Factors Affecting Gobbling Activity of Wild Turkeys in Central Mississippi

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Abstract: Call counts for a number of gamebirds (e.g., northern bobwhite [*Colinus virginianus*] and wild turkey [*Meleagris gallopavo*]) have been used to index population levels and trends and to document species presence or absence. Call counts for wild turkeys have been used for these purposes, but gobbling activity has not been related quantitatively to population size, reproduction, weather, male age structure, or hunting variables. Consequently, we examined these factors as they affected gobbling activity on Tallahala Wildlife Management Area, Bienville National Forest, in central Mississippi, from 1984 to 1995. Using multiple linear regression, we determined that within-year gobbling activity was related to hunter effort, days into call count period, wind velocity, year, and dewpoint. Among years, gobbling activity was related to hunter effort and hunter success. An index to proportion of 2-year-old gobblers in the population was correlated to an increased number of gobblers heard, but not number of calls heard. Gobbling activity was influenced by a complex interaction of population and environmental conditions that cannot easily be modeled. In central Mississippi, gobble call counts were not related to gobbler population size, and their applicability in other areas warrants examination.

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Call count surveys have been used widely to index upland game bird species in the Southeast, especially wild turkeys (Lint et al. 1995), mourning dove (*Zenaida macroura*; Tomlinson et al. 1994), and northern bobwhite (Brennan et al. 1997). Rosene (1957) believed whistling counts of male bobwhite during summer provided an index to fall and winter population size. Norton et al. (1961) challenged this conclusion and Brennan et al. (1997) determined bobwhite call counts were poor

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predictors in Georgia. Mourning dove call counts may be too variable to precisely estimate breeding pair densities on a local scale (Armbruster et al. 1978). However, Tomlinson et al. (1994) concluded nationally standardized dove call counts have performed well in indexing long-term population trends.

Several researchers have investigated wild turkey gobbling activity to monitor turkey abundance, but these studies have been limited in scope and/or presented conflicting results. Bevill (1973), in South Carolina, determined gobbling activity was affected by dewpoint, cloud cover, and wind velocity. However, Scott and Boeker (1972), in Arizona, were not able to correlate weather with gobbling activity. Kienzler et al. (1996), in Iowa, related presence of hunters, temperature, light intensity, precipitation, and wind to gobbling activity. They estimated hunting was responsible for a mid-season decrease in gobbling activity. Bevill (1973) based his results on intensive monitoring of 5 adults and 7 subadults for 24 days during 1 spring. Kienzler et al. (1996) and Scott and Boeker (1972) both used <4 years of data.

Porter and Ludwig (1980) and Scott and Boeker (1972) determined gobble call counts may be useful population indices. However, in central Mississippi, Palmer et al. (1990) determined call counts were weakly correlated with population estimates. On the same area in Mississippi, Lint et al. (1995) determined number of gobblers heard per day was correlated to number of harvested gobblers (i.e., males) and harvest effort but not to gobbler population size.

No previous study has simultaneously related weather, harvest characteristics, nest success, and turkey population size to gobble call counts. Additionally, no one has investigated quantitatively effects of gobbler age structure on gobbler activity. Furthermore, most studies used <5 years of data which have limited applicability in accounting for long-term trends and changes in environmental conditions (Leopold et al. 1996). We used 12 years of continuous data (i.e., gobble call counts, weather variables, harvest records, nesting success, population estimates) to (1) determine factors affecting gobbling activity of eastern wild turkeys within and among years and (2) examine effects of age structure on gobbling activity.

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Methods

Our study area was the 14,410-ha Tallahala Wildlife Management Area (TWMA) located within the Bienville National Forest in parts of Scott, Newton, Jasper, and Smith counties, Mississippi. It was located within the Lower Coastal Plain Province and the Blackland Prairie Resource Area (Pettry 1977). Most (95%)

of TWMA was forested with 30% in mature bottomland hardwood forests, 37% in mature pine (*Pinus* spp.) forests, 17% in mixed pine-hardwood forests (30%–70% pine), and 11% in 0- to 14-year-old loblolly pine (*P. taeda*) plantations. The remaining 5% was comprised of openings, human habitations, and odd areas.

We conducted gobble call counts 3 days/week from 10 March to 7 May 1984–1995. Call counts began 1 week before and ended 1 week after spring turkey hunting season. This period encompassed the wild turkey mating season. We listened for gobbling turkeys from 2 routes composed of 10 and 8 stations from 30 minutes before sunrise to 30 minutes after sunrise (Bevill 1975, Lint et al. 1995). We located stations along U.S. Forest Service roads throughout the study area at 1.6-km intervals. Observers listened 4 minutes at each station. During inclement weather (rain or wind ≥6.25 km/hour), counts were postponed until the next possible day. Sampling stations were positioned to effectively census 60%–75% of TWMA. Distances between stations minimized the possibility of hearing the same turkey from >1 location, although this may have occurred. Every turkey heard was recorded as a unique observation with no attempt made to determine if the same gobbler was heard from multiple stations. Observers were experienced and/or trained to detect gobbling, although hearing examinations, to standardize observers, were not performed.

