

Evaluation of Southeastern Coyote Diets During the Wild Turkey Reproductive Season

Guy D. Wagner,¹ *Mississippi Cooperative Fish and Wildlife Research Unit, P.O. Drawer BX, Mississippi State, MS 39762*

Edward P. Hill,² *Mississippi Cooperative Fish and Wildlife Research Unit, P.O. Drawer BX, Mississippi State, MS 39762*

Abstract: The role of coyotes (*Canis latrans*) as predators of wild turkeys (*Meleagris gallopavo*) remains unclear. We determined proportion of wild turkey and other prey species in coyote scats collected during the wild turkey reproductive and non-reproductive seasons from 4 study areas with wild turkey populations. Wild turkey constituted only a small portion ($\bar{x} = <4\%$) of coyote diet on all study areas. Wild turkey increased in coyote diet during the wild turkey reproductive season, but the differences were not significant. Wild turkeys have evolved in the presence of predators and possess adaptations for dealing with predation such as wariness, large clutch sizes, and roosting at night. Wild turkeys in quality habitat appear to maintain populations when sympatric with coyotes.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 48:173-181

Few wild canids occurred east of the Mississippi River before coyotes (*Canis latrans*) began spreading across the Southeast during the late 1960s (Paradiso 1966, Gipson 1978, Hill et al. 1987). Coyotes now exist in all southeastern states and are likely a permanent addition to southeastern fauna.

Adult wild turkey (*Meleagris gallopavo*) hens and their poults sustain higher mortality rates from predation during the reproductive period (March to July) (Glidden and Austin 1975, Everett et al. 1980, Speake 1980, Williams 1980, Speake et al. 1985, Exum et al. 1987, Seiss 1989, Palmer 1990). Hens are most vulnerable during the incubating and early brood-rearing periods, when mortality rates range from 20%–40%. Annual poult loss rates frequently exceed 80%. Poults surviving the initial flightless period (approximately 14 days) have a much higher survival rate (Williams and Austin 1988). Nest destruction by mamma-

¹ Present address: Department of Fish and Wildlife Resources, University of Idaho, Moscow, ID 83843.

² Present address: Denver Wildlife Research Center, P.O. Box 25266, Bldg. 16, Denver Federal Center, Denver, CO 80225-0266.

lian predators also causes appreciable reductions in wild turkey recruitment (Leopold and Miller 1992). Although feral dogs (*Canis familiaris*) and grey foxes (*Urocyon cinereoagenteus*) were considered important predators of wild turkey hens, poults, and nests (Everett et al. 1980, Speake 1980), the coyote's role as predator of wild turkeys in the Southeast remains unclear.

Estimating proportion of wild turkey in coyote diet during the wild turkey reproductive season may provide information on coyote/wild turkey relations. Nine previous studies of coyote diet had been conducted in the Southeast (Gipson 1974, Wilson 1967, Michaelson 1975, Hall 1979, Smith and Kennedy 1983, Wooding 1984, Lee 1986, Blanton 1988, and Hoerath 1991), but few can be geographically linked to areas of abundant wild turkey populations and temporally linked to the reproductive period.

The study's objectives were 1.) to determine, in areas of wild turkey abundance, proportion of wild turkey in coyote diet during the wild turkey reproductive season in order to test the null hypothesis that wild turkey remains did not increase in the coyote diet during the wild turkey reproductive season and 2.) to evaluate digestion of prey items by using captive coyotes.

We thank the Mississippi Department of Wildlife, Fisheries and Parks and Mississippi Cooperative Fish and Wildlife Research Unit for funding the study, and L. A. Brennan, B. D. Leopold, G. A. Hurst, and R. N. Griffin for statistical and editorial advice. Special thanks is extended to B. T. Kelly for sharing his knowledge of coyote feeding ecology and carnivore scat analysis. We are indebted to M. Bice and D. Nelson of the Alabama Department of Conservation for their help conducting feeding trials. We also thank C. Sisson of Tall Timbers Research Station, D. Everett of Sumter Farms, M. Staten and R. Williams of Merigold Hunting Club, and M. Perry and R. Standridge of Holla Bend National Wildlife Refuge for providing study areas and general assistance throughout the study.

