ABUNDANCE, FOOD HABITS, AND HABITAT USE BY MAMMALIAN PREDATORS ON PUSHMATAHA WILDLIFE MANAGEMENT AREA

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USE BY MAMMALIAN PREDATORS

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MANAGEMENT AREA

Thesis Approved.

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The purpose of this study was to determine food habits and road and habitat use by various mammalian predators on the Pushmataha Wildlife Management Area (PWMA) and to help biologists better manage turkey and predator populations. This was accomplished through field studies and laboratory analysis taking place in 27 months

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CHAPTER I

INTRODUCTION

The purpose of this study was to determine the abundance, food habits, and habitat use of mammalian predators on the Pushmataha Wildlife Management Area (PWMA). To achieve this, scent stations and road track stations were used to obtain relative abundance indices. Scent stations were also used in conjunction with artificial nests to determine habitat use of mammalian predators. Scats were collected and analyzed to determine food habits of the mammalian predators on the study site and the overall importance of wild turkey (*Meleagris gallopavo*) in their diet.

This thesis is composed of 3 distinct manuscripts formatted for submission to a scientific journal. Each chapter is complete as written and does not require any additional material. Chapters are formatted for the Journal of Wildlife Management

CHAPTER II

USE OF ROADS AND HABITATS BY MESOCARNIVORES IN SOUTHEASTERN OKLAHOMA

ABSTRACT

Eastern wild turkey (*Meleagris gallopavo silvestris*), have been shown to nest in close proximity to roads and in some populations mammalian predators may be responsible for their decline. I sought to investigate road use by mesocarnivores. I used road track stations and scent stations to index predator use of various habitats at various distances from the nearest roads on Pushmataha Wildlife Management Area (PWMA), in 1996 and 1997. I found a relative abundance index of 628.5 (total no. of visits/total operable station nights x 1000). Scent stations also were used in 1996 and in 1997 as another means to obtain a relative abundance index for predatory species on the area. Relative abundance indices were 210.2 and 228.6. Scent stations also were used to determine habitat use. In 1996, there were 62 positive visitations, and in 1997, there were 179 positive visitations, (three stations had multiple visits). Habitat type ($\underline{X}^2 = 7.53$, $\underline{df} = 6$, $\underline{P} = 0.2743$) or distance from road ($\underline{X}^2 = 0.06$, $\underline{df} = 2$, $\underline{P} = 0.9704$) was not related to visitation by predators to scent stations. Results indicated that there was no distance-from-road or habitat preference by the predators monitored using this technique

INTRODUCTION

In Oklahoma, annual trapping and special license sales remain low relative to the mid 1980's. Decreased levels of hunting and trapping of mammalian predators may have substantially increased predator populations throughout Oklahoma. Such an increase could have an impact on various prey populations (Kruuk 1982), including eastern wild turkey. Winter flock and summer brood surveys conducted by the Oklahoma Department of Wildlife Conservation in the early to mid 1990's indicated that populations of eastern wild turkey in southeastern Oklahoma were steadily declining (Dinkines and Smith 1993), although surveys in 1995 and 1996 indicated a slight increase, (Dinkines and Smith 1996). Data from an intensive 3-year study conducted by the Oklahoma Cooperative Fish and Wildlife Research Unit and the Oklahoma Department of Wildlife Conservation suggest that nest predation and low poult survival may be limiting turkey populations and may have contributed to the earlier decline (Nicholson et al. 1998). To evaluate effects of predation on turkey populations, I determined if predatory species such as the bobcat (*Lynx rufus*), coyote (*Canis latrans*), free-ranging dogs, feral hogs, gray fox (*Urocyon cineargenteus*), opossum (*Didelphis virginiana*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), and skunk (*Mephitis mephitis*), used the same habitat types as eastern wild turkey hens. I assessed habitat and road use of various mesocarnivores, utilizing scent stations and road-track stations to determine if there was preferential use of roads and associated habitats.

The scent-station index has become one of the most popular methods for determining relative abundance and trends in carnivore populations (Smith et al. 1994). Scent stations have proven effective in monitoring red and gray foxes (Conner et al. 1983, Smith et al. 1994), swift foxes (*Vulpes velox*... Kruse et al. 1995), bobcats (Brady 1979, Conner et al. 1983, Conner et al. 1984, Hon 1979, Knowlton and Tzilkowski 1979, Rolley 1985), raccoons (Conner et al. 1983, Conner et al. 1984), coyotes (Conner et al. 1983, Linhart and Knowlton 1975, Roughton and Sweeney 1982), black bear (Lindzey et al. 1977), and skunks (Smith et al. 1994), but not opossums (Conner et al. 1983).

According to Hatcher (1983), the scent-station survey method is an objective and quantitative technique for collecting relative abundance indices for trend analysis in many carnivore populations. If biases are constant each year, major changes in the index will be caused by changes in the population, not the survey (Hatcher 1983). Not only can scent stations detect area-wide changes in abundance, they also can detect changes in habitat use (Conner et al. 1983). However, they can not be used to make between-species comparisons for population trends (Conner et al. 1983). Stations should be distributed so that all major habitat types are sampled. Replicate samples in habitat types are necessary if habitat use is going to be measured (Conner et al. 1983). According to Conner et al. (1983) and Diefenbach et al. (1994), stations should be located at 0.32-km intervals to minimize multiple visits from individual animals

Signs left by animals are a noninvasive method commonly used by wildlife managers in making inferences about population characteristics (Van Sickle and Lindzey 1992). To have another means of gathering population information, I used road track stations located over the study area.

The primary objective of this study was to establish relative abundance of major mammalian predators at PWMA, their habitat preference and associated use of roads. I hypothesized that there would be preferential habitat use and that scent stations near roads would have higher visitation rates.

STUDY AREA

The study area was located in the Pushmataha Wildlife Management Area (PWMA) consisting of 7,390 ha in Pushmataha County, Oklahoma (34°32'N, 95°21'W) The PWMA was set aside as a deer refuge in the 1940's. The study site lies along the western edge of the Ouachita Highland Province (Duck and Fletcher 1945).

The study area consisted of habitat types that were representative of those throughout southeastern Oklahoma. The overstory consisted of oak-pine (*Quercus* spp.-*Pinus* spp.) forest, dominated by post oak (*Q. stellata*), shortleaf pine (*P. echinata*), blackjack oak (*Q. marilandica*), and hickory (*Carya* spp.). Dominant understory plants included flowering dogwood (*Cornus floridanus*), blueberry (*Vaccinium* spp.), blackberry (*Rubus* spp.), little bluestem (*Schizachyrium scoparium*), panicums (*Panicum* spp. and *Dicanthelium* spp.), broomsedge (*Andropogon virginicus*), and big bluestem (*Andropogon gerardii*). Dominant woody vines included poison ivy (*Toxicodendron radicans*), greenbriar (*Smilax bonanox*), Virginia creeper (*Parthenocissus quinquefolia*), and muscadine grape (*Vitis rotundifolia*) (Masters 1991)

Climate was semi-humid to humid with hot summers and mild winters. Summer temperatures commonly exceeded 32°C with strong southerly winds. The mean maximum winter temperatures are about 13°C. The average annual precipitation is 109-127 cm. The annual precipitation varied seasonally and yearly. The yearly frost-free period averaged 190 days and occurred from late March to mid-October (Bain and Watterson 1979).

