precipitation averages 60 cm, with 73% occurring April through September.

There are 6 main cover-types on this area: Rangeland (open grassland and shrub areas, usually exposed to grazing), riparian (wooded areas along streams), cropland (planted crops), Conservation Reserve Program lands (CRP; grasslands established (1987 and 1988) in areas that were classified as highly erodible croplands), treerow (windbreaks planted to limit soil erosion), and urban (residential and business areas). Approximately two-thirds of the study area is rangeland and riparian, and one-third is cropland. Farming and livestock production are the main uses of these cover-types. Most cropland is planted with winter wheat (55%), with grain sorghum, corn, alfalfa, oats and soybeans making up the remaining 45%. Most livestock production is cow-calf or feeder-stocker management.

The climax vegetation for this region is tallgrass prairie. Rangeland plant communities were characterized by 75 percent climax vegetation and were dominated by big bluestem (*Andropogon gerardi*), little bluestem (*Andropogon scoparius*), switchgrass (*Panicum virgatum*), sideoats grama (*Bouteloua curtipendula*), sand sagebrush (*Artemisia filifolia*) eastern redcedar (*Juniperus virginiana*), and sandhill plum (*Prunus angustifolia*). Riparian areas contained eastern cottonwood (*Populus deltoides*), american elm (*Ulmus americana*), hackberry (*Celtis occidentalis*), and sandhill plum. CRP fields were planted primarily in 1987 and 1988 with 5 main species of grasses: Big bluestem, little bluestem, switchgrass, sideoats grama, and Indiangrass (*Sorghastrum nutans*). Treerows were planted mainly with siberian elm (*Ulmus pumila*), catalpa (*Catalpa speciosa*), and eastern redcedar.

Methods

Capture

Drop nets and rocket nets were used to capture 130 turkey hens (86 juveniles and 44 adults) at 4 baited sites

(Bell, Haas, Dunn, and Woolfolk) in south central Kansas from January through March, 1991 and 1992. Captured hens were sexed, aged, weighed, and fitted with aluminum leg bands and radio-transmitters. Each transmitter was lithium-powered, operated on the 150-152 MHz band, weighed approximately 105 g, and had a lifespan of 24 months. They were attached to the hens in a backpack fashion (Kurzejeski et al. 1987) and were fastened by a nylon-coated rubber harness looped under each wing (Kenward 1987; 104). The hens were released at the capture site.

Radio-Tracking

Radio-tracking was conducted from 15 March to 15 August (reproductive season) during 1991 and 1992. Hens were located by visual observation or triangulation from 2 mobile receiving towers (Pollock et al. 1990) with dual antenna arrays. Universal Transverse Mercator (UTM) coordinates (Lancia 1974) of receiving stations were estimated from U.S.G.S. 7.5 minute quadrangle maps. Beacons (transmitters placed at known UTM coordinates) were used to orient the mobile receiving towers to true north prior to taking a bearing. Accuracy (Lee et al. 1985) of the mobile towers was estimated for Barber (SD = 2.92°) and Comanche (SD = 2.72°) Counties.

The reproductive season was divided into 2 intervals (15 March to 31 May and 1 June to 15 August), and each day was partitioned into 3 tracking periods (sunrise to 4 hours after sunrise, 4 hours after sunrise to 4 hours before sunset, and 4 hours before sunset to sunset). Home ranges and core areas were only calculated for hens with ≥ 30 acceptable location estimates in the reproductive season. Location estimates were acceptable if error polygons were ≤ 2% of the hen's minimum convex polygon (MCP) home range (Mohr 1947) and the angle of bearing intersection was within the range 45° to 135°. Each bearing intersection was converted to UTM coordinates, and error polygons were evaluated using the program CHAP (Whittaker et al. 1990). Visual observations were plotted on U.S.G.S. 7.5 minute quadrangle maps and their respective UTM coordinates were recorded. Individuals were censored from the home range and core area selection analyses if loss or failure of a transmitter occurred.

Home Range Size

Home range sizes for the reproductive season were estimated with the MCP method using the computer program TELEM88 (Coleman and Jones 1988). The main advantages of using the MCP method are its simplicity and its high degree of use, which make home range size comparisons with previous work possible. I used a completely random experimental design with age and year as fixed treatment effects to investigate their relationships to home range size. The home range size data was non-normal; therefore, a Kruskal-Wallis test (Steel and Torrie 1980) was utilized (SAS Inst. Inc. 1985).

Cover-type Availability

Availabilities of 5 land cover-types (rangeland, cropland, CRP, riparian, and treerow) were estimated for each trap site (_n_ = 4) from maps created on a Geographic Information System (GIS) (Appendix A). A trapsite was delimited by a MCP home range utilizing all the reproductive season locations of instrumented hens at that site. A contingency table based on cover-type availabilities was used to determine that the Dunn and Bell trapsites could be combined (EAST site) and the Woolfolk and Haas trapsites could be combined (WEST site), where appropriate, for use-availability analysis of nest sites and core use areas.

Core Area Selection

I investigated second-order selection (Johnson 1980) by comparing cover-type use within 50% and 85% harmonic mean home range contours (Dixon and Chapman 1980) to the cover-type availabilities in their respective trap sites (Bidwell et al. 1989, Gratson et al. 1990). Harmonic mean home ranges were generated based on the 50% and 85% contours of area using a 20 x 20 grid size (TELEM88; Coleman and Jones 1988). No standard criteria were found for selecting the number of grid divisions; TELEM88 offers the range of 5 to 30 divisions. Proportions of cover-types within the home range contours were determined using the GIS software package PC ARC/INFO (Environmental Systems Research Institute, Inc. 1990).

Bonferroni 95% family confidence intervals (Neu et al. 1974, Byers et al. 1984) were used to determine if cover-types were used in proportion to their availability, in a lesser proportion to their availability (selected against), or in a greater proportion to their availability (selected for) (Gratson et al. 1990). Each hen was given equal weighting for analyses, regardless of home range size and number of locations contributed. The Bell trapsite offered the only opportunity to compare cover-type selection between age classes and years, since this was the only trapsite to have both age classes and years represented. If selection of cover-types at Bell's was similar for age classes, or years, then I made the assumption that these relationships existed at the other sites, as well. For example, if adult selection was similar in 1991 and 1992 at Bell's, years would be pooled for adults at the other sites.

Nest Habitat Selection

I investigated nest habitat selection by comparing nest site cover-type use to availability of cover-types (Wertz and Flake 1988) on the EAST and WEST sites. Individual animals were not identified for this investigation, therefore, use and availability were measured at the population level (Design 1 study; Thomas and Taylor 1990). The G-test goodness-of-fit (Sokal and Rohlf 1981) and the Williams (1976) correction were used to test the hypothesis that nesting attempts were located in habitats completely at random (i.e., no selection occurring). Bonferroni 95% confidence intervals were utilized to determine selection of cover-types. Nests were divided into 3 groups for analysis: first nesting attempts at the EAST and WEST sites and renesting attempts at the EAST site. A small sample size (n=9) prohibited the use-availability analysis of renesting attempts at the WEST site.