Methods

Study Areas

Techniques to accurately census wild turkey populations remain undeveloped (G. A. Hurst, pers. commun.). However, certain areas of the Southeast are well known for their abundant wild turkey populations. We identified 4 such areas as study sites, with the additional criteria of presence of coyotes and existence of a network of roads and trails.

Tall Timbers Research Station was located in Leon County, Florida. Approximately 85% of the area was dominated by mature, large diameter stands of loblolly pine (*Pinus taeda*) and shortleaf pine (*P. echinata*). Hardwood stands occurred along streams throughout the pine uplands. Wild turkey populations were considered moderately high relative to the South in general (D. Speake, pers. commun.) and the wild turkey population was estimated as 75 individuals or approximately 0.06 turkeys/ha (C. Sisson, game bird manager).

Sumter Stock Farms Inc., located in Sumter County, Alabama, was intensively managed for northern bobwhite quail (*Colinus virginianus*), white-tailed deer (*Odocoileus virginianus*), and wild turkey. Vegetation consisted of a heterogeneous mix of upland pine sites, bottomland hardwoods, and food plots. The resident wild turkey population was estimated as 300 to 500 wild turkeys or 1.4 turkeys/ha (D. Everett, Sumter Farms wildlife manager).

Merigold Hunting Club, in Bolivar County, Mississippi, was bordered on the west by the Mississippi River and on the east by the main levee. Most of the area was bottomland hardwood forest, but several large openings existed on old sand bars. Estimated density of wild turkeys was 0.09 turkeys/ha (Kenamer 1986).

Holla Bend National Wildlife Refuge was located on the floodplain of the Arkansas River in Perry County, Arkansas. The center of the refuge was intensively farmed to furnish food for wintering waterfowl. Bottomland hardwood forests surrounded the agricultural lands. Refuge staff estimated that 150 to 200 wild turkeys lived on the refuge. Disregarding acreage of open cropland and water, a density of 0.11 turkeys/ha was estimated.

Sample Collection

Roads and trails were traveled on each study area, and coyote scats were collected, placed in plastic bags, labeled, and frozen until analyzed. Study areas were visited at approximately 2-week intervals. Scats were collected from 15 March to 12 July 1991 and 16 March to 1 August 1992. As a control, we collected scats during the nonreproductive period from 16 January to 15 March 1992. Collection periods were determined from information provided by an ongoing wild turkey study at Tall Timbers, breakup of winter flocks, and Williams and Austin (1988). Scats were identified to species using size, conformation, odor, and presence of tracks or other field sign (Murie 1974). Scats not identifiable to species were not collected.

Sample Processing and Identification of Prey Remains

Scats were dried at 60–80 C for at least 48 hours to kill eggs of parasitic nematodes. Scats were sealed in rip-stop nylon bags and soaked for 48 hours. Bags were kneaded to help breakdown the fecal matrix. To remove mucus, bile salts, and fecal matter, bags were washed in an automatic clothes washer, then oven dried at 60–80 C for at least 8 hours (Kelly 1991).

Each scat's residue was weighed, and then spread over a 0.5 × 0.5-cm screen to facilitate separation of bone, hair, and other diagnostic parts. Remains were identified to the lowest taxon possible by using reference collections of hair, seeds, feathers, teeth, and bones obtained from species inhabiting the study areas. In addition, mammalian hair (Moore et al. 1974, Wilkins et al. 1982) and skull keys (Glass 1951, Brown 1952) were used to identify mammalian remains, and feathers were identified to Order (Day 1966). To facilitate further identification, a reference collection of wild turkey feathers, body parts (from a variety

of ages), and egg shells was assembled. If wild turkey remains were mixed with other species within a scat, then proportion of weight attributed to wild turkey was ocularly estimated. Ocular estimates were checked by directly weighing the separated wild turkey remains and dividing by the scat's total residue weight.

Feeding Trials

One- to 2-day-old domestic turkey poults, approximately 8-day-old wild turkey poults, and wild turkey eggs were fed to captive coyotes in separate trials to qualitatively examine their detectability in coyote scats. Eggshell fragments occurring in field-collected scats were compared to wild turkey eggshell fragments recovered from the feeding trial scats. Eggshell fragments occurring in field-collected scats were classed as either possibly wild turkey or definitely not wild turkey. Wild turkey eggshell fragments also were compared to eggshell fragments of other large ground-nesting birds.