METHODS AND MATERIALS

To derive a relative abundance index of predators, I used scent stations, road-track stations, and spotlight surveys. Spotlight surveys were conducted in November and December 1996. The survey route of about 32 km included Pine Tree Circle and Dogwood Drive in PWMA. Surveys were conducted by at least 2 people from the cab of a pick-up using hand-held spotlights producing 500,000-1,000,000 candlepower, at a speed of 5-16 km/h (Rybarczyk et al. 1981). Spotlight surveys were conducted 4 times Surveys were not conducted during rain, mist, fog or when temperatures were < 0° C (Rybarczyk et al 1981). Surveys were begun no earlier than 1900 h and ended no later than 0500 h. A list of species observed was recorded at the time of sighting. Species were tabulated at the end of each survey

Road-track stations also were used to estimate a relative abundance index Twenty-five locations for track stations were selected uniformly throughout the study site in areas where the road surface permitted recognition of tracks. Stations were visited and tracks recorded once a week, weather permitting, from 29 March 1997 to 5 October 1997. If a station was inoperable (due to rain, vehicles, excessive dry weather), it was excluded from analysis. Existing tracks were destroyed to eliminate duplicate observations of the same tracks on consecutive surveys. A relative abundance index (RAI) was calculated as total # visits/total operable station nights x 1,000

Placement of scent stations (Hatcher 1983) (126 total, 42 in 1996 and 84 in 1997) also were used to determine RAI of predators relative to roads and habitats. Equal numbers of scent stations were placed randomly in the seven major habitat types on the study area: hardwood-pine, hardwood, pine, pine-hardwood, bottomland hardwood, food plots, and early successional openings (ESO). Habitat types were assessed using ocular assessment to determine the predominant vegetative component of the immediate area. Equal numbers of stations were located in 3 distance categories from the road (0-100 m, 101-200 m, and 201-300 m). Stations were located a minimum of 0.32 km apart to minimize multiple visits of individuals >1 site on any given 24-h period (Conner et. 1983, Diefenbach et al. 1994). Each station consisted of a 70-cm x 70-cm plate of 16-gauge sheet metal with a hole drilled in the center. The plate was coated with a solution of ethyl alcohol and activated carbon (charcoal) following Kruse et al. (1995). In 1996, a mixture of 12-15 tsp of charcoal to 1-l of alcohol was used. In 1997, the amount of charcoal in the mixture was increased to 20-25 tsp to aid in the identification of tracks. The solution was shaken at each station and applied using a 7.6-cm foam paint roller. The alcohol evaporated in 2-30 sec depending on ambient temperature and relative humidity, leaving a thin layer of charcoal on the plate. Stations were baited with a combination of fatty-acid solution (FAS) disks (Roughton and Sweeny 1982, Diefenbach et al. 1994, Smith et al 1994) glued to a 108-mm craft stick and sardines (Andelt and Wooley 1996).

Scent stations were run from 19 July 1996 to 29 September 1996 and 24 June 1997 to 4 October 1997. Scent stations were set up on 1 day and checked for any disturbance the following day at intervals of once a week (weather permitting). When present and identifiable, tracks were lifted from the plate by placing clear packaging tape over the footprint (Kruse et al. 1995), gently adhering the tape to the plate, then removing the tape and attaching it to a blank sheet of paper to produce a permanent record. In 1996, there were 62 positive visitations; in 1997, there were 176 positive visitations. All scent-station visitations were analyzed by habitat type and distance from road using log-linear modeling procedures (PROC CATMOD; SAS Institute, 1988).

RESULTS

Spotlight Surveys

Spotlight surveys were conducted 4 times from 1 November 1996 to 6 December 1996. A total of 59 deer, 1 elk, and 2 raccoons was observed. Spotlight counts were discontinued because sightings of predators were extremely rare. A set of permanent track locations were established along roads to replace the spotlight counts.

Road-Track Counts

Road-track stations were visited and tracks were recorded once a week, weather permitting, from 29 March 1997 to 5 October 1997; there were 355 operable station nights. Coyotes and raccoons were the most common mesocarnivore (Table 1).

Scent Stations

Forty-two scent stations were established the first summer and were checked from 19 July through 29 September 1996. A total of 84 scent stations were established and checked from 24 June through 4 October 1997. In 1996, I found 62 positive visitations during 295 operable station nights, yielding an overall relative abundance index of 210.2. Of the 62 visitations, there were similar numbers of visitations within habitat types (Table 2). The breakdown of positive visitations by species by habitat are shown in Table 2. In 1996 the largest percentage of positive visits was in the 101-200 m category, but the difference was small (Table 3). The allocation of positive visitations by species by distance category for 1996 are shown in Table 3. In 1997, there were 179 positive visitations of 783 operable station nights, yielding a combined relative abundance index of

228.6, similar to 1996. Of the 179 positive visitations, 3 scent stations had multiple species' tracks. Habitat breakdown of the positive visitations are shown in Table 4. A species specific account of positive visitations by habitat type can be found in Table 4. Visitations by distance category are illustrated in Table 3. Of all the tracks, 72 were smudged and unidentifiable; of the identifiable tracks, raccoons were the most predominant visitor (Tables 3 and 4). A species-specific account of relative abundance can be found in Table 5. Habitat placement ($\underline{X}^2 = 7.53$, $\underline{df} = 6$, $\underline{P} = 0.2743$) or distance from roads ($\underline{X}^2 = 0.06$, $\underline{df} = 2$, $\underline{P} = 0.9704$) were not significantly related to visitation of predators to scent stations.

DISCUSSION

Spotlight Surveys

Only 2 predators were seen on all 4 spotlight counts, which could have been due to the degree of overall visibility on the study area. Dense vegetation, downed trees and forests affected the degree of visibility. According to McCullough (1982), dense vegetation causes spotlight penetration to be ineffective. Rybarczyk et al. (1981) successfully used spotlight surveys to census raccoons in south-central Iowa during different periods of the year. They found that the degree of visibility was an important factor in observing raccoons during all spotlighting periods. The habitat types that they surveyed consisted predominately of pasture, cornfields, hay fields, soybean fields, and oak-hickory forests. Raccoons occurred in more open habitats (Rybarczyk et al. 1981), which could have been due largely to enhanced visibility for the observer

Predator behavior could be another reason why so few were seen during the spotlight surveys at PWMA. Carnivores are cryptic in nature making them difficult to observe (Mills, 1996). Although spotlight surveys have been found effective in censusing deer (*Odocoileus virginanus* ... Rowe 1980, Gunson 1979, and McCullough 1982), rabbits (*Sylvilagus floridanus* ... Trautman et al. 1974), striped skunks (Jacobson 1969), and raccoon (Rybarczyk et al. 1981), we found that they were inadequate for surveying predators in the predominate habitat types of PWMA.

Road-track Counts

According to Van Dyke et al. (1986), track stations may be a reliable estimator of relative abundance. Relative abundance indices from road-track stations were appreciably higher for the majority of the species concerned than relative abundance indices from scent stations. Road-track counts indicated that coyote, raccoon, and bobcat were the 3 most common potential predators at PWMA. It should be noted that road-track counts indicated a high proportion of armadillo (*Dasypus novemcinctus)*, while they could be potential nest predators they were not considered a predator to adult turkeys (Nicholson et al. 1998). One explanation for the higher RAI and varying species account, may be the use of roads as corridors, allowing a greater number of tracks to be seen. This is a relatively inexpensive technique that requires few materials and proved successful in obtaining tracks in this study

Scent Stations

We observed variation among years for visitation rates and relative abundance indices (RAI) of the various species. There was a decrease in the smudged and an increase in the majority of the identifiable species in 1997 compared with results in 1996. This could be due in part to the fact that more charcoal was used in the second season creating a heavier tracking medium on plates and allowing more tracks to be identifiable

Scent stations are often used to assess trends in predator populations. Conner et al. (1983) found that scent-station indices accurately reflected trends in abundance of bobcats, raccoons, and gray foxes, but not opossums. I contend that this technique can provide a reliable index to reflect trends in the majority of species of carnivores. There was not a significant difference in habitat or road use by mammalian predators.

Scent stations are set up primarily along roads or trails (Linhart and Knowlton 1975, Lindzey et al.1977, Knowlton and Tzilkowski 1979, Conner et al. 1983, Diefenbach et al. 1994) and used to derive relative abundance information only. A study design similar to ours could not be found for comparison.

Techniques used for scent stations in the past consisted of methods described by Linhart and Knowlton (1975), in which a circle is cleared of vegetation and sifted with sand, or in some cases lime (Diefenbach et al. 1994), and is baited. Due to the experimental design of my study, the rocky substrate of the landscape, and transportation difficulties, a newer technique was chosen. I adapted the method used by Kruse et al. (1995), in which charcoal was used as the tracking medium. I also made modifications in the attractant used, opting for a combination of a FAS disk and sardine, to elicit a higher response from a wider variety of potential mesocarnivores at PWMA. As with traditional scent stations, this technique is susceptible to weather conditions, such as rain and wind. In some cases, heavy dew also rendered stations inoperable.