Brood Habitat Selection

During 1992, brood habitat selection was investigated at the Dunn and Woolfolk trapsites. A brood-rearing hen was defined as an instrumented hen that successfully nested and had poults, or an instrumented hen that joined another that had poults (commingled brood). An attempt was made to locate broods 5 times weekly from hatching to 8 weeks of age. Locations were obtained by semi-circling broods (Schmutz et al. 1990), or by triangulation from 2 mobile receiving units. A maximum allowable error polygon of 2.5 ha was applied to each animal location derived from triangulation.

Brood cover-type selection was determined by comparing brood-rearing hen locations to the availability of cover-types on the Dunn and Woolfolk trapsites. Individual hen use of cover-types was not analyzed; use and availability were measured at the population level (Design 1 study; Thomas and Taylor 1990). The G-test of goodness-of-fit and the Williams correction were used to test the hypothesis that brood-rearing hens used cover-types completely at random. Bonferroni 95% confidence intervals were utilized to determine selection of cover-types.

Results

Home Range Size

The number of hens contributing a home range to the analysis was affected by the high mortality rate during the reproductive season (38%), as well as, the failure of 9 transmitters during the 1991 field season. Sixteen hens (12 juveniles and 4 adults) contributed home ranges to the analysis in 1991, and 26 hens (12 juveniles and 14 adults) contributed home ranges to the analysis in 1992 (Appendix B). The average number of relocations per home range was 40 (range 33-45). Home range size ($\bar{x}$ = 2,879 ha, SE = 473 ha) did not differ (X^2 = 3.98, P > 0.05, df = 3) between age classes or years. Home range size was correlated (r = 0.781, P < .001, df = 37) with dispersal distance.

Core Area Selection

Adults and juveniles were separated for the core area cover-type selection analyses at the EAST and WEST sites, since cover-type selection differed between age classes (Table 3.1). Adult cover-type selection during 1991 and 1992 was not different, and therefore, years for adults were pooled at the East site. No adults were available at the WEST site during 1991, consequently, only 1992 adults are represented for the analysis of adults at this site. Selection of cover-types by juveniles was different between years, thus, years were separated for juvenile selection analysis at the EAST and WEST sites. Cover-type selection by a single juvenile was documented for the 1992 juvenile analysis at the WEST site.

Table 3.1. Selection of cover-types by Rio Grande turkey hens at the Bell trapsite in south central Kansas, 15 Mar - 15 Aug, 1991 and 1992.

				Cover-types[a]				
Contour	Class	Sample Size	TRL[b]	Riparian	Range	Crop	Treerow	CRP
85%	Adults 91	4	147	-	NS	NS	NS	NS
	Adults 92	6	237	-	+	NS	NS	NS
	Juv. 91	6	230	NS	-	+	NS	NS
	Juv. 92	9	359	NS	NS	NS	NS	+
50%	Adults 91	4	147	NS	+	NS	NS	NS
	Adults 92	6	237	-	+	NS	NS	NS
	Juv. 91	6	230	NS	NS	+	NS	-
	Juv. 92	9	359	NS	NS	-	NS	+

[a]Cover-type use greater than (+) or less than (-) ($\underline{P}$ < 0.05) cover-type availability, using 95% confidence intervals (Neu et al. 1974). NS = difference not significant.

[b]Total radio locations

Adult 85% Core Area Selection

I analyzed EAST adult (n = 14) cover-type selection within the 85% contours and found they selected for rangeland and selected against riparian, cropland, and CRP (Table 3.2). No cover-types were used more than expected by WEST adults; however, adults at the WEST site also used cropland and CRP less than expected. The confidence intervals barely contained the expected values for the rangeland and riparian cover-types at the 0.05 level at the WEST site.

Adult 50% Core Area Selection

I analyzed cover-type selection within 50% core use areas of adults in the EAST (n = 14) and found they selected for rangeland, while selecting against riparian, cropland, and CRP (Table 3.2). Adults at the WEST site (n = 4) also selected against cropland and CRP in their 50% contours. However, the riparian cover-type was used in a greater proportion than its availability.

Juvenile 85% Core Area Selection

Examination of cover-type selection within 85% contours of 1991 juveniles at the EAST site (n = 6) exposed that they selected for cropland and selected against rangeland (Table 3.2). The 1992 juveniles at the EAST site (n = 11) selected for CRP, displaying a change in selection from 1991 to 1992. Both 1991 juveniles (n = 6) and 1992 juveniles (n = 1) at the WEST site used all cover-types in proportion to their availability.

Juvenile 50% Core Area Selection

Inspection of cover-type use within 50% core use areas of 1991 juveniles at the EAST site (n = 6) revealed that they selected for cropland and selected against CRP (Table 3.2). The 1992 juveniles in the EAST (n = 11) selected for

Table 3.2. Selection of cover-types by Rio Grande turkey hens in south central Kansas, 15 Mar - 15 Aug, 1991 and 1992.

				Cover-types[a]				
Contour	Class	Sample Size	TRL[b]	Riparian	Range	Crop	Treerow	CRP
85%	East Adults	14	533	-	+	-	NS	-
	West Adults	4	158	NS	NS	-	NS	-
	East Juv. 91	6	230	NS	-	+	NS	NS
	East Juv. 92	11	443	NS	NS	NS	NS	+
	West Juv. 91	6	259	NS	NS	NS	NS	NS
	West Juv. 92	1	41	NS	NS	NS	NS	NS
50%	East Adults	14	533	-	+	-	NS	-
	West Adults	4	158	+	NS	-	NS	-
	East Juv. 91	6	230	NS	NS	+	NS	-
	East Juv. 92	11	443	NS	NS	-	NS	+
	West Juv. 91	6	259	NS	NS	NS	NS	NS
	West Juv. 92	1	41	NS	NS	NS	NS	NS

[a]Cover-type use greater than (+) or less than (-) ($\underline{P}$ < 0.05) cover-type availability, using 95% confidence intervals (Neu et al. 1974). NS = difference not significant.

[b]Total radio locations

CRP and against cropland in their 50% contours, revealing an opposite shift in juvenile selection of cover-types from 1991 to 1992. Both 1991 juveniles ($\underline{n}$ = 6) and 1992 juveniles ($\underline{n}$ = 1) at the WEST site used cover-types in proportion to their availability.

Nest Habitat Selection

Cover-types were not used in proportion to their availability ($\underline{P}$ < 0.005, $\underline{G}$ = 19.55, df = 3) for first nesting attempts at the WEST site ($\underline{n}$ = 24). Nesting hens selected for the CRP cover-type, and selected against the cropland cover-type (Table 3.3). The rangeland and riparian cover-types were used in proportion to their availability. The G-test was also significant ($\underline{P}$ < 0.005, $\underline{G}$ = 29.03, df = 3) for use of cover-types by hens attempting first nests at the EAST site ($\underline{n}$ = 48). Again, nesting hens selected for CRP (Table 3.3). The remaining cover-types were used in proportion to their availability. Cover-types were used in proportion to their availability ($\underline{P}$ > 0.05, $\underline{G}$ = 6.73, df = 3) for renesting attempts at the EAST site ($\underline{n}$ = 16).