We calculated the biomass of wild turkey represented in a sample of scats following Kelly (1991). A ratio estimator (Cochran 1977) for wild turkey was developed to correct the non-flesh component bias. Eight hen wild turkeys were obtained from the Alabama Department of Natural Resources and fed to captive coyotes. Live weight of wild turkey fed divided by weight of residue recovered from resulting scats produced the ratio estimator. The ratio estimator multiplied times the weight of wild turkey residue recovered from field-collected scats estimated the biomass of wild turkey represented in a sample of scats. Biomass estimates of other prey species represented in a sample also were calculated (Wagner 1993). Dividing biomass of wild turkey by total biomass of all prey items in a sample estimated percent biomass of wild turkey represented in a sample.

Data Analysis

We defined "percent of scats" as the percent of a sample of scats in which a prey species occurs and "percent of occurrences" as number of times a prey species occurs as a percent of total number of occurrences for all prey species (Kelly 1991). Percent of scats and percent of occurrences for each prey item were calculated by study area, year, and season (reproductive or nonreproductive) (Wagner 1993).

Scats were classified as containing or not containing turkey remains. A binomial test for the differences between 2 proportions (Zar 1984:395) was used to test the null hypotheses that no significant differences existed in proportions of scats containing wild turkey between the winter nonbreeding season and each reproductive season for each study area, and that no significant differences existed in proportions of scats containing wild turkey between the 2 reproductive seasons for each study area. A 4×2 G-factor test of independence (Sokal and Rohlf 1981:731-746) was used to test the null hypothesis that no significant differences existed in proportions of wild turkey occurrences between the 4 study areas. A 2×2 G-factor test of independence was used to test the hypothe-

sis that proportion of scats containing wild turkey was equal between winter control period and reproductive seasons with data from all study areas and both reproductive seasons combined. Two tests were conducted, with and without eggshells believed to be from wild turkey. All tests were conducted at 0.05 level of significance.

Results

During the reproductive season, percent of scats containing wild turkey components equaled 1.7% ($N = 688$), not counting wild turkey-like eggshells, and 3.2% counting wild turkey-like eggshells as occurrences of wild turkey (Table 1). Estimated total biomass of wild turkey consumed during the wild turkey reproductive seasons was 10.51 kg or 4.0% of total fresh weight of prey. Wild turkey occurred in only 1 scat of 218 (0.46%) collected during the winter nonreproductive season.

There were no significant differences ($P = 0.32$ Tall Timbers, $P = 0.10$ Sumter Farms in 1991; $P = 0.98$ Tall Timbers, $P = 0.51$ Sumter Farms, $P = 0.23$ Merigold Hunting Club in 1992) in proportion of scats containing wild turkey between scats collected during the reproductive season (1991 or 1992) and scats collected from winter of 1992. There were no occurrences of wild

Table 1. Frequency and biomass estimates of wild turkey occurring in coyote scats collected from Tall Timbers Research Station, Florida; Sumter Farms, Alabama; Merigold Hunting Club, Mississippi; and Holla Bend National Wildlife Refuge, Arkansas, during the wild turkey reproductive season, 1991 and 1992.

Year	<i>N</i>	<i>N</i> Occurrences ^a	% Wt ^b	% Occurrence ^c	kg ^d	% Fresh weight
Sumter Farms						
1991	130	5 (2)	3.9 (1.5)	1.7 (0.7)	5.6	13.6
1992	155	1 (0)	0.7 (0.0)	0.3 (0.0)	1.1	2.3
Tall Timbers						
1991	41	0 (0)	0.0 (0.0)	0.0 (0.0)	0.0	0.0
1992	86	2 (1)	2.3 (1.2)	1.1 (0.5)	1.8	7.5
Merigold Hunting Club						
1991	34	0 (0)	0.0 (0.0)	0.0 (0.0)	0.0	0.0
1992	115	4 (4)	3.5 (3.5)	1.6 (1.5)	2.0	6.8
Holla Bend National Wildlife Refuge						
1991	58	0 (0)	0.0 (0.0)	0.0 (0.0)	0.0	0.0
1992	69	0 (3)	0.0 (4.4)	0.0 (2.1)	0.0	0.0
Total	688	12 (10)	1.7 (1.5)	0.8 (0.7)	10.51	4.0

^aNumber of occurrences of wild turkey; numbers in parentheses represent number of occurrences of wild turkey-like eggshells.