The metal plate and medium used also may explain some of the unidentified tracks, because the substrate was slicker than sand and presumably had an unfamiliar feel to the animals causing a streak or smear instead of clearer tracks. However, in cases where lack of person-power and natural materials make it impossible to use the traditional techniques, this method is useful because it is readily adaptable to extensive areas and habitat types, it involves relatively small person-hour commitment, materials can be transported without the means of a traditional automobile (in my study an all terrain 4-wheeler was used), and it can be repeated uniformly, allowing for annual comparisons. A permanent track record also makes this method attractive, as it provides a record and data that can be referenced and compared, allowing for fewer mistakes in field identification of tracks.

Management Implications

Spotlight surveys were not an adequate tool for censusing predator population in habitats exhibited at PWMA. Road-track stations provided means of detecting relative abundance of carnivores, assuming they do not use roads differentially. Road-track stations should be continued on the study area to detect trends in predator populations Additional stations could be established and conducted during different seasons of the year for continuous years to gather more information and detect population trends. Another means to gain additional information would be to use Fitzhugh and Gorenzel's (1985) suggestion that road-track data in conjunction with radio tracking can yield even more valuable information on population size of mesocarnivores.

Although there were unidentified tracks using the charcoal scent-station technique, the method was successful and a permanent track record was established To detect changes in trends of predator populations, it would be advisable to continue scent stations.

I found no significant difference in habitat or road use by mammalian predators This does not demonstrate a preference for habitat use at particular times such as denning or loafing. For additional information concerning habitat and road use, use of the same experimental design in scent stations as indicated by this study is recommended during different seasons of the year for continuous years. To gather more complete information, predatory species should be trapped, radiocollared, and monitored over time to determine habitat and spatial preferences, in addition to scent stations.

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Table 1. Relative abundance indices (RAI) per species using road-track stations (RAI = # positive visitations / total operable station nights x 1,000) at the Pushmataha WMA, Oklahoma.

Species	Scientific name	RAI
Armadillo	*Dasypus novemcinctus*	90.1
Bear	*Ursus americanus*	0.00
Bobcat	*Lynx rufus*	39.4
Coyote	*Canis latrans*	222.5
Dog	*Canis familiaris*	11.3
Gray fox	*Urocyon cineargenteus*	14.1
Opossum	*Didelphis virginiana*	0.00
Raccoon	*Procyon lotor*	160.6
Red fox	*Vulpes vulpes*	11.3
Skunk	*Mephitus mephitis*	31.0
Smudged		28.2
Total		608.5

Table 2. Number of positive scent-station visitations for each species per habitat type in 1996 at the Pushmataha WMA, Oklahoma. BH = bottomland and/or streamside hardwood. ESO= early to mid-successional openings. FP = foodplots. H = hardwood, HP = hardwood-pine. P = pine, and PH = pine-hardwood.

	Habitat						
Species	BH	ESO	FP	H	HP	P	PH
Bear	0	0	1	0	0	0	0
Bobcat	0	0	1	0	0	0	1
Coyote	0	0	2	0	0	0	0
Dog	0	1	0	0	0	0	0
Gray fox	0	0	0	1	0	0	0
Raccoon	0	3	1	1	0	1	1
Red fox	1	1	0	2	0	0	1
Skunk	0	0	0	0	0	1	0
Smudged	11	5	7	6	3	3	7
Total	12	10	12	10	3	5	10
Operable Nights	46	39	45	41	40	41	43

Table 3. Number of positive scent-station visitations per species per distance category from roads in 1996 and 1997 at the Pushmataha WMA, Oklahoma.

	Distance category					
	0 - 100 m		101 - 200 m		201 - 300 m	
Species	1996	1997	1996	1997	1996	1997
Bear	0	0	1	0	0	0
Bobcat	0	3	0	3	2	2
Coyote	0	1	2	1	0	4
Dog	1	0	0	0	0	1
Gray fox	0	5	0	1	1	4
Opossum	0	1	0	2	0	1
Raccoon	4	18	2	17	1	19
Red fox	2	6	3	3	0	1
Skunk	0	6	0	6	1	2
Smudged	9	28	16	21	17	23
Total	16	68	24	54	22	57
Operable Nights	106	263	98	253	89	267

Table 4. Number of positive scent-station visitations per species per habitat type in 1997 at the Pushmataha WMA, Oklahoma. BH = bottomland and/or streamside hardwood, ESO = early to mid-successional openings, FP = foodplots, H = hardwood, HP = hardwood-pine, P = pine, and PH = pine-hardwood.

	Habitat						
Species	BH	ESO	FP	H	HP	P	PH
Bear	0	0	0	0	0	0	0
Bobcat	0	0	1	1	2	1	3
Coyote	0	0	2	0	1	0	3
Dog	0	1	0	0	0	0	0
Gray fox	0	0	0	2	2	3	3
Opossum	0	0	1	0	1	1	1
Raccoon	17	4	2	5	13	4	9
Red fox	0	0	1	2	4	1	2
Skunk	0	1	2	3	6	1	1
Smudged	9	9	12	11	12	13	6
Total	26	15	21	24	41	24	28
Operable nights	109	117	106	117	113	102	119

Table 5. Relative abundance indices (RAI) per species using scent-stations for 1996 and 1997 at the Pushmataha WMA, Oklahoma (RAI = # positive visitations/total operable station nights x 1000).

Species	1996	1997
Bear	3.4	0.00
Bobcat	6.8	10.2
Coyote	6.8	7.7
Dog	3.4	1.3
Gray fox	3.4	12.8
Opossum	0.00	5.1
Raccoon	23.7	69.0
Red fox	16.9	12.8
Skunk	3.4	17.9
Smudged	142.4	92.0
Total	210.2	228.6

CHAPTER III

EFFECT OF HABITAT TYPE AND ROAD DISTANCE ON DEPREDATION OF ARTIFICIAL TURKEY NESTS IN SOUTHEASTERN OKLAHOMA

ABSTRACT

During the spring nesting season of 1997 and 1998, artificial nests were used to examine the influence of habitat and distance to roads on fate of eastern wild turkey (*Meleagris gallopavo silvestris*) nests on the Pushmataha Wildlife Management Area (PWMA) in southeastern Oklahoma. Predation rates were 57.8% in 1997 and 91.1% in 1998, there was a significant difference found between years which may be related to the hot spring of 1998 (National Climatic Data Center, Asheville, NC). In 1997, I found a similar predation rate to that determined for actual turkey nests at PWMA ($\underline{P}$ = 0.389). Neither habitat type ($\underline{X}^2$ = 2.14, $\underline{df}$ = 4, $\underline{P}$ = 0.74094) nor distance from road ($\underline{X}^2$ = 0.94, df = 2, $\underline{P}$ = 0.6245) significantly influenced nest fate. Hair catchers at the nests had a 7.8% efficiency rate, with the predominant identified predator being raccoon (*Procyon lotor*) which was the same dominant nest predator indicated by Nicholson et al. (1998). Because of the low efficiency rate of the hair catchers another means of predator identification is suggested. Although caution must be taken in applying results from artificial nest studies to estimate the nest success of wild turkeys, artificial nest studies are potentially beneficial for identifying nest predators, habitat use, road use, and facilitating management decisions.

INTRODUCTION

According to Lovell et al. (1998) both predator populations and conflicts between people and predators have increased in the past decades. It has been stated that lack of trapping has influenced the increase in predator populations (Lovell et al. 1998). In Oklahoma annual trapping and special license sales remain low relative to the mid 1980's (Hoagland 1994). Because of this decrease, it is thought that population densities of mammalian predators have increased substantially throughout Oklahoma. Such an increase could affect various prey populations including eastern wild turkey (*Meleagris gallopavo silvestris*... Kruuk 1982) These potential predators are found in various habitat types and undoubtedly propose a threat to the wild turkey throughout its life cycle (Miller and Leopold 1992) Predators have the ability to regulate, depress, or maintain prey populations, or to even improve them by removing sick and weak members of the population (Miller and Leopold 1992)

Winter flock and summer brood surveys of eastern wild turkey conducted by the ODWC (Oklahoma Department of Wildlife Conservation) in the mid-to early 1990's indicated steadily declining densities in southeastern Oklahoma (Dinkines and Smith 1993). More recent surveys conducted in 1996 indicate a slight increase, but populations are still low (Dinkines and Smith 1996). Preliminary data from an intensive 3-year study suggest that predation may have contributed to declines (Nicholson et el. 1998). Because turkey hunting is a major activity in southeastern Oklahoma, it is important to determine if predators such as the bobcat (*Lynx rufus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cineargenteus*), raccoon, opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), free-ranging dogs, and feral hogs use the same habitat types as eastern wild turkey.