Number of discernible gobblers heard/day (NOGOBS) and number of calls/day (NOCALL) were used as dependent variables. Within years, these variables were actual number heard/day. Among years, NOGOBS and NOCALL were totaled within years and divided by number of sample days to produce an index of number heard/day (Table 1). Number of harvested gobblers included all gobblers killed on TWMA from 1984 to 1995 plus any gobblers wing-tagged and/or leg-banded on TWMA that were killed off the area. This differs from number of harvested gobblers reported by Lint et al. (1995) for this area because they only used gobblers harvested on TWMA. We included all gobblers because there was a possibility of hearing gobblers off the area during surveys and, because of large gobbler home ranges, these birds also may have been heard on TWMA during a given survey period. An effective study area size determined for TWMA, based on location of harvested gobblers, also encompassed much of the area surrounding TWMA (Lint et al. 1992). Hunters were required to report harvested gobblers at TWMA headquarters (Lint et al. 1995); compliance was estimated at 95% (Gribben 1986). We calculated hunter effort (EFFORT) (*N* of hunters/day) and hunter success (HUNT) from permit card counts; compliance was estimated at 85% (Palmer et al 1990).

We used Buckland population estimates at the beginning of the spring turkey hunting season for gobblers (GOBPOP) (Lint et al 1995) and hens (HPOP) (Hurst 1995) to estimate population size for among-year comparisons. We adjusted population estimates within years to account for harvested birds so that, given the day a call count was conducted, we had an estimate of gobbler population size. This approach to estimating daily population size was reasonable because 91% of gobbler mortality on TWMA occurred during the spring hunting season (Godwin et al. 1991:220). Of this, 78% was from reported harvest. We obtained percentage nest initiation (NEST) and nest success (NSUCC) of radio-tagged hens for 1984–1994 from Palmer et al.

Table 1. Independent variables (and their acronyms) used in multiple linear regressions with dependent variables of number of gobblers heard/day (NOGOBS) and number of calls/day (NOCALL) for within- and among-year analyses. Tallahala Wildlife Management Area, Mississippi, 1984–1995.

Between-years		Within-years	
Variable	Acronym	Variable	Acronym
Year	YR	Year	YR
Percentage nest initiation	NEST	Hunter effort/day	EFFORT
Nest success	NSUCC	Daily gobbler population	GPOP
Hunter effort	EFFORT	Number hens nesting	NONESTS
Hunter success	HUNT	Windspeed (km/hour)	WND
Hen population	HPOP	Dewpoint (C)	DEWPT
Gobbler population	GPOP	Maximum relative humidity (%)	XHUM
Population ratio	POPRAT	Minimum relative humidity (%)	MHUM
Maximum temperature (C)	XTEMP	Barometric pressure (mmHG)	PRESS
Minimum temperature (C)	MTEMP	Cloud cover (%)	CC
Dewpoint (C)	DEWPT	Maximum daily temperature (C)	XTEMP
Maximum relative humidity (%)	XHUM	Minimum daily temperature (C)	MTEMP
Minimum relative humidity (%)	MHUM	Days into call count period	DAYS
Barometric pressure (mmHG)	PRESS		
Cloud cover (%)	CC		
Windspeed (km/hour)	WND		
Precipitation (cm)	PREC		

(1993) and Miller et al. (1995). Based on HPOP, NEST, and number of radio-tagged hens incubating/day, we estimated number of hens in the population incubating nests/day (NONESTS) throughout call count periods.

We obtained daily summaries of minimum and maximum humidity (MHUM, XHUM), barometric pressure (PRESS), dewpoint (DEWPT), percentage cloud cover (CC), and windspeed (WND) from the National Climatic Data Center (NCDC) in Meridian, Mississippi, located 59.5 km east of TWMA. Daily summaries of minimum and maximum temperatures (MTEMP, XTEMP) and precipitation (PREC) were obtained from the NCDC office in Newton, Mississippi, located 12 km northeast of TWMA. Precipitation was not used as a within-season variable because call counts were postponed during rain. For among-year analyses, weather variables were averaged for the period 1 March to 31 May. Although weather data were remotely collected, it was the only source available to provide consistent weather data during the entire study period. Additionally, although local conditions most likely varied from these stations, we assumed these data provided a reasonable index to weather conditions on TWMA. We also used year (YR) and days into call count period (DAYS) as independent variables. Independent variables numbered 16 for among-year analyses and 12 for within-year analyses (Table 1).