^bPercent of scats containing wild turkey remains and wild turkey-like eggshells.

^cPercent of total occurrences for wild turkey and wild turkey-like eggshells.

^dEstimated biomass of wild turkey consumed in sample.

^ePercent fresh weight of wild turkey consumed in sample.

turkey in scats collected from Merigold Hunting Club in 1991 and Holla Bend National Wildlife Refuge in 1991 or 1992. No significant differences existed between reproductive seasons within study area ($P = 0.33$ Tall Timbers, $P = 0.06$ Sumter Farms, $P = 0.34$ Merigold Hunting Club). No significant differences ($G = 2.96$, $P = 0.40$) existed among the 4 study areas in the proportion of wild turkey occurrences. When combining data across study area and year, there was no significant increase in percent of scats containing wild turkey during the reproductive season compared to winter ($G = 2.43$, $P = 0.12$). Statistical power equaled approximately 0.85 (Cohen 1977).

When we counted wild turkey-like eggshells as wild turkey occurrences in scats, a 2×2 G-factor test of independence showed a significant increase ($G = 6.86$, $P = 0.01$) in wild turkey remains during the spring reproductive season. Statistical power equaled approximately 0.85 (Cohen 1977).

The ratio estimator developed from feeding trials using 8 hen wild turkeys equaled 101.60 g of turkey per 1 g of scat residue ($N = 28$) with a variance of 277.20 g. Percent fresh weight of prey consumed in a sample ranged from 0–13.6% (Table 1). Qualitative examination of feeding trial scats containing 1- to 2-day-old domestic turkey poults showed that turkey poults of this age would likely not be detectable in field-collected scats. Wild turkey poults approximately 8 days old would be detectable in field-collected scats based on similar feeding trials. Therefore, a gap existed between hatching and approximately 1 week old, where scat analysis may not have reliably indicated proportion of poults in coyote diet. One field-collected scat in this study contained identifiable remains of a wild turkey poult.

Rodents, lagomorphs, white-tailed deer, and fruit constituted most of coyote diet on the 4 study areas. However, wild hogs (*Sus scrofa*) also were important at Merigold Hunting Club. Proportions of other prey species are reported by Wagner (1993).

Discussion

We collected scats during the wild turkey reproductive season on 4 different study areas believed to have abundant wild turkey populations, yet wild turkeys constituted a minor proportion of coyote diet (0–3.9%). Only 2 previous southeastern coyote diet studies (Lee 1986, Hoerath 1991) reported occurrence of wild turkey, but neither study was designed to assess occurrence of wild turkey in coyote diet during the wild turkey reproductive season. Hoerath (1991) reported an annual occurrence of 0.2% for wild turkey from a study area in Sumter County, Alabama; whereas Lee (1986) did not report a specific percentage.

Wild turkey did not increase significantly in coyote diet during the reproductive season. However, the increase was statistically significant when wild turkey-like eggshell fragments were considered. Hoerath (1991) reported avian eggshells occurring in 5.2% of spring scats and 2.9% of summer scats, "with most being thick and/or flat enough to conform to turkey."

Coyotes have been reported to prey on adult wild turkeys (Leopold and Miller 1992), but because wild turkeys constituted a minor portion of coyote diet in the present study, they apparently are not regularly successful on the 4 study areas during winter or reproductive season. Furthermore, coyotes are scavengers, and presently it is not possible in scats or stomach analyses to distinguish scavenged remains from actual kills. Some, or possibly all, of the wild turkey remains identified in this study could have been scavenged.