Nest predation is thought to be a major source of mortality in populations of ground nesting birds (Badyaev 1994, Baker 1978, Miller and Leopold 1992, Ortega et al. 1998). Artificial nests have been used in numerous studies addressing nest success because they can be used in many experimental designs and because the sample size can be controlled.

Because wild turkeys are ground nesting birds the relationship between habitat characteristics and nest predation is an important concern that should be addressed (Baker 1978, Bowman and Harris 1980, and Moore 1995). Wild turkey hens select nest sites based on understory and ground cover and often are in close association with roads and corridors (Moore 1995). My objective was to evaluate the success of artificial nest in various habitat types, chosen by actual turkeys on the area (Stewart 1999), at varying distances from roads. To address this question I took a classical experimental approach of testing hypothesis that habitat type and distance from the road would influence artificial nest fate because biologists have assumed that roads are travel corridors and that turkeys are predisposed to predation by nesting close to roads.

STUDY AREA

The study area was the Pushmataha Wildlife Management Area (PWMA) consisting of 7,390 ha in Pushmataha County, Oklahoma (34°32'N, 95°21'W). The PWMA was set aside as a deer refuge in the 1940's. The study site lies along the western edge of the Ouachita Highland Province (Duck and Fletcher 1945)

The study area consisted of habitat types that were similar to habitat types found throughout southeastern Oklahoma. The overstory of the area consisted of oak-pine (*Quercus* spp.-*Pinus* spp.), dominated by post oak (*Q. stellata*), shortleaf pine (*P.*

echinata), blackjack oak (*Q. marilandica*), and hickory (*Carya* spp.). Dominant understory plants included flowering dogwood (*Cornus floridanus*), blueberry (*Vaccinium* spp.), blackberry (*Rubus* spp.), little bluestem (*Schizachyrium scoparium*), panicums (*Panicum* spp. and *Dicanthelium* spp.), broomsedge (*Andropogon virginicus*), and big bluestem (*Andropogon gerardii*). Dominant woody vines included poison ivy (*Toxicodendron radicans*), greenbriar (*Smilax bonanox*), Virginia creeper (*Parthenocissus quinquefolia*), and muscadine grape (*Vitis rotundifolia*) (Masters 1991).

Climate was semi-humid to humid with hot summers and mild winters. Summer temperatures could exceed 32°C with strong southerly winds. The mean maximum winter temperatures were about 13°C. The average annual precipitation was 109-127 cm. The annual precipitation varied seasonally and yearly. The yearly frost-free period was 190 days and occurred from late March to mid-October (Bain and Watterson 1979).

METHODS AND MATERIALS

Predation patterns in relation to roads and habitats were assessed using artificial nests. Artificial nests were placed in the 5 major habitat types most commonly used by turkeys for nest sites: ESO's (early successional openings) , hardwood, hardwood-pine, pine, and pine hardwood, (Nicholson et al 1998). Artificial nests were distributed evenly in 3 distance categories (0-100 m, 101-200 m, and 201-300 m) from roads. For the purpose of this study, a "road" was defined as "a clear pathway that is regularly traveled by vehicles and people."

To minimize human scent at the artificial nest location, extensive vegetative analysis was not performed. Artificial nest sites were chosen throughout the study area from general areas located in appropriate habitat types using ocular assessment based on nest characteristics selected by hen turkeys at PWMA (Nicholson et al. 1998,). Nest-site characteristics included: 1) understory vegetation height of about 29 cm, 2) conifers between 0-0.5 m in height <1 stem in a 1-m radius plot, 3) total density of all woody stems <25 cm DBH ≤ to 10 stems in a 1-m radius plot, 4) nest located within a patch of low bush vaccinium, blackberry, or poison ivy, or backed against a tree or snag, 5) percent ground cover around immediate nest site <1% of rock, bare ground, or cryptogams, and about 18% (<1 m) woody cover (Nicholson et al. 1998). Artificial nest sites also were placed in areas disjunct from known turkey nest locations located during the corresponding radio-telemetry study of wild turkey nesting ecology in PWMA.

An artificial nest consisted of a slight depression (Yahner and Mahan 1996) containing 4 turkey eggs provided by Butterball Turkey (Sarcoxie, Missouri) and 2 strategically placed hair catchers (Baker 1980). Hair catchers were constructed from wooden stakes about 80 mm in width with 3 13-mm wide strips of serrated aluminum flashing (serrations pointed outwards) attached at 0, 75 and 150 mm from the top of the stake (Baker 1980) with wood screws. The aluminum flashing was painted (while on the stakes) with brown exterior spray paint and allowed to sit outdoors to weather and to alleviate the paint scent. Painting the flashing allowed the strips to be more camouflaged with the environment. Although Baker (1978) found that hair catchers did not seem to attract or repel predators, they were placed at the nest site ≥1 week prior to the placement of eggs. Hair catchers usually were placed <0.5 m from the nest with 275 mm of the stake above ground and in a location that the predator would most likely use when entering or leaving the nest site (Baker 1980). Hair was identified by comparison to reference slides of hair donated from the mammalian collection at the Oklahoma State University Museum.

Artificial nest sites were marked with flagging. Flagging was placed $\geq$25 m from the nest. Flagging was present throughout the study area as a part of other field studies, so flagging was not considered to be a novel feature that might attract predators to the nest (Yahner and Wright 1985)

In 1997, 90 artificial nests were set up between 3 and 11 May. In 1998, 90 artificial nests were set up on 29 and 30 of April. Those dates corresponded to the time frame when turkeys begin initiating nests at PWMA (Nicholson et al. 1998). Nests were checked once a week (Yahner 1996) for 6 weeks to simulate the laying and incubation period of wild turkeys (Baker 1978). When setting up and checking artificial nests and handling eggs, latex or rubber gloves and rubber boots, long sleeve shirts and long pants were worn to minimize human scent (Yahner and Scott 1988, Yahner et al. 1989, Yahner et al. 1993, Bayne and Hobson 1997, Yahner and Mahan 1997). Eggs in "surviving" nests were replaced after 2 weeks, unless the ambient temperature was >32.2°C, at which time eggs were replaced weekly to prevent attracting olfactory searching predators to the scent of rotten eggs. Eggs that were removed from the nest were placed in a secured container, taken from the nest site and disposed. Location and description of egg remains from depredated nests were recorded but were not used to identify predators (Baker 1978). An area of $\geq$50 m radius was searched for eggshell fragments, predator tracks, and other sign (D. Nicholson, pers. comm.). All findings were recorded and where possible preserved Hairs found on hair catchers were placed in plastic ziploc bags and labeled until they could be identified Log-linear modeling procedures (PROC CATMOD; SAS Institute 1988) were used to test for relationships between habitat type and distance from roads of predated and non-predated nests. To test between year nest success a likelihood ratio of chi-square was used.

RESULTS

In 1997 the predation rate was 57.8 % (Figs. 1 and 2). In 1998, the predation rate was 91.1% (Figs. 3 and 4). Fate of nest was not significantly related to habitat placement ($\underline{X}^2 = 2.14$, $\underline{df} = 4$, $\underline{P} = 0.709$) or proximity to roads ($\underline{X}^2 = 0.94$, $\underline{df} = 2$, $\underline{P} = 0.624$). Fate of nest was significantly different between years ($X^2 = 26.282$, $\underline{df} = 1$, $\underline{P} = 0.001$).

Predator hair was found on hair catchers at only 7.8% of 180 total artificial nests Ten samples were identified as raccoon, 1 as fox, 1 as opossum, and 2 as unidentifiable (broken underfur). Raccoon hair also was found on egg fragments at 2 artificial nests.