Both within- and among-year hypotheses were tested using Multiple Linear Regression (MLR) (Myers 1990). Only data from 1984 to 1992 were used for MLRs because low capture/recapture rates after 1992 precluded population estimates (Table 2). Hypotheses tested were that independent variables did not contribute significantly to variability observed in the dependent variables (NOGOBS and NOCALL) within or among years at $\alpha = 0.05$. Before regressions were conducted, we used correlation matrices to reduce number of independent variables. All variable pairs with $r \geq 0.4$ were recorded and the least significant variables of these variable pairs in the model were deleted (Brennan et al. 1986, Miller et al. 1994). We conducted MLR models with remaining independent variables. Variance inflation factors of ≥10 and condition numbers ≥30 indicated multicollinearity and identified variables for removal (Myers 1990). Once an independent variable subset was identified, MLR models were run with PROC REG in SAS (SAS Inst. Inc. 1988). Within PROC REG, options were specified to provide Akaike's Information Criterion (AIC) (Burnham and Anderson 1992) for all possible model subsets. The most parsimonious model, as indicated by AIC scores, was used to conduct a final regression to determine variable significance regarding explanation of variation within dependent variables.

We also used an index of gobbler age structure to examine effect of age structure on gobbling activity. Because gobblers have high survival rates on TWMA (Godwin et al. 1991), it is reasonable to assume that higher NSUCC from 2 years previous, for example, would increase relative number of 2-year-olds in the population. We tested hypotheses that nest success does not affect gobbling activity with correlation analyses ($\alpha = 0.05$) between NOGOBS and NSUCC of radio-tagged birds from the same year (NSUCC0), 1 year previous (NSUCC1), 2 years previous (NSUCC2), and 3

Table 2. Yearly summaries of wild turkey gobbler population, call count, and hunter effort variables. Tallahala Wildlife Management Area, Mississippi 1984–1995.

Year	NR[a]	NS[b]	HE[c]	HS[d]	TH[e]	GJR[f]	CLS[g]	GOB[h]	GPOP[i]	HPOP[j]
1984	80.0	62.5	476	12.4	59	3.21	13.8	5.7	123	125
1985	77.3	41.7	443	11.5	51	2.90	10.9	3.9	78	103
1986	80.0	16.7	497	11.7	58	3.14	22.2	6.9	98	90
1987	100.0	25.0	593	10.6	63	1.86	12.1	4.3	78	81
1988	53.6	20.0	406	7.1	29	3.14	2.7	0.9	102	120
1989	58.3	23.8	594	5.2	31	14.50	3.9	1.4	62	85
1990	100.0	50.0	415	8.7	36	1.40	10.9	1.2	78	40
1991	88.9	0.0	321	7.8	25	1.50	3.5	1.3	72	90
1992	100.0	33.3	346	7.2	25	11.50	6.4	2.1	49	117
1993	42.9	16.7	NA[k]	NA	NA	NA	3.1	0.9	NA	NA
1994	57.1	25.0	NA	NA	NA	NA	13.9	4.4	NA	NA
1995	NA	NA	NA	NA	NA	NA	0.5	0.23	NA	NA

a. Nesting rate: number hens nesting/total number of hens.
b. Nest success: number of hatched nests/total number of nests.
c. Hunter effort: number of hunters/year.
d. Hunter success: number of hunters harvesting birds/hunter effort
e. Total harvest.
f. Gobbler: jake ratio in harvest.
g. Average number of calls heard/day (NOCALL).
h. Average number of gobbles heard/day (NOGOBS).
i. Estimated gobbler population.
j. Estimated hen population.
k. Data not available or not used in analyses.

years previous (NSUCC3). We also conducted correlation analyses between NOCALL and all nest success variables. We conducted correlation analyses because data existed (i.e., nest success and call counts) to test correlations from 1984 to 1995, adding 3 years past possible regression models. Additionally, although NSUCC0 was entered into among-year regression models, it was included to examine its effect without interaction with other variables.

Results

Within-Year Regressions

After variable reduction and controlling for multicollinearity, the NOCALL model ($N = 189$) had 7 variables remaining: YR, DAYS, EFFORT, XHUM, PRESS, WND, and CC. Of these, AIC scores indicated that a 4-variable model (YR, DAY, EFFORT, and WND) was the most parsimonious ($AIC = 907.3$, $R^2 = 0.19$, $P < 0.001$, Table 3). Significant variables in the NOCALL model were intercept, YR, DAY, EFFORT, and WND.

The NOGOBS model ($N = 189$) had 5 variables enter the model (YR, DAY, EFFORT, WND, and DEWPT) after variable reduction (Table 3), which produced the most parsimonious model ($AIC = 425.8$, $R^2 = 0.29$, $P < 0.001$). For this model, intercept, YR, DAY, WND, and DEWPT were significant.