The role of coyotes as predators of newly-hatched wild turkey poults remains unclear, because poults <1 week old are unlikely to be detected by scat analysis. Coyotes were documented as consuming wild turkey poults at Tall Timbers during the 1992 reproductive season (C. Peoples, pers. commun.). However, this study indicates poults >1 week old constitute a very small proportion of coyote diet.

Wild turkeys constituted a greater portion of coyote diets, when viewed from a biomass perspective rather than a frequency perspective. Frequency data may not have accurately represented proportions of actual prey biomass consumed, because 2 biases were present, the non-flesh component bias and an equal occurrences bias (Lockie 1959, Floyd et al. 1978, Kelly 1991). However, the proportion of wild turkey consumed remained low relative to other prey species (Table 1). Biomass estimates of wild turkey for each study area and season were less than or equal to the weight of a single adult hen (3.6 to 5.0 kg, Pelham and Dickson 1992).

Management Implications

Effects of coyote predation on wild turkey populations may best be determined within the context of other interacting variables affecting wild turkeys such as food sources, diseases, weather, and possible other predators. Analysis of coyote diet alone may not reflect effects of coyote predation on wild turkey populations. The infrequent occurrence and small biomass of wild turkeys represented in the scat samples leads to the inference that coyotes do not limit or cause declines in wild turkey populations. Wild turkeys have evolved in the presence of predators and possess many adaptations, such as wariness, large clutch sizes, reneating, roosting at night, flocking, longevity, and large body size for dealing with predation (Leopold and Miller 1992). Given quality habitat and carefully managed human impacts, wild turkeys should be able to maintain populations when sympatric with coyotes.

Literature Cited

- Blanton, K. M. 1988. Summer diet of coyotes in the southeast, and the response of coyotes to siren surveys. M.S. Thesis, Miss. State Univ., Mississippi State. 82pp.
- Brown, G. H. 1952. Illustrated skull key to the recent land mammals of Virginia. Release No. 52-2. Va. Coop. Wildl. Res. Unit., Blacksburg. 75pp.

- Cochran, W. G. 1977. Sampling techniques. 3rd. ed. J. Wiley & Sons, Inc., New York, N.Y. 428pp.
- Cohen, J. 1977. Statistical power analysis for the behavioral sciences. Acad. Press, New York, N.Y. 474pp.
- Day, M. G. 1966. Identification of hair and feather remains in gut and faeces of stoats and weasels. *J. Zool. Proc.* 148:201–217.
- Everett, D. D., D. W. Speake, and W. K. Maddox. 1980. Natality and mortality of a north Alabama wild turkey population. *Proc. Natl. Wild Turkey Symp.* 4:117–126.
- Exum, J. H., J. A. McGlincy, D. W. Speake, J. L. Buckner, and F. M. Stanley. 1987. Ecology of the eastern wild turkey in an intensively managed pine forest in southern Alabama. *Tall Timbers Res. Bul. No. 23.* Tallahassee, Fla. 70pp.
- Floyd, T. J., L. D. Mech, and P. A. Jordan. 1978. Relating wolf scat content to prey consumed. *J. Wildl. Manage.* 42:528–532.
- Glass, B. P. 1951. A key to the skulls of North American mammals. *Dep. Zool. Okla. Agric. and Mechanical Coll., Stillwater.* 54pp.
- Gipson, P. S. 1974. Food habits of coyotes in Arkansas. *J. Wildl. Manage.* 38:848–853.
- . 1978. Coyotes and related *Canis* in the southeastern United States with a comment on Mexican and Central American *Canis*. Pages 191–208 in M. Bekoff, ed. *Coyotes: biology, behavior, and management.* Acad. Press, New York, N.Y.
- Glidden, J. W. and D. E. Austin. 1975. Natality and mortality of wild turkey poults in southwestern New York. *Proc. Natl. Wild Turkey Symp.* 3:48–54.
- Hall, D. I. 1979. An ecological study of the coyote-like canid in Louisiana. M. S. Thesis, La. State Univ., Baton Rouge. 233pp.
- Hill, E. P., P. W. Sumner, and J. B. Wooding. 1987. Human influences on range expansion of coyotes in the southeast. *Wildl. Soc. Bul.* 15:521–524.
- Hoerath, D. 1991. Influences of coyotes on game animals as monitored by fecal analysis. M.S. Thesis. Auburn Univ., Auburn, Ala. 51pp.
- Kelly, B. T. 1991. Carnivore scat analysis: an evaluation of existing techniques and the development of predictive models of prey consumed. M.S. Thesis, Univ. Idaho, Moscow. 200pp.
- Kennamer, J. E. 1986. Guide to the American wild turkey. *Natl. Wild Turkey Fed., Inc.* Edgefield, S.C. 189pp.
- Lee, R. M., III. 1986. Food habits of the coyote, *Canis latrans* in Tennessee. M.S. Thesis, Memphis State Univ. Memphis, Tenn. 55pp.
- Leopold, B. D. and J. E. Miller. 1992. Population influences: predation. Pages 119–128 in J. Dickson ed. *The wild turkey, biology and management.* Stackpole Books, Harrisburg, Pa.
- Lockie, J. D. 1959. The estimation of the food of foxes. *J. Wildl. Manage.* 23:224–227.
- Michaelson, K. A. 1975. Food habits of coyotes in northwest Louisiana. M.S. Thesis, La. Tech Univ., Ruston. 28pp.
- Moore, T. D., L. E. Spence, C. E. Dugnolle, and W. G. Hepworth. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. *Wyo. Game and Fish Dep. Bul.* 14. 177pp.
- Murie, O. J. 1974. A field guide to animal tracks. Second ed. Houghton Mifflin Co., Boston, Mass. 375pp.
- Palmer, W. E. 1990. Relationships of wild turkey hens and their habitat on Tallahala Wildlife Management Area. M.S. Thesis, Miss. State Univ., Mississippi State. 117pp.