DISCUSSION

In 1997, predation rate of artificial nests was 57.8%, which is similar to the predation rates found by other artificial nest studies (Yahner and Mahan (1997), of 53%, Yahner et al. (1989) of 41%, Yahner and Wright (1985) 67%). Predation rates of wild turkey nests from a study conducted on the same study site were as follows: overall = 65.5%, 1995 = 65%, 1996 = 66.7%, 1997 = 64.9% (Nicholson et al. 1998). This study of artificial nests coincided with the turkey study for only 1 year. In 1997, I found a similar predation rate to that determined for actual turkey nests at PWMA ($\underline{P} = 0.389$). Other studies that located turkeys with radiotelemetry and other means reported predation rates of 43, 44 and 62.5% (Pharris and Goetz 1980) and 86% (Moore 1995)

Hoerath (1990) used artificial nests to study the influences of coyotes on game animals. He established 20 artificial trial nests, each with 5 chicken eggs. Nests were placed in different habitat types chosen to represent turkey nests. Of the 20 artificial nests that he established, only 5 survived 6 weeks, resulting in a predation rate of 75%

(Hoerath, 1990). Predation rates of both experimental and control subgroups in the investigation conducted by Pharris and Goetz (1980) ranged from 58 to 94%. The lower rate is similar to my first field season in 1997 and the higher rate is similar to my second season in 1998, which was 91 1%. Moore (1995) examined predation of artificial nests in association with roads on 2 study sites in the Ozark mountains in Arkansas where she found predation rates of 88.8% and 30.0%

I found no difference in predation rates between habitats or distances from roads Some investigators question the extent to which olfactory-searching predators find artificial nests. Although precautions were taken in setting up and checking the nest to prevent human scent trails, it may not have been completely effective. Because there is no significant difference in road or habitat use, it may suggest that predators used habitats equally in their search for food and that roads may not act as significant corridors for predators in searching for prey Bowman and Harris (1980) found that spatial heterogeneity of habitat characteristics is more important than degree of nest cover in preventing predation

According to Ortega et al (1998) artificial nests may attract different predators than natural nests. They found through the use of radiotelemetry that artificial nests were more readily predated by avian predators and that natural nests were preyed upon by mammalian predators. This could be because of the scent from the hen and the fact that artificial nests have no protection by incubating parents. Butler and Rotella (1998) found that different types of predators may be attracted to different nest types (natural and artificial) through means of different methods such as olfaction and vision. Willebrand and Marcstrom (1988) warn that dummy nests were more vulnerable than natural nests to visual predators and they may overestimate the importance of avian predation on natural nests.

Baker (1978) studied factors affecting nest predation of wild turkeys. In his artificial nest studies, he found that there was no difference in survival rate for cover type, egg type, or effects of hair-catchers at nests. He also found that nest predators cannot be reliably identified by sign left at destroyed nests, unless sign other than the egg is present Hair catchers used in my study were considerably less effective than Baker's (1980). He showed a success rate of 89% for the design of hair catcher used in our study. I had an efficiency rate (percent of nests with hair-catchers that caught hair) of only 7.8%. Possible explanations for the difference in success rates could be the difference in metal utilized, the fact that I painted my hair catchers, or the possibility that the majority of my nest predators were non-mammalian. Aluminum flashing was used instead of 30-mil sheet metal (Baker 1980), because the 30-mil sheet metal was unavailable. Upon consulting with sheet metal distributors, I was instructed to use the aluminum flashing because of the similarity in weight. In an attempt to make my hair catchers more cryptic, I painted the aluminum flashing, which may have caused a decrease in the efficiency in picking up hairs. Of the hair found on hair-catchers, 71.4% was raccoon According to Nicholson et al. (1998) raccoons were the most predominant nest predator in their study. According to Pharris and Goetz (1980), raccoon was the most prominent nest predator identified using cameras placed at nest sites Although caution must be taken in applying results from artificial nest studies to estimate the nest success of wild turkeys, artificial nest studies are potentially beneficial for identifying nest predators, habitat use, road use, and facilitating management decisions.

Predation rates for artificial nests were comparable to similar studies. The non-significance in habitat and distance-to-road preferences may indicate that nest predators used habitats equally in their search for food and that roads are not used as search corridors. The significant difference found between years on nest success may be related to the hot spring of 1998 ($\underline{t} = 3.81$, $\underline{df} = 80$, $\underline{P} = 0.0003$; National Climatic Data Center, Asheville, NC).

Management Implications

It is important to monitor turkey populations annually for survival along with predator population status, and land and habitat changes. Ideally, artificial nest studies should be conducted at the same time as studies on actual wild turkeys. To accrue additional information on habitat use in conjunction with turkeys, monitoring of predators and turkeys by radiotelemetry is suggested.

Monitoring predator response to both artificial and natural turkey nests in studies that examine landscape and habitat use is important and should be conducted over a period of several years (Ortega et al. 1998).

Another means of identifying nest predators is recommended because of the low efficiency rate obtained from hair-catchers. Automatic cameras (Pharris and Goetz, 1980) or the use of clay or plastic eggs (Bayne and Hobson, 1997, Keyser et al. 1998) could be used to identify nest predators.

Predator-control programs are not recommended as an option because in most cases they are relatively costly and yield relatively short-term results. According to Miller and Leopold (1992) studies indicate that predator control should be applied cautiously as the results are controversial. Knowlton (1972) found that areas that had intensive predator control had larger average litter sizes for coyotes when compared to areas with low predator control. Connoly and Longhurst (1975) suggest that a population of coyotes would have to be reduced 70-75% annually to maintain coyotes at one-half the carrying capacity of an area.

Information gained from a radiotelemetry study would give additional insight to overall habitat use by predators thereby providing more information to base a habitat management program to benefit the eastern wild turkey and to discourage predatory species. It should also be noted that according to Miller and Leopold (1992) proper management of habitat and the people that use that habitat does more to benefit the wild turkey populations than predators do harm.

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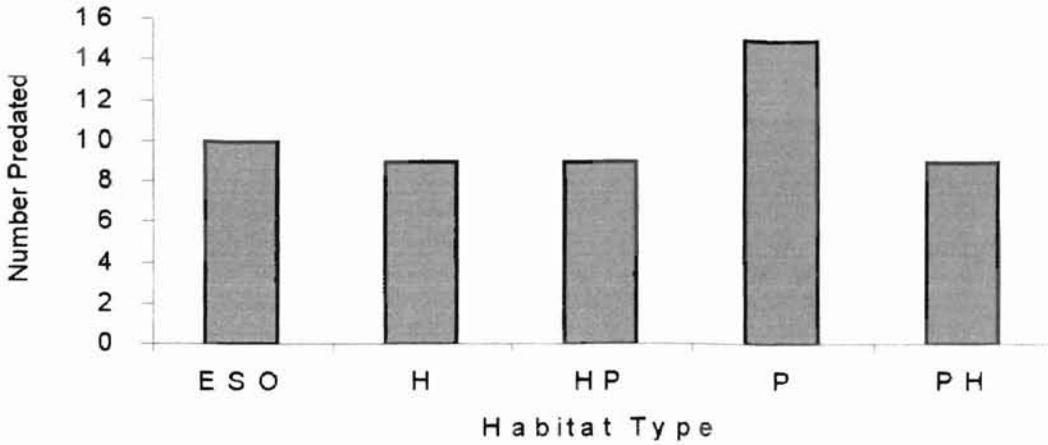

Figure 1. Number of artificial nests preyed on for each habitat type in 1997 at the Pushmataha WMA, Oklahoma. ESO = early to mid-successional openings, H = hardwood, HP = hardwood-pine, P = pine, and PH = pine-hardwood.