Brood Habitat Selection

Five hens contributed 97 total brood locations (range: 4 to 37) at the Woolfolk trapsite. Fourteen percent of the locations were excluded from analysis due to large error polygon, yielding 83 total locations. Brood-rearing hens did not use cover-types in proportion to their availability ($\underline{P}$ < 0.005, $\underline{G}$ = 108.39, df = 4). Brood-rearing hens selected for wooded habitats (riparian and treerow) and against cropland and CRP (Table 3.4). Rangeland was used in proportion to its availability.

Eight hens contributed a total of 92 brood locations (range: 2 to 40) at the Dunn trapsite. Twenty-three percent of the locations were excluded from the analysis due to large error polygons, producing 71 total locations.

Table 3.3. Simultaneous confidence intervals for utilization of cover-types for first nesting attempts at the WEST ($\underline{n}$ = 24) and EAST ($\underline{n}$ = 48) sites in south central Kansas, 1991 and 1992.

Site	Cover type	Number of nests located	Actual proportion of usage	Expected proportion of usage	Confidence interval
WEST	Riparian	1	0.041	0.06	$0 \leq P \leq 0.142$
	Range	14	0.583	0.528	$0.337 \leq P \leq 0.829$
	Crop[a]	1	0.042	0.329	$0 \leq P \leq 0.142$
	CRP[b]	8	0.333	0.083	$0.098 \leq P \leq 0.569$
EAST	Riparian	2	0.042	0.057	$0 \leq P \leq 0.112$
	Range	30	0.625	0.769	$0.454 \leq P \leq 0.796$
	Crop	4	0.083	0.139	$0 \leq P \leq 0.181$
	CRP[b]	12	0.25	0.035	$0.097 \leq P \leq 0.403$

[a]Used in lesser proportion than its availability ($\underline{P}$ < 0.05).

[b]Used in greater proportion than its availability ($\underline{P}$ < 0.05).

Table 3.4. Simultaneous confidence intervals for utilization of cover-types by brood-rearing hens at the Woolfolk ($\underline{n}$ = 83) and Dunn ($\underline{n}$ = 71) trapsites in south central Kansas, 1992.

Site	Cover type	Number of locations	Actual proportion of usage	Expected proportion of usage	Confidence interval
Woolfolk	Riparian[a]	32	0.386	0.109	$0.25 \leq P \leq 0.521$
	Range	27	0.325	0.406	$0.195 \leq P \leq 0.455$
	Crop[b]	13	0.157	0.425	$0.056 \leq \underline{P} \leq 0.258$
	CRP[b]	1	0.012	0.055	$0 \leq P \leq 0.042$
	Treerow[a]	10	0.121	0.005	$0.03 \leq P \leq 0.211$
Dunn	Riparian	2	0.029	0.028	$0 \leq P \leq 0.079$
	Range	57	0.803	0.822	$0.683 \leq P \leq 0.922$
	Crop	0	0	0.091	NA
	CRP	3	0.127	0.058	$0.027 \leq P \leq 0.227$
	Treerow	9	0.042	0.001	$0 \leq P \leq 0.103$

[a]Used in greater proportion than its availability ($\underline{P}$ < 0.05).

[b]Used in lesser proportion than its availability ($\underline{P}$ < 0.05).

Cover-types were not used in proportion to their availability ($P < 0.005$, $G = 38.42$, df = 4) by brood-rearing hens at the Dunn trapsite. However, the simultaneous confidence intervals revealed that all cover-types were used in proportion to their availability (Table 3.4), which was probably due to the conservative nature of the Bonferroni z-statistic (Alldredge and Ratti 1986).

Discussion

Home Range Size

Home range size information on the Rio Grande turkey hens is very limited, in comparison to the eastern subspecies. The reproductive season home range size ($\bar{x}$ = 2,879 ha) in south central Kansas was very large in comparison to eastern wild turkey annual home ranges for several studies (Brown 1980). However, my results were very similar to the March through August MCP home range size (n = 22, $\bar{x}$ = 3,012 ha) for Rio Grande turkey hens on the west Texas Rolling Plains (Blair, unpubl. data), despite the difference in vegetation communities.

Reproductive season home ranges were typified by a breeding range that was joined to a summer range by a dispersal movement. Korschgen (1967) stated that wild turkey home range size was governed by available food supplies. I believe food supply, as it relates to nutritive requirements for specific reproductive season activities, dictated some movements in this study. The large home range sizes may have been necessary in south central Kansas to meet the constantly changing habitat needs (breeding, nesting, roosting, and brood-rearing) of the hens during the reproductive period. Dispersal distance was another factor that played a key role in determining home range size.

Core Area Selection

The proportions of cover-types within the 50% core use areas were very similar to cover-type proportions in the 85% contours for both age groups. The lack of difference between the 50% and 85% contours indicates that selection of harmonic mean contour may not be critical for defining area of use during the reproductive season, at least in the 50% to 85% range. Although selection was similar in the 50% and 85% core use areas, selection of cover-types did change for very specialized activities during the reproductive season, such as nesting and brood-rearing.

Adult hens, regardless of capture year or site, displayed similar cover-type selection patterns in core use areas. Both EAST and WEST adults selected against cropland and CRP in their 50% and 85% core areas. Sixty-six percent of the cropland in south central Kansas was wheat that was usually harvested in June, then disked and fallowed until the next wheat planting (Smith 1993). Twenty-four percent of the cropland was fallowed for the entire year. Therefore, only an estimated 10% of the available cropland was actually planted in crop (grain sorghum, corn, alfalfa, and soybeans) during the last 2 months of the reproductive season; this may explain the low use of the cropland cover-type.

The majority of the CRP fields in south central Kansas were only 3 or 4 years old during our research. The Soil Conservation Service (SCS) recommends that CRP fields be burned or mowed four years after establishment; these treatments remove large amounts of dense, standing dead plant material. Most CRP fields on the study area had not received their 4-year treatment yet, or they were treated for the first time in 1992. Therefore, CRP fields had very dense growth in 1991 and 1992, before treatments were initiated. While this type of cover seemed favorable for nesting (presented in the forthcoming section), I believe that the dense growth of tall grasses not only hindered visibility of loafing and feeding turkeys, but also restricted their movements. Feeding in grassland habitats that have dense and rank growth may cost more in energy expenditure than can be compensated by food intake.

EAST adults selected for rangeland in their 50% and 85% core areas. Although rangeland was not used more than expected by WEST adults (85% contours), the confidence intervals just contained (within 0.005) the rangeland expected value at the 0.05 level. The use of rangeland in proportion to its availability for nesting and brood-rearing activities does not indicate unimportance. The selection for rangeland in the core areas of adults demonstrates that it may have provided the best overall combination of resources for daily reproductive season activities. Although hens did not select for rangeland for the specialized nesting and brood-rearing activities, I observed a myriad of turkey activities in the rangeland cover-type: feeding, loafing, dusting, roosting, as well as, nesting and brood-rearing.

A more specific explanation for the disproportionate use of rangeland deals with the nutritive requirements of hens during the reproductive season. In order to meet nutritive requirements for egg laying, turkey hen protein intake levels are increased by greater consumption of insects (Hurst 1992). Insects may exist at higher densities in rangeland than CRP, since rangeland areas are subject to disturbances, which have been shown to promote the production of plant (Porter 1992), and subsequently, insect (Hurst 1978) food resources.