- Paradiso, J. L. 1966. Recent records of coyotes, *Canis latrans*, from the southeastern states. Southwest Nat. 11:500-501.
- Pelham, P. H. and J. G. Dickson. 1992. Physical characteristics. Pages 32-45 in J. G. Dickson, ed. The wild turkey, biology and management. Stackpole Books, Harrisburg, Pa.
- Seiss, R. S. 1989. Reproductive parameters and survival rates of wild turkey hens in east-central Mississippi. M.S. Thesis, Miss. State Univ., Mississippi State. 99pp.
- Smith, R. A. and M. L. Kennedy. 1983. Food habits of the coyote (*Canis latrans*) in western Tennessee. J. Tenn. Acad. Sci. 58:27-28.
- Sokal R. R. and F. J. Rohlf. 1981. Biometry. Second ed. W. H. Freeman and Co., San Francisco, Calif. 859pp.
- Speake, D. W. 1980. Predation on wild turkeys in Alabama. Proc. Natl. Wild Turkey Symp. 4:86-101.
- , D. W., R. Metzler, and J. McGlincy. 1985. Mortality of wild turkey poults in northern Alabama. J. Wildl. Manage. 49:472-474.
- Wagner, G. W. 1993. Coyote diet in areas of wild turkey abundance during the wild turkey reproductive season. M.S. Thesis, Miss. State Univ., Mississippi State. 144pp.
- Wilkins, L., M. Langworthy, C. D. Rathbun, and R. Sullivan. 1982. Identification of the dorsal guard hairs of some Florida mammals. Unpubl. rep., Fla. State Museum, Gainesville. 59pp.
- Williams, L. E. and D. H. Austin. 1988. Studies of the wild turkey in Florida. Florida Game and Fresh Water Fish Comm., Tech. Bul. No. 10. Tallahassee. 232pp.
- . 1980. Turkey nesting success on a Florida study area. Proc. Natl. Wild Turkey Symp. 4:102-107.
- Wilson, W. C. 1967. Food habits of the coyote, *Canis latrans*, in Louisiana. M.S. Thesis, La. State Univ., Baton Rouge. 50pp.
- Wooding, J. B. 1984. Coyote food habits and the spatial relationship of coyotes and foxes in Mississippi and Alabama. M.S. Thesis, Miss. State Univ., Mississippi State. 43pp.
- Zar, J. H. 1984. Biostatistical Analysis. Second ed. Prentice-Hall, Inc., Englewood Cliffs, N.J. 718pp.