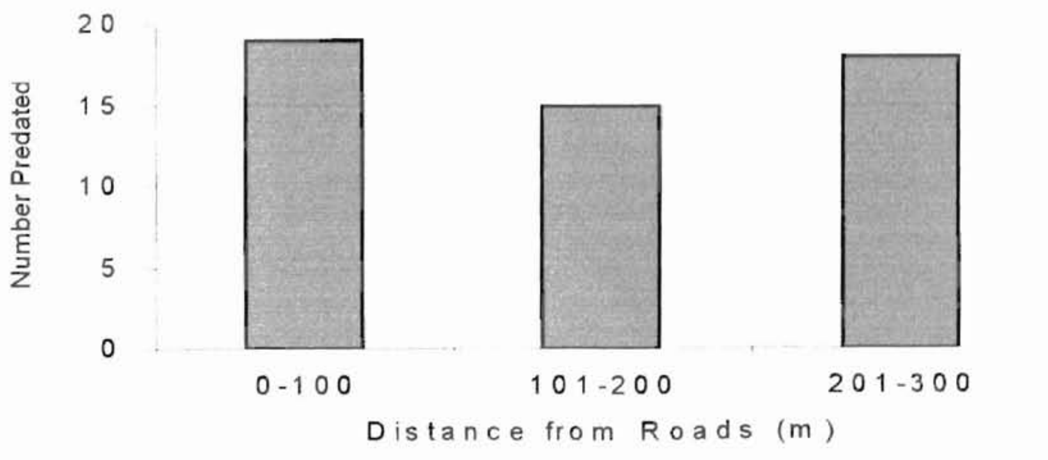

Figure 2. Number of artificial nests preyed on for each distance category in 1997 at the Pushmataha WMA, Oklahoma.

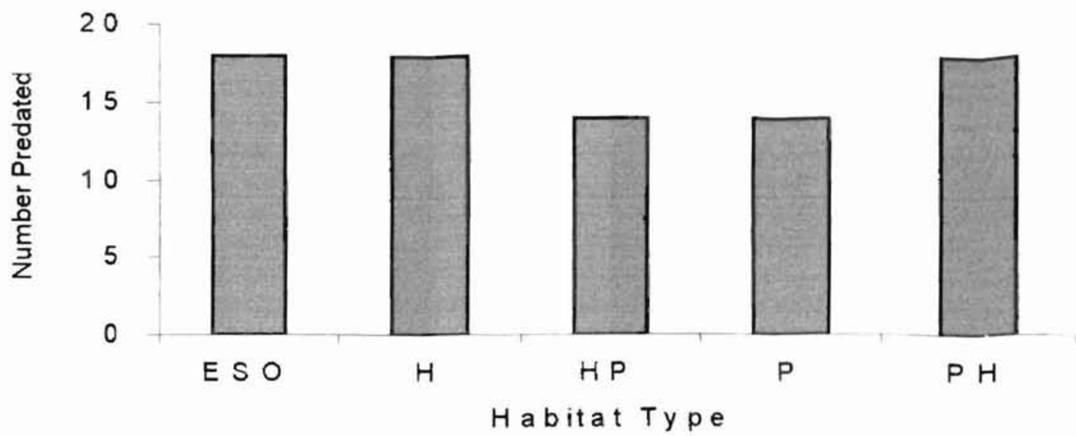

Figure 3. Number of artificial nests preyed on for each habitat type in 1998 at the Pushmataha WMA, Oklahoma. ESO = early to mid-successional openings, H = hardwood, HP = hardwood-pine, P = pine, and PH = pine-hardwood.

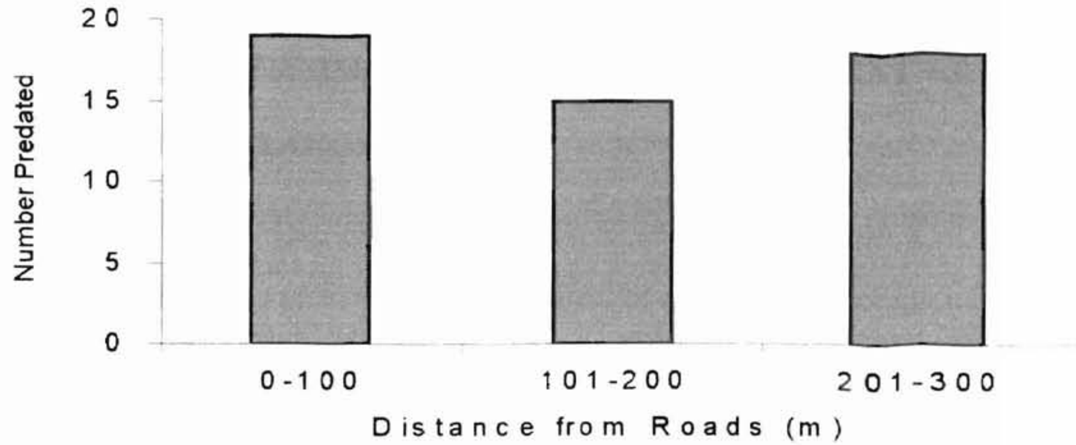

Figure 4. Number of artificial nests preyed on for each distance category in 1998 at the Pushmataha WMA. Oklahoma.

CHAPTER IV

SEASONAL EMPHASIS OF TURKEYS IN DIETS OF SYMPATRIC CARNIVORES AT THE PUSHMATAHA WILDLIFE MANAGEMENT AREA, IN SOUTHEASTERN OKLAHOMA

ABSTRACT

Declining populations of eastern wild turkey (*Meleagris gallopavo silvestris*) in southeastern Oklahoma, together with preliminary results from a study of the eastern wild turkey prompted this investigation of mammalian predators, their food habits, and habitat and road use. Food habit analysis was conducted to determine the importance of turkey in the diet of the mammalian predators on the study site. A total of 353 scats was collected along roadways on the study site. Across all predator species, turkey bones were found in only 30 (8.5%) scats, turkey feathers were found in only 5 (1.4%) scats, and egg fragments were found in only 3 (0.8%) scats. Turkey comprised only a small portion of the diets of the mammalian predators on this study area suggesting that turkeys are not a major food source for the various predators found on the area and that the decline in turkey populations is not totally contributed to consumption by predators. Thin-layer chromatography (TLC) was used to identify scats to species to better evaluate food habits by individual species of predators. Of 353 scats 111 (31.4%) were identified to species. Because TLC results were not clear and easy to specifically identify predator scats another means of scat identification is recommended.

INTRODUCTION

Various mammalian predators occur extensively throughout Oklahoma. Annual trapping and special license sales in Oklahoma remain low relative to the mid 1980's (Hoagland 1994). Because of the decreased interest in hunting and trapping of mammalian predators, it is likely that population densities of such predatory species have increased. Such an increase may have an impact on various prey populations (Kruuk 1982), including eastern wild turkey (*Meleagris silvestris gallopavo*).

Winter flock and summer brood surveys conducted by the Oklahoma Department of Wildlife Conservation in the mid 1990's indicated that densities of eastern wild turkey in southeastern Oklahoma were steadily declining (Dinkines and Smith 1993). More recent surveys, conducted in 1995 and 1996 indicate a slight increase in turkey population numbers (Dinkines and Smith 1996); however, preliminary data from an intensive 3-year study conducted by the Oklahoma Cooperative Fish and Wildlife Research Unit and the Oklahoma Department of Wildlife Conservation indicated that predation may be limiting turkey populations in this region and may have contributed to the earlier decline (Nicholson et al. 1998). Given the popularity of turkey hunting in southeastern Oklahoma, it was important to determine if predatory species such as the bobcat (*Lynx rufus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), gray fox (*Urocyon cineargenteus*), raccoon (*Procyon lotor*), opossum (*Didelphis virginiana*), skunk (*Mephitis mephitis*), free-ranging dogs, and feral hogs use the same habitat types as eastern wild turkeys and prey upon them frequently enough to depress or suppress populations. Accordingly, I assessed predator food habits to identify prey consumed and the relative importance of turkeys in their diets. My objective was to evaluate the effects of mammalian predators on a local population of wild turkeys, and the proportion of turkey in their diets..

Predation is often the major cause of mortality for adult wild turkey hens, especially during the reproductive period (Everett et al. 1980, Wagner 1993). Generally hens are more susceptible at this time because they are generally away from a flock and nesting on the ground instead of roosting in trees. Various mesocarnivores have been found to be predators to both adult wild turkey and poults. By deriving an estimate of the total number of occurrence for all prey items, and the percentage of occurrence for each individual prey item, I was able to offer area biologists basic information that can help in future research and management plans

STUDY AREA

The study was conducted in the Pushmataha Wildlife Management Area (PWMA) consisting of 7,390 ha in Pushmataha County, Oklahoma (34°32'N, 95°21'W). The PWMA was set aside as a deer refuge in the 1940's. The study site lies along the western edge of the Ouachita Highland Province.