Juvenile cover-type selection not only differed by site, but also by year. The earliest nesting attempt was on 1 April, and the latest attempt was on 11 July; therefore, juveniles may differ in age by as much as 102 days. The variation in juvenile core area selection patterns may reflect the variation in juvenile ages and their different levels of reproductive readiness. Age is one of the factors that may stimulate or delay breeding activity in wild turkeys (Blankenship 1992).

The variation in selection by juveniles may also indicate that juveniles were constant explorers of their range until they learned the most efficient manner of meeting their reproductive season requirements. On the other hand, adults, possibly through learned behavior and experience, were more consistent in their selection of cover-types. Both learning and memory have roles in wild turkeys' efficient use of habitat (Healy 1992).

Nest Habitat Selection

Several wild turkey investigators have identified dense herbaceous cover as an important component at nesting sites (Wertz and Flake 1988, Ransom et al. 1987, Schmutz et al. 1989, Buford 1993). Grassland nests in South Dakota were found in areas that had moderately dense understory cover (< 0.9 m in height) and were located in ungrazed tall grass prairie or small patches of shrubs. In northeast Colorado, Schmutz et al. (1989) found Rio Grande wild turkey nests in microhabitats that provided denser and taller vegetation than surrounding environments. In south central Kansas, the CRP cover-type, with its abundance of warm-season, perennial grasses from the previous growing season, as well as, lack of grazing pressure, affords the best opportunity for hens to obtain proper nest concealment for first attempts.

Schmutz et al. (1989) found that the relative cover value of western snowberry (Symphoricarpos occidentalis) early in the nesting season was much greater than that provided by the surrounding herbaceous vegetation, and thus, most nesting attempts (24 of 35) were found in the snowberry. However, as the nesting season progressed, they found a greater proportion of nests in herbaceous cover and attributed this shift in nesting habitat use to an increase in the cover value (approaching that of snowberry) of the forbs and grasses.

Similarly, the lack of preference for the CRP cover-type by renesting hens at the EAST site directed attention to the shift in cover-type use observed during the nesting season (Table 3.5). The CRP cover-type was used less frequently for renesting attempts than it was used for first nesting attempts. I also witnessed an increase in the use of rangeland from first nesting attempts to renesting attempts. Turkey hens relied more heavily on forb growth for concealment of nests in the rangeland cover-type, as opposed to the dense growth of perennial grasses at nest sites in CRP fields (Buford 1993). I believe that the availability of suitable herbaceous nesting cover in rangeland increased as the nesting season progressed, in response to spring and early summer precipitation. This shift in cover-type use could indicate that given the choice, hens would rather nest in rangeland for all attempts, *if* sufficient herbaceous cover was present during the entire nesting season.

Brood Habitat Selection

In western Oklahoma, Logan (1970) found that loafing sites for broods were located in habitat types that provided overhead concealment and good visibility. He listed plum thickets, cottonwood groves, and chinaberry (*Sapindus drummondii*) as examples of typical loafing areas. Turkey broods in Oklahoma typically fed until midmorning in rangeland hillsides and fields, loafed in wooded habitats until late afternoon, and resumed feeding before moving to roost in the evening. Personal, qualitative observations suggested that brood-rearing hens in Kansas displayed similar daily activity patterns. Wooded areas have been

Table 3.5. Use of cover-types by nesting Rio Grande turkey hens in south central Kansas, 1991 and 1992.

Site	Cover-type	Use (proportions)	
		1st nests	Renesting
WEST	Riparian	0.042	0
	Rangeland	0.583	0.667
	Cropland	0.042	0.111
	CRP	0.333	0.222
EAST	Riparian	0.042	0
	Rangeland	0.625	0.938
	Cropland	0.083	0
	CRP	0.25	0.063

found to be important brood-rearing habitats for several reasons. First, wooded areas may provide overhead concealment from avian predators of the prairie (Schmutz et al. 1990). Second, wooded areas provide excellent escape cover, once poults can fly (Porter 1992). On several occasions, I approached a brood too closely only to witness poults flushing from a rangeland-riparian ecotone into trees of the riparian cover-type. Third, poults may need the shade of wooded habitats to maintain their thermoneutrality (Schmutz et al. 1990, Porter 1992). Little use of open agricultural habitats was documented for broods during the afternoon period in northeast Colorado and was attributed to the high afternoon temperatures during the summer (Schmutz et al. 1990).

The low use of cropland and CRP cover-types by broods in this study was very comparable to the findings of McCabe and Flake (1985) and Schmutz et al. (1990). The avoidance of the CRP fields at the Woolfolk trapsite was not surprising, since poult movements were likely restricted by the dense vegetative growth (Porter 1992) associated with this cover-type. Again, up to 90% of the available cropland was actually fallow during most of the 1992 brood-rearing season (18 May to 13 September), which may explain the low use of the cropland cover-type in proportion to its availability. I would also expect the abundance of herbaceous plant matter and insects (keys to the growth of young poults) to be much higher in the rangeland, riparian, treerow, and CRP cover-types, than in fallow fields.

Management Implications

This chapter offers evidence that habitat selection by wild turkeys in south central Kansas was dependent on age class and specific activity of hens during the reproductive season. Adult hens selected for rangeland and against cropland and CRP in their core areas. The large proportions of rangeland in the core areas may have provided the best overall combination of resources for supporting diverse reproductive season activities. Juvenile habitat core area selection was highly variable.

Conservation Reserve Program fields provided a dependable source of residual vegetative cover for first nesting attempts. They not only received a high degree of use, but provided the highest nesting success of any available cover-type (Buford 1993). The importance of CRP as a source of nesting cover stems from the fact that rangeland is susceptible to overgrazing because of varying seasonal and annual rainfall patterns. Conservation Reserve Program land is exposed to the same rainfall patterns, but not exposed to the additional grazing pressure. Therefore, a more consistent availability of herbaceous cover is provided in the CRP fields. When treatments need to be conducted, I recommend mowing or burning CRP fields as the warm season grasses break dormancy in the spring, but before the onset of nesting in April. My data demonstrates that treatment of CRP fields later in April or May would result in the unnecessary loss of nesting attempts. If the availability of early season nesting cover is of interest, efforts should be made to extend CRP contracts before these lands revert to crop production.

Use of rangeland increased for renesting attempts, whereas CRP use declined. This shift in nest cover-type use indicated that hens may have actually selected for the rangeland cover-type for nesting, if it could have provided sufficient herbaceous cover during the early part of the nesting season. Grazing systems and stocking rates that provide more standing herbaceous cover for first nesting attempts in rangelands should be encouraged. Management plans for increasing herbaceous cover in rangelands offers the <u>most</u> potential for improving wild turkey nesting habitat because of the availability (67% of study area) of the rangeland cover-type.

Brood-rearing hens spent more time in wooded cover-types than expected. Although the riparian and treerow cover-types made up a very small proportion of the study area (6%), they may have provided the only suitable loafing cover for broods. Riparian and treerow habitats should be maintained for brood-rearing hens. Land use activities that destroy riparian areas should be discouraged if availability of wild turkey brood habitat is a concern of the land owners or conservation agencies.

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CHAPTER IV
CONCLUSIONS

Wildlife biologists often set goals of maintaining wild turkey populations at their highest possible levels. This can be accomplished by focusing management efforts on improving survival or productivity. Hen survival was lowest during April and May (peak months for initiation of first nests) and was higher for renesting hens (later in the reproductive season). The higher survival rate for renesting hens was attributed to the increase in the availability of herbaceous vegetation in response to spring and early summer rainfall. Management for higher levels of herbaceous nesting cover for first nesting attempts would not only increase nesting success, but could also improve survival during April and May.

The reproductive season survival rate was 0.621, with the survival rate being lowest during the 1 April through 31 May period. Poaching was not a major source of hen mortality in south central Kansas. Mammalian predators, mainly coyotes, were responsible for 83% of the hen mortality. The extrapolated annual survival rate of 0.449 and the estimate of hen success (46%) indicated that turkey populations on the study area were sustaining themselves if 2.75 poults were reared to 8 weeks by each successfully nesting hen.

I presented evidence that habitat selection changed depending on the resolution of the analyses. Adult hens consistently selected against cropland and CRP fields in their 50% and 85% core use areas. EAST adults selected for rangeland in their 50% and 85% core use areas. The selection for rangeland in the core areas of adults demonstrates that it may have provided the best overall combination of resources for daily reproductive season activities, while CRP and cropland were used for very specialized purposes.

The CRP cover-type offered the best opportunity for hens to obtain proper nest concealment for first nesting attempts because of its lack of grazing pressure, and hence, abundance of perennial grasses from the previous year's growth. The rangeland cover-type received more use than CRP for renesting attempts. This shift in use was attributed to an increase in herbaceous growth in rangeland in response to spring and summer rainfall.

Broods at the Woolfolk trapsite selected for riparian and treerow cover-types and against cropland and CRP fields. Low use of cropland and CRP cover-types was not surprising, since poult movements were likely restricted in the CRP fields, and most of the cropland was fallow during the summer months. Wooded areas may have provided shade, overhead concealment and escape cover that were not provided by the other cover-types.

My results support the concept that it may be more suitable to study only the adult segment of wild turkey populations when habitat selection is being assessed. Adult hens were more consistent than juveniles in their selection of cover-types, which may have been due to experience. Adult habitat selection could indicate the optimal combination of habitats for sustaining the existence of the Rio Grande subspecies in south central Kansas. By pooling adults and juveniles for habitat selection analyses, I found that all cover-types were used in proportion to their availabilities. Pooling age classes that differ in their habitat selection strategies increases variation and leads to erroneous conclusions. Certainly, these results offer evidence that juveniles should not be classified as adults for their first reproductive season.

Although juveniles dispersed long distances and displayed variable habitat selection, their chance of survival was no different than that of adults. Furthermore, survival did not differ between hens attempting first nests in rangeland and hens attempting first nests in CRP. Therefore, there was little or no risk in long movements, variable habitat selection, and cover-type selection for nesting. These findings support the long-held belief that wild turkeys have evolved as habitat generalists, omnivores exploiting available resources in virtually every habitat they occupy.

APPENDIX A

MAPPING RIO GRANDE WILD TURKEY HABITAT IN SOUTH CENTRAL KANSAS USING A GEOGRAPHIC INFORMATION SYSTEM

MAPPING RIO GRANDE WILD TURKEY HABITAT IN SOUTH CENTRAL KANSAS USING A GEOGRAPHIC INFORMATION SYSTEM

Introduction

Wildlife habitats provide the necessary components for a species' existence. Habitat classification involves the organization of these components or similar land elements into homogeneous groups based on their value as food, cover, or space (Best 1982). Many characteristics of wildlife habitat, such as vegetation types, water sources, elevations, and man's use of the land, can be interpreted from remotely-sensed data.

Aerial photography has been a popular source of imagery for identifying and delineating habitats of the wild turkey (Porter et al. 1980, Zwank et al. 1988, and Vander Haegen et al. 1989). Although satellite imagery has recently become readily available and more affordable, medium scale aerial photography is very affordable, offers higher spatial resolution than most satellite systems can produce, and produces an image that can be interpreted by someone not skilled in computer science and multispectral imaging systems. The Bureau of Land Management, with its land evaluation and management responsibilities, found that medium scale aerial photography was worth the additional interpretation costs because it offered greater precision and accuracy when rangeland vegetation was mapped (U.S. Department of the Interior, Bureau of Land Management, 1984).

The use of Geographic Information Systems (GIS) has increased since the 1980's to become one of the most commonly used mapping tools for geographically-referenced data (Environmental Systems Research Institute, Inc. 1990). GIS allows researchers to link attribute information (i.e., stream order, habitat type, age of timber stand, etc.) with map topology. A GIS can be seen as a base map with several registered overlays (i.e., vegetation types, streams, streets, etc.). These overlays can be combined to create a data base upon which animal locations and ranges can be plotted. Then, map layers can be created that represent the resulting relationships, which can help researchers to determine the suitability of habitats for a species, calculate biomass, and so on.

The goal of this aspect of my study was to identify and delineate 5 cover-types (level I, cover-type classification system: Anderson et al. 1976) in south central Kansas and to create a GIS documenting their locations and attributes. This data base was used to better understand how wild turkey hens use the available habitats in this region. I did this by plotting animal locations and ranges to estimate the use of each available cover-type.

Methods

Approximately 160 black and white, 1:40,000 scale aerial photos from 1979 and 1980 were used to identify 5 land cover-types: rangeland, cropland, treerow, riparian, and Conservation Reserve Program (CRP) land. Transparencies documenting rangeland and cropland were created from the photos by delineating those cover-types with the aid of a fine-tipped marker and a stereoscope. These transparencies were placed on a Kargl projection device and cover-types were projected onto 31-7.5 minute U.S.G.S. quadrangle maps, where they were recorded.

Maps of CRP fields were obtained from various S.C.S. field offices in Kansas and Oklahoma. I used the CRP maps to delineate the CRP cover-type on the quadrangle maps. Many of the areas previously classified as cropland were replaced by the CRP fields, since the photos were taken prior to the enactment of the CRP. Streams were depicted on the quadrangle maps as linear features and were represented by solid and dashed blue lines. Treerows were also shown on quadrangle maps as linear symbols shaded with green.

The PC ARC/INFO software package (Environmental Systems Research Institute, Inc. 1990) was utilized in this study to create map overlays or coverages. ARC/INFO uses a vector or polygon position indexing system that more accurately defines boundaries and requires less hard drive space than does a raster or grid-coding structure. ARC/INFO builds topology from data input, whereby arcs are formed by connecting nodes, and polygons are formed by connecting arcs (Figure A.1). Overlays or coverages are made up of points, arcs, polygons, or a combination of all 3 features (Figure A.2).

A digitizing table was utilized to transfer the rangeland, cropland, and CRP fields from the quadrangle maps to a polygon coverage. Each polygon was assigned a unique ID number and respective cover-type in the polygon attribute table of the coverage. The polygon attribute table links attribute information, such as cover-type, to the map topology.