The study area consisted of habitat types that were similar to habitat types found throughout southeastern Oklahoma. The overstory of the area consisted of oak-pine (*Quercus* spp.-*Pinus* spp.), dominated by post oak (*Q. stellata*), shortleaf pine (*P echinata*), blackjack oak (*Q. marilandica*), and hickory (*Carya* spp.) Dominant understory plants included flowering dogwood (*Cornus floridanus*), blueberry (*Vaccinium* spp.), blackberry (*Rubus* spp.), little bluestem (*Schizachyrium scoparium*), panicums (*Panicum* spp and *Dicanthelium* spp.), broomsedge (*Andropogon virginicus*), and big bluestem (*Andropogon gerardii*). Dominant woody vines included poison ivy

(*Toxicodendron radicans*), greenbriar (*Smilax bonanox*), Virginia creeper (*Parthenocissus quinquefolia*), and Muscadine grape (*Vitis rotundifolia*) (Masters 1991).

Climate was semi-humid to humid with hot summers and mild winters. Summer temperatures commonly exceeded 32°C with strong southerly winds. The mean maximum winter temperature was about 13°C. The average annual precipitation was 109-127 cm The annual precipitation varied seasonally and yearly. The yearly frost-free period averaged 190 days and occurred from late March to mid-October (Bain and Watterson 1979).

METHODS AND MATERIALS

Scats were used to assess diets of mammalian predators during critical times of the year relative to reproductive (1 April - 1 August) and non-reproductive (2 August -31 March --Nicholson et al. 1998) seasons of wild turkeys in southeastern Oklahoma. Roads on the study area were searched regularly for scats. Scats were placed in ziploc bags, labeled with date and location, and kept in an insulated cooler until the end of the day when they were transferred to a chest freezer. Realizing that scats may have a high degree of morphological difference because external fecal characteristics can be affected by diet, health, size and age of the individual (Fernandez et al 1997), allowing sympatric species of carnivores to produce feces that are similar in size and shape (Major et al 1980, Jimenez et al. 1996, Fernandez et al. 1997) no attempt at field identification of species of predator was made. Bile acids in feces of carnivores are species specific (Major et al 1980); thus, thin-layer chromatography (TLC) was used to identify scats to species (Aldred 1980, Major et al 1980, Clinite 1981, Johnson et al 1981, Capurro et al 1997, Fernandez et al. 1997)

At the end of field seasons in 1996 and 1997, scats were removed from the freezer, transferred to brown paper bags (lunch bags), given a unique I.D. number, and allowed to thaw. Scats were then oven dried at a relatively low temperature of 48.9°C for a minimum of 72 h. A high heat causes binding of bile acids (Johnson et al. 1980). Realizing the low temperature would not kill certain parasites, a surgical mask and latex gloves were worn when handling or preparing scats (A. Kocan, pers. comm.). Immediately upon removal from ovens, dry weight (nearest 0.1 g) was recorded for each scat.

Reference scats from known species were obtained from the Cincinnati Zoo (Cincinnati, Ohio), Tulsa Zoo (Tulsa, Oklahoma), Little River Zoo (Norman, Oklahoma), Randy Large (wildlife rehabilitator; Noble, Oklahoma), and Larry Levesque (graduate student at Oklahoma State University; Stillwater, Oklahoma), and prepared identically to the unknown scats.

About 1 g of fecal matrix (soluble fecal material, non-hair, and non- skeletal remains) was removed from each scat for TLC analysis. The remaining portions of the scat samples were saved for food-habit analysis. The 1 g of fecal matrix was pulverized using a mortar and pestle, placed in 50-ml falcon tubes (Midwest Scientific, St. Louis, Missouri), dissolved with 2- ml of methanol:mehylene chloride (1:1). Samples were centrifuged at 5,000 g for 10 min. and the supernatant was poured off into 20-ml scintillation bottles (Fisher Scientific, Pittsburgh Pennsylvania). Aliquots of the supernatant were seeded onto Whatman 60 F_{254} channeled silica gel plates (Fisher Scientific, Pittsburgh, Pennsylvania). Because spot characteristics can be influenced by local variables such as plate thickness, humidity, and temperature (Fernandez et al. 1997), 2 sets of standards were ran on each plate as a control. Standards consisted of a mixture of equal amounts of the most common bile acids found in carnivore feces (Major et al. 1980): lithocholic, chenodeoxycholic, cholic, hyodeoxycholic, hyocholic, and deoxycholic acids. Cholesterol was added as a reference compound because according to Fernandez et al. (1997), it is present in all fecal samples.

Plates were developed in a paper-lined, equilibrated bath containing 100 ml of Petcoff's solution : hexane:methylethylketone:acetic acid (56:36:8). Steroid bands were visualized by spraying the plate with 50% (by volume) sulfuric acid (Capurro et al. 1997, Fernandez 1997) at room temperature. Plates were placed on a heating block (ca.100° C) until color development was complete. Spots were observed under white light and ultraviolet light. Photographs were taken of the plate with white light using a plain lens and under ultraviolet light both before and after developing using an ultraviolet lens Instead of using Rf's (ratio of the distance that the solute moved to the distance traveled by the solvent front), we used Rc's, (ratio of the distance that the solute moved to the distance traveled by the cholesterol) (D. Brigham, pers. comm.). Compounds running further than cholesterol were assumed not to be bile acids (Capurro et al. 1997, Fernandez et al. 1997). Rc's were recorded along with color. Fecal samples were identified by comparing acids present between unknown and known samples.

For food habit analysis, dried scats were placed in finely sewn rip-stop nylon bags Their number was written in permanent marker on a piece of white flagging, placed in the bag, and on the outside of the bag. Bags were secured by twisting and bending over the top and securing with 2 rubber bands (Kelly 1991, Wagner 1993, Wagner, pers. comm.) Bags were placed in a rubber tub of warm water and soaked for ≥24 h at which time they were carefully kneaded to assist in the breakdown of fecal matrix (Springer and Smith 1981, Wagner 1993, Kelly 1991, Wagner, pers. comm.). The soak water was changed after the kneading process, and scats were soaked for another ≥24 h.

To remove excess mucus, bile salts, and fecal matter, bag-enclosed scats were washed in an automatic clothes washer (≤30 at a time) on gentle or permanent press settings. A low sudsing soap was used to help break down the residue (Springer and Smith 1981). Scats were run through 3-5 cycles or until the rinse water was relatively clear (Springer and Smith 1981, Kelly 1991, Wagner 1993). After washing, contents of bags were transferred to brown paper bags and oven dried at 48.9° C for a minimum of 48 h (Johnson and Hansen 1979, Kelly 1991, Wagner 1993)

Cleaned scats were emptied one at a time into a white tray. Recognizable food items were sorted and recorded for each scat. Food items were classified as plant, hair, bone (avian, mammal, and unidentifiable), skin, feathers (possible turkey and non-turkey), insect, crustacean, unidentified egg, and other. Food items were weighed to the nearest 0.1 g. The frequency nomenclature described by Wagner (1993) and Kelly (1991) was used to analyze food items in this study. "Percent of scats" (% scats) was defined as the percentage of a sample of scats in which a prey item occurs. "Percent occurrence" (% occurrence) was defined as the number of times a prey item occurs as a percent of total number of occurrences for all prey items. Percent of scats and percent of occurrence for each individual prey item were calculated collectively and for the reproductive (1 April - 1 August) and non-reproductive (2 August - 31 March) season of the wild turkey

RESULTS

Of all scats collected avian bones were found in 30 scats (8.5% scats, 2.2 % occurrence) egg remains were found in 3 scats (0.9% scats, 0.2% occurrence) and possible turkey feathers were found in 5 scats (1.4% scats, 0.4% occurrence --Table 1). During reproductive season avian bones were found in 8 scats (3.2% occurrence) egg remains were found in 1 scat (0.4% occurrence) and possible turkey feathers were found in 1 scat (0.4% occurrence --Table 2). During non-reproductive season avian bones were found in 21 scats (1.9% occurrence) egg remains were found in 1 scat (0.1% occurrence) and possible turkey feathers were found in 4 scats (0.4% occurrence -- Table 2)

Analysis of thin-layer chromatography plates and ultraviolet photo's provided only 111 (31.4%) positive identifications of 353 scats (43 bobcat, 24 opossum, 22 fox, 16 coyote, 4 raccoon, and 2 skunk), to species because of similarity in band location and color. Scats identified as skunk contained the most avian bone with 11.11 % occurrence and the most non-turkey feathers with 11 11% occurrence. Coyote scats identified containing avian bone had a 4.92% occurrence (Table 3)

DISCUSSION

According to Mills (1996), when conducting food habit studies, the contribution in terms of biomass can not be measured, data can only be analyzed on a presence or absence basis, realizing that this may allow some items (insects and rodent sized prey) to be over-represented. Wagner (1993) showed that wild turkey remains in scats are easier to identify than other birds because of larger bones and feathers. Wagner (1993) also conducted a feeding trial in which he found that 1-2-day-old poults would most likely not be detectable in field collected scats, while poults about 8 days old would be detectable.