Treerows were digitized as arcs (lines) from the quadrangle maps to their own arc coverage in PC ARC/INFO. Lines or arcs contain no area like polygons, therefore, the arcs were assigned an average width so that an estimate of availability would be possible. A representative sample of treerow widths were measured in the field and averaged; A width of 36 meters was assigned to the arcs in the treerow coverage using a buffer command in PC ARC/INFO. Therefore, the resulting coverage was a polygon overlay, instead of the original arc coverage.

Streams were also digitized as arcs from the quadrangle maps and were recorded in their own stream arc coverage. The average width of each stream order (Strahler 1952) was estimated by taking field and photo measurements from a representative sample of stream orders found on the study

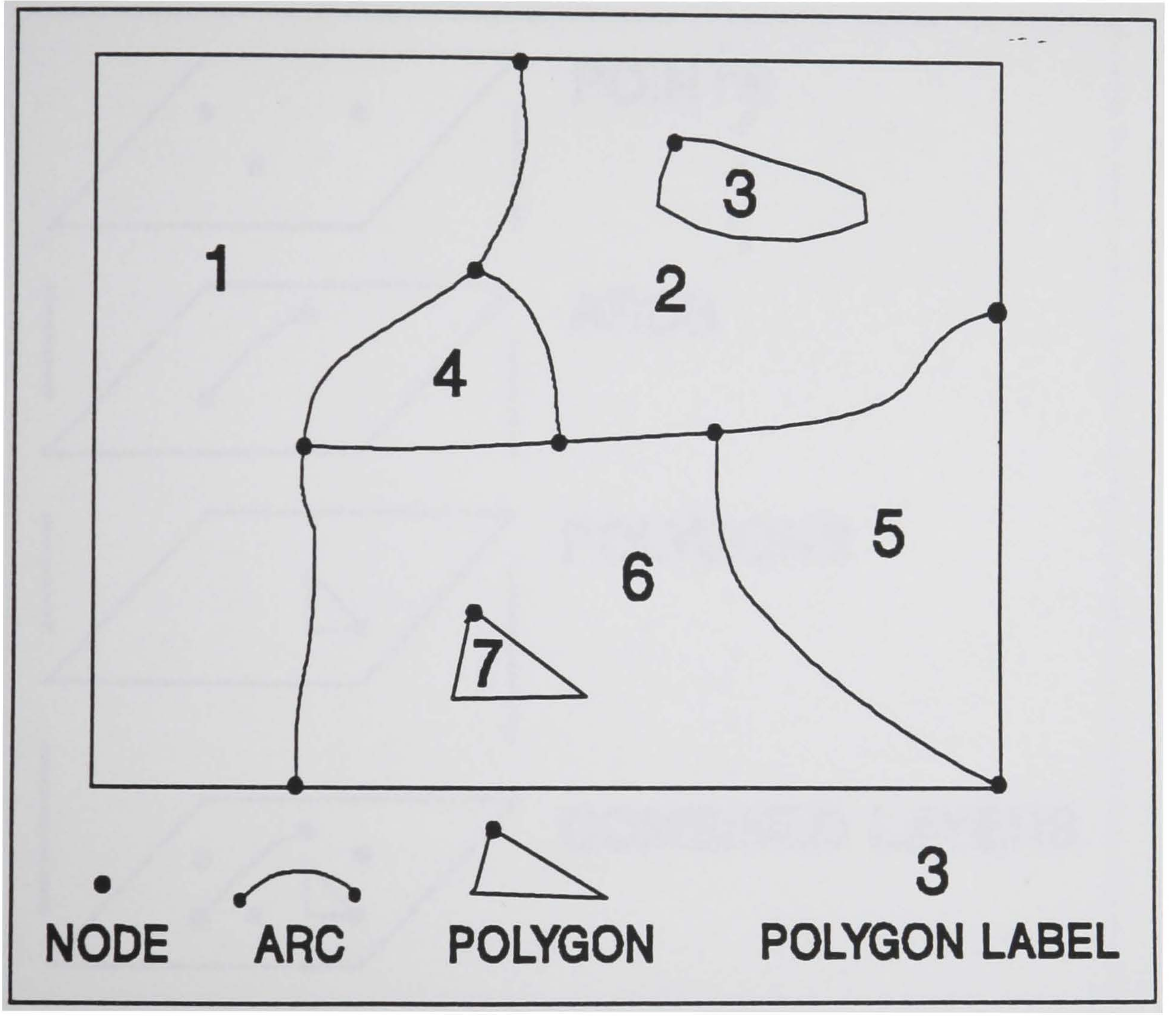

Figure A.1: Topological elements in a GIS coverage.

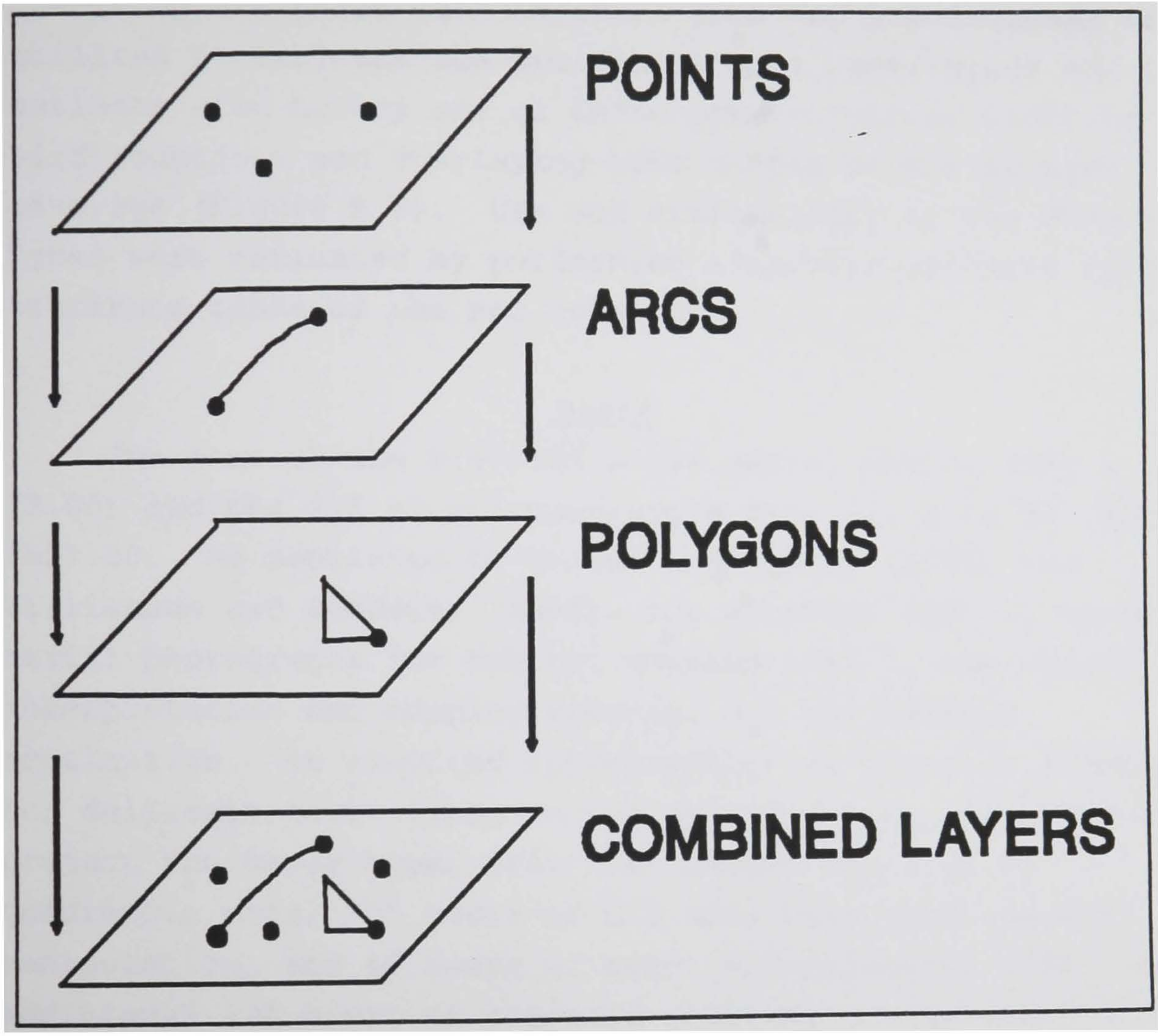

Figure A.2: Overlays or coverages in a GIS.

area. The following widths were assigned to each stream order utilizing the buffer command: 1st: 8.6m; 2nd: 13.4m; 3rd: 19.2m; 4th: 35.1m; 5th: 169.1m; Medicine River: 390.2m; Cimarron River: 945.8m; Arkansas River in Barber County: 733.5m. The resulting coverage was a polygon overlay depicting riparian zone vegetation.

A single polygon cover-type map was created by combining all three data layers. This new map coverage was utilized to estimate the availability of cover-types and to estimate wild turkey use of those cover-types by plotting bird locations and overlaying home ranges on the polygon coverage (Figure A.3). Use and availability of the cover-types were estimated by performing a tabular analysis on the attribute table of the new coverage.

Costs

The cost of the 1:40,000 scale aerial photos (160 x $3.00) and the 7.5 minute quadrangle maps (31 x $2.50) was $557.50. As mentioned in Miller and Conroy (1990) and Williamson and Lindauer (1988), the greatest cost in using aerial photography for habitat mapping lies in the manual interpretation and mapping process, not the imagery acquisition. It required approximately 80 hours to identify and delineate cover-types on the aerial photos, 35 hours to project the cover-types from transparent overlays to quadrangle maps, 305 hours of GIS data base creation and manipulation, and 40 hours of other miscellaneous work. An additional 120 hours of computer processing time was required to perform clipping routines to obtain the individual use of cover-types by turkey hens. Macros were written to run these clipping operations with minimal operator intervention, therefore, these hours did not contribute to the following cost estimate. At $10.00/hour, the total cost of map creation would be $5,157.50. Much of

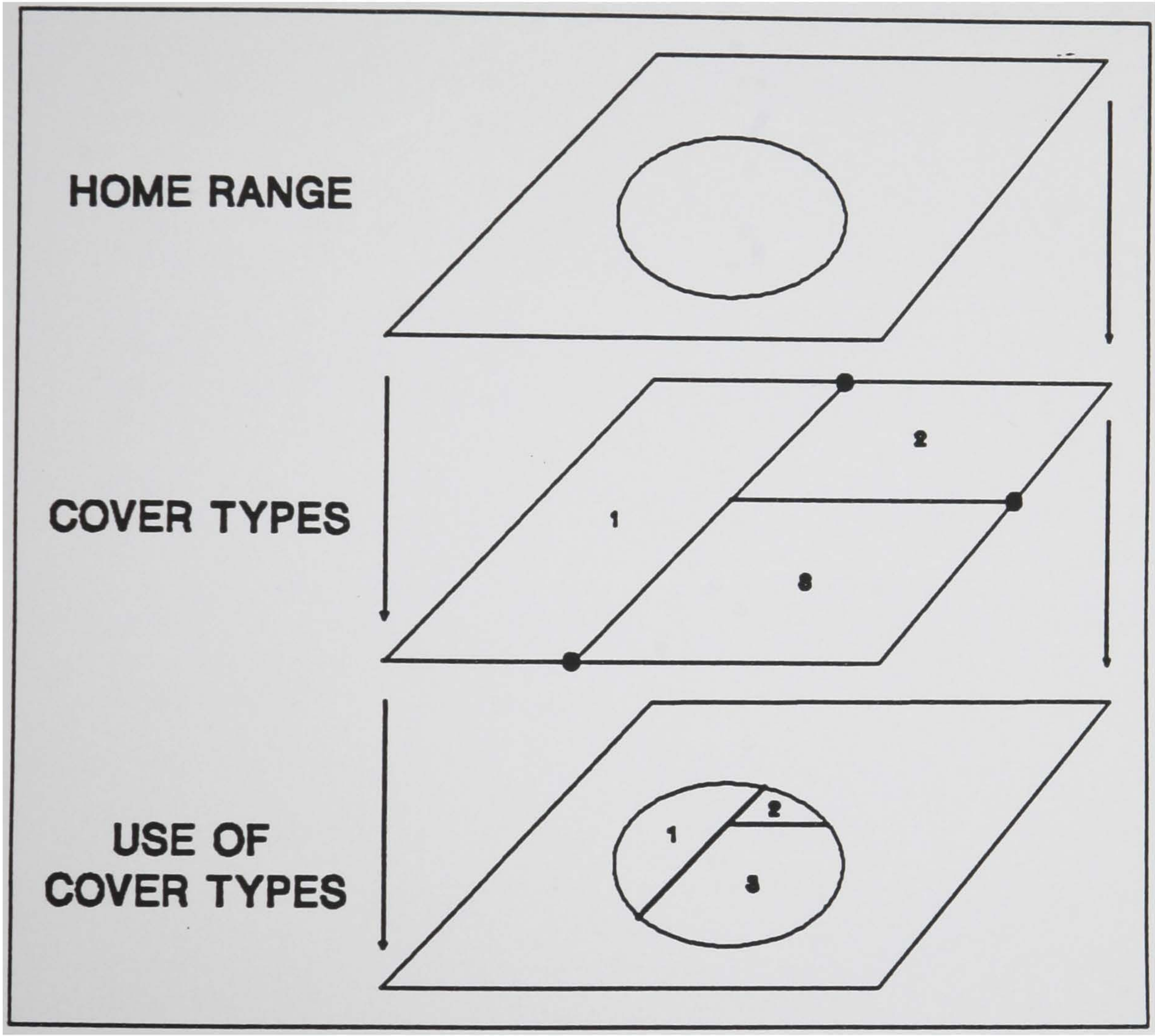

Figure A.3: The cover type coverage is clipped by the home range overlay to produce a cover type use map.

the estimated labor costs involved learning the PC ARC/INFO package and the GIS process. If the operator had experience with a GIS software package, the labor costs would be reduced.

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APPENDIX B

INDIVIDUAL MINIMUM CONVEX POLYGON HOME RANGES

Table B.1. Minimum convex polygon home ranges for wild turkey hens in south central Kansas, 15 March-15 August, 1991 and 1992.