In this study, I was primarily interested in assessing the impact of predators on the local populations of turkeys; therefore, prey items were sorted into major categories that allowed us to focus on primary food groups. Of all 353 scats examined, avian remains were minimal, which is similar to findings by Springer and Smith (1981), Bowyer et al. (1983), Craig (1986), Andelt et al. (1987), Hoerath (1990), Wagner 1993), Boileau et al. (1994), and Lewis et al. (1994). This study showed only 3 instances of egg remains, 32 instances of feathers (5 of which were possibly turkey), and 30 instances of avian bone. When comparing percentage of occurrence, avian remains were only represented as: avian bone = 2.1%, non-turkey feather = 2.0%, possible turkey feather = 0.4%, and egg = 0.2%. When looking at the percent occurrence of food items within different seasons (reproductive vs. non-reproductive), avian remains were present at a greater extent during the non-reproductive season. This may be explained in part by the fact that some scats were collected in vicinities of turkey bait or trap sites (during trapping season for the turkey research project). Some of the unusual things found in scats and classified as "other" were: cotton string, aluminum foil, seran wrap, bologna rind, and the knot from a turkey transmitter harness. The scat that contained the portion of harness also contained avian bones, indicating that the adult bird was predated or scavenged (it was not possible to know if food items were killed or scavenged -- Mills, 1996)

Extensive analysis of thin-layer chromatography (TLC) plates and ultraviolet photo's yielded relatively few conclusive results because of similarity in band location and color. This is contradictory to findings from Major et al. (1980) and Capurro et al. (1997), but in concurrence with Quinn and Jackman (1994) and Jimenez et al. (1996). According to Quinn and Jackman (1994), fruit in coyote diet can increase scat deposition rate and also may reduce the concentration of fecal bile acids. Plant material occurred in 278 of the 353 scats (78.7%), with fruit comprising a large proportion of the total plant materials. Quinn and Jackman (1994) also found that Major et al. (1980) and Johnson et al.(1981 and 1984) did not provide conclusive evidence that TLC could be used in the identification of species by bile acids. Using scats from known species, they found variation in bile acids within the same species, as well as the same bile acids among different species. Similar results were observed in this study. According to Quinn and Jackman (1994), at least 5 other papers were cited, thus giving the impression that the TLC technique was accurate and could be used to distinguish species through the use of scats. However, Quinn and Jackman (1994) felt that the effect of diet needs to be better understood before thin layer chromatography of bile acids is considered effective. Another problem is that many studies obtain reference scats from zoos or captive specimens, while unknown scats are collected from the wild. This would explain the fact that most of our samples would not match the reference scats used. Jimenez et al. (1996) warned that TLC not be used to distinguish between sympatric carnivores.

MANAGEMENT IMPLICATIONS

Additional collection of scats and food habit studies are recommended throughout the year for continuous years. Because results from thin-layer chromatography results were not clear and easy to specifically identify predator scats it is not recommended. DNA methods have been used to identify samples of field collected feces to species for the brown bear (*Ursus arctos* -- Hoss et al. 1992, and Kohn et al. 1995), baboons (Constable et al. 1995), and seals (Reed et al. 1997). If positive identification to species is required, a DNA analysis is recommended.

While data and evidence from concurrent studies (Nicholson et al. 1998) showed that turkeys are predated by both avian and mammalian predators, this study found that turkey comprised only a small portion of the diets of the mammalian predators on this study area suggesting that turkeys are not a major food source for the various predators found on the area and that the decline in wild turkey populations is not totally contributed to consumption by predators.

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Table 1. Food item, number of occurrences, percent scats and percent occurrence (all scats collected) of items identified in collected scats from Pushmataha WMA, Oklahoma.

Food item	Number of Occurrences	% scat	% occurrence
Bone (avian)	30	8.5	2.2
Bone (mammal)	157	44.5	11.4
Bone (total)	205	58.1	14.9
Bone (unidentified)	49	13.9	3.6
Crustacean	2	0.6	0.2
Egg	3	0.9	0.2
Feather (non-turkey)	27	7.6	2.0
Feather (possible turkey)	5	1.4	0.4
Hair	287	81.3	20.8
Insect	162	45.9	11.8
Plant	278	78.8	20.2
Skin	101	28.6	7.3
Unidentified	61	17.3	4.4
Other*	10	2.8	0.7

*Man-made items

Table 2. Food items in scats, number of occurrences, percent occurrence during the reproductive season (1 April - 1 August), percent occurrence during the non-reproductive season (2 August - 31 march) for items identified in scats collected from Pushmataha WMA, Oklahoma.

Food item	# of occurrences reproductive season	% occurrence reproductive season	# of occurrences non-reproductive season	% occurrence non-reproductive season
Bone (avian)	8	3.2	21	1.9
Bone (mammal)	34	13.7	120	10.9
Bone (total)	40	16.1	162	14.7
Bone (unidentified)	9	3.6	40	3.6
Crustacean	0	0.0	2	0.2
Egg	1	0.4	1	0.1
Feather (non-turkey)	3	1.2	24	2.2
Feather (possible turkey)	1	4.0	4	0.4
Hair	50	20.1	231	21
Insect	22	8.8	136	12.4
Plant	45	18.1	226	20.6
Skin	24	9.6	76	6.9
Unidentified	12	4.8	47	4.3
Other*	0	0.0	10	0.9

*Man-made items

Table 3. Food habits of species identified through thin layer chromatography on the Pushmataha WMA, Oklahoma, denoted as percent occurrence (Bone (mam) = mammal bone, Bone (unid.) = unidentified bone, Feather (nt) = non-turkey feather, Feather (poss turk) = possible turkey feather, Unid. = unidentified).

Food Item	Bobcat *n*=43	Coyote *n*=16	Fox *n*=22	Opossum *n*=24	Raccoon *n*=4	Skunk *n*=2	Unid. *n*=243
Bone (avian)	0.64	4.92	2.17	2.97	0.00	11.11	2.12
Bone (mam)	14.65	13.11	13.04	10.89	15.38	0.00	10.70
Bone (total)	17.83	16.39	15.22	14.85	15.38	11.11	14.30
Bone (unid.)	3.18	1.64	2.17	2.97	0.00	11.11	3.92
Crustacean	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Egg	0.00	0.00	0.00	0.00	0.00	0.00	0.32
Feather (nt)	2.55	0.00	2.17	0.99	0.00	11.11	2.01
Feather (poss turk)	0.00	0.00	0.00	0.00	0.00	0.00	0.53
Hair	21.02	24.59	20.65	17.82	15.38	22.22	20.97
Insect	10.19	6.56	9.79	15.84	15.38	11.11	12.08
Plant	19.75	18.03	21.74	18.82	23.08	22.22	20.34
Skin	4.46	9.84	9.78	5.94	7.70	0.00	7.63
Unidentified	5.09	1.64	2.17	6.93	7.70	0.00	4.45
Other*	0.64	3.28	1.09	1.98	0.00	0.00	0.42

* Man-made items

VITA

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