ID #	Year	Trapsite	Age	Home range size (ha)
550	91	Haas	J	7,277
554	91	Haas	J	674
557	91	Haas	J	373
560	91	Haas	J	12,585
591	91	Haas	J	9,322
593	91	Haas	J	862
600	91	Bell	J	2,998
601	91	Bell	A	1,706
605	91	Bell	A	3,449
611	91	Bell	J	1,494
612	91	Bell	J	5,632
618	91	Bell	A	1,035
620	91	Bell	A	3,374
629	91	Bell	J	733
630	91	Bell	J	1,523
636	91	Bell	J	5,531
567	92	Woolfolk	A	1,815
576	92	Woolfolk	A	1,015
579	92	Woolfolk	A	2,722
584	92	Woolfolk	J	1,699
598	92	Woolfolk	A	463
546	92	Dunn	A	1,432
561	92	Dunn	J	4,019
578	92	Dunn	A	194
582	92	Dunn	A	579
587	92	Dunn	A	246
590	92	Dunn	J	3,776

Table B.1. Continued

ID #	Year	Trapsite	Age	Home range size(ha)
032	92	Bell	A	1,836
603	92	Bell	A	2,628
609	92	Bell	J	6,373
613	92	Bell	A	2,158
614	92	Bell	J	2,194
616	92	Bell	J	685
622	92	Bell	J	6,034
625	92	Bell	J	2,600
626	92	Bell	A	1,270
632	92	Bell	A	1,323
635	92	Bell	A	536
638	92	Bell	J	2,479
640	92	Bell	J	553
642	92	Bell	J	762
643	92	Bell	J	12,941

APPENDIX C

INDIVIDUAL HABITAT USE IN 50% AND 85% HARMONIC MEAN CONTOURS

Table C.1. Individual turkey cover type use proportions in 50% and 85% harmonic mean contours for south central Kansas, 15 Mar to 15 Aug, 1991 and 1992.

		Cover types									
		Riparian		Range		Crop		CRP		Treerow	
Bird	Site	50%	85%	50%	85%	50%	85%	50%	85%	50%	85%
550	Haas	0.014	0.014	0.620	0.812	0.258	0.097	0.101	0.077	0.007	0.001
554	Haas	0.034	0.035	0.651	0.521	0.185	0.248	0.113	0.188	0.018	0.008
557	Haas	0.048	0.031	0.528	0.457	0.355	0.389	0.052	0.108	0.017	0.014
560	Haas	0.012	0.009	0.438	0.528	0.487	0.446	0.000	0.000	0.064	0.017
591	Haas	0.000	0.018	0.341	0.550	0.643	0.374	0.000	0.050	0.017	0.007
593	Haas	0.031	0.021	0.763	0.702	0.079	0.087	0.127	0.188	0.000	0.003
567	Woolfolk	0.176	0.175	0.526	0.432	0.280	0.350	0.011	0.030	0.000	0.013
576	Woolfolk	0.065	0.063	0.324	0.289	0.550	0.587	0.039	0.051	0.023	0.011
579	Woolfolk	0.859	0.349	0.140	0.644	0.000	0.006	0.000	0.000	0.000	0.001
584	Woolfolk	0.123	0.115	0.464	0.548	0.391	0.314	0.000	0.000	0.022	0.022
598	Woolfolk	0.224	0.121	0.633	0.643	0.128	0.213	0.000	0.000	0.015	0.022
546	Dunn	0.013	0.029	0.858	0.816	0.000	0.031	0.119	0.124	0.009	0.001
561	Dunn	0.015	0.034	0.711	0.776	0.021	0.118	0.252	0.072	0.000	0.000
578	Dunn	0.070	0.033	0.929	0.845	0.000	0.003	0.000	0.118	0.000	0.000
582	Dunn	0.063	0.021	0.937	0.676	0.000	0.019	0.000	0.284	0.000	0.000

Table C.1. Continued.

		Cover types									
		Riparian		Range		Crop		CRP		Treerow	
Bird	Site	50%	85%	50%	85%	50%	85%	50%	85%	50%	85%
587	Dunn	0.049	0.035	0.919	0.796	0.000	0.040	0.032	0.129	0.000	0.000
590	Dunn	0.016	0.037	0.731	0.769	0.059	0.121	0.195	0.073	0.000	0.000
636	Bell	0.037	0.090	0.764	0.572	0.130	0.259	0.069	0.057	0.000	0.004
612	Bell	0.024	0.021	0.654	0.514	0.310	0.449	0.000	0.000	0.013	0.014
601	Bell	0.038	0.023	0.707	0.886	0.251	0.090	0.000	0.000	0.005	0.001
605	Bell	0.020	0.018	0.947	0.909	0.033	0.070	0.000	0.000	0.000	0.002
618	Bell	0.027	0.022	0.869	0.744	0.028	0.177	0.076	0.050	0.000	0.007
620	Bell	0.030	0.027	0.872	0.761	0.098	0.207	0.000	0.000	0.000	0.005
629	Bell	0.028	0.022	0.860	0.830	0.109	0.116	0.000	0.032	0.003	0.001
630	Bell	0.078	0.043	0.703	0.701	0.219	0.256	0.000	0.000	0.000	0.000
600	Bell	0.027	0.020	0.777	0.600	0.187	0.360	0.000	0.000	0.009	0.020
611	Bell	0.060	0.048	0.572	0.584	0.368	0.349	0.000	0.014	0.000	0.004
603	Bell	0.029	0.020	0.871	0.927	0.100	0.053	0.000	0.000	0.000	0.000
643	Bell	0.038	0.179	0.962	0.769	0.000	0.039	0.000	0.011	0.000	0.002
609	Bell	0.034	0.022	0.907	0.936	0.060	0.042	0.000	0.000	0.000	0.000

Table C.1. Continued.

		Cover types									
		Riparian		Range		Crop		CRP		Treerow	
Bird	Site	50%	85%	50%	85%	50%	85%	50%	85%	50%	85%
616	Bell	0.023	0.022	0.973	0.775	0.005	0.141	0.000	0.060	0.000	0.002
625	Bell	0.032	0.020	0.716	0.732	0.000	0.082	0.252	0.165	0.000	0.001
635	Bell	0.023	0.019	0.688	0.775	0.289	0.181	0.000	0.023	0.000	0.003
638	Bell	0.021	0.023	0.876	0.747	0.103	0.177	0.000	0.051	0.003	0.002
613	Bell	0.020	0.021	0.968	0.820	0.012	0.063	0.000	0.096	0.000	0.000
640	Bell	0.033	0.024	0.871	0.787	0.015	0.124	0.080	0.059	0.000	0.005
642	Bell	0.054	0.054	0.582	0.617	0.000	0.010	0.364	0.319	0.000	0.000
032	Bell	0.027	0.029	0.845	0.816	0.128	0.153	0.000	0.000	0.000	0.001
614	Bell	0.013	0.017	0.868	0.901	0.119	0.082	0.000	0.000	0.000	0.000
622	Bell	0.379	0.215	0.051	0.205	0.503	0.512	0.058	0.060	0.009	0.007
626	Bell	0.016	0.016	0.946	0.941	0.036	0.011	0.000	0.031	0.002	0.001
632	Bell	0.050	0.035	0.679	0.700	0.271	0.265	0.000	0.000	0.000	0.001