Among-Year Regressions and Correlation Analyses

The NOCALL model had 5 variables remaining after reduction: YR, HPOP, EFFORT, HUNT, and DEWPT. The most parsimonious model ($AIC = 5.6$, $r^2 = 0.85$, $P = 0.004$) included EFFORT, HUNT, and an intercept term (Table 4), which were all significant.

For the NOGOBS model, 5 variables remained after variable reduction: YR, HPOP, EFFORT, HUNT, and DEWPT (Table 4). The most parsimonious model (*AIC*

Table 3. Independent variables, regression coefficients (RC), standard errors (SE), and *P*-values for within-year model of number of wild turkey gobblers heard/day (NOGOBS) and number of calls heard/day (NOCALL), Tallahala Wildlife Management Area, Mississippi, 1984–1992.

	NOGOBS model			NOCALL model		
Variable	RC	SE	*P*-value	RC	SE	*P*-value
Intercept	9.92	1.28	<0.001	20.86	3.44	<0.001
Year	−0.43	0.09	<0.001	−1.13	0.35	0.001
Day[a]	−0.09	0.04	0.014	−0.43	0.13	0.001
Effort[b]	0.06	0.03	0.062	0.27	0.13	0.036
Wind[c]	−0.01	0.01	0.007	−0.09	0.03	0.030
Dew point (C)	−0.03	<0.01	0.019			

a. Number of days into call count period.
b. Hunter effort: number of hunters/day.
c. Wind velocity (km/hour).

Table 4. Independent variables, regression coefficients (RC), standard errors (SE), and *P*-values for among-year model of number of wild turkey gobblers heard/day (NOGOBS) and number of calls heard/day (NOCALL), Tallahala Wildlife Management Area, Mississippi, 1984–1992.

	NOGOBS model			NOCALL model		
Variable	RC	SE	*P*-value	RC	SE	*P*-value
Intercept	−26.43	7.84	0.015	−8.94	2.38	0.009
Effort[a]	0.04	0.01	0.050	0.01	<0.01	0.046
Hunt[b]	−0.03	0.56	0.007	0.80	0.17	0.003

a. Hunter effort: number of hunters/day.

b. Hunter success: number of turkeys killed/total hunters.

= 5.6 $r^2 = 0.85$, $P = 0.004$) included EFFORT, HUNT, and an intercept term. EFFORT, HUNT, and CC were included in the NOCALL model. An AIC of 27.06 indicated a 2-variable model with EFFORT and HUNT had the most parsimony (Table 4). For this model ($r^2 = 0.81$, $P = 0.007$), intercept, EFFORT, and HUNT were all significant.

A significant correlation existed between NSUCC2 and NOGOBS ($r = 0.82$, $P = 0.004$), but not between NSUCC2 and NOCALL ($r = 0.57$, $P = 0.11$), nor NSUCC2 and YR ($r = -0.48$, $P = 0.16$). Additionally, no significant correlations ($P \geq 0.29$) existed between NSUCC0 and NOGOBS or NOCALL, between NSUCC1 and NOGOBS or NOCALL, nor NSUCC3 and NOGOBS or NOCALL.

Discussion

Based on a correlation between NSUCC2 and NOGOBS, we inferred that proportion of 2-year-old birds in the population, as indexed by NSUCC2, may contribute to the likelihood of hearing an individual turkey gobble. However, proximate, within-year factors, possibly on a daily basis, exerted enough influence over gobbling behavior that it could not be predicted similarly. Scott and Boeker (1972) noted wide daily variations in gobbling activity and Bevill (1973) ascribed daily variations in gobbling activity to weather influences. Individual gobblers have differing propensities to gobble and vary gobbling activity according to hen presence (Hoffman 1990). Another possible influence is gobbler condition (Lint et al. 1995). Gobblers in poor condition may not invest in breeding activities. Gobblers lose weight during breeding season and rely on their breast sponge for much of their energy requirements (Lewis 1967). Gobblers entering breeding season with smaller energy reserves may not be able to invest as much effort for breeding. This may be affected by winter habitat conditions (e.g., available mast), although it has not been investigated.

Results obtained from within-year regressions were consistent with the correlation analyses. Both analyses suggested that some unmeasured factors (i.e., gobbler condition, individual gobbler behavior, presence of hens) significantly affected daily variations in gobble call counts. Both analyses also indicated that we were able to explain only a small proportion of variation in gobbling activity within years.

Miller et al. (1997) determined that chronology of gobbling, within years, was related to hunter numbers, harvest, and gobblers heard, but that these relations varied among years. Additionally, Miller et al. (1997) observed only 1 gobbling peak, which may have been influenced by break-up of winter flocks, initiation of egg-laying, and mating opportunities. Results of our study and Miller et al. (1997) suggest many different factors may affect gobbling activity.

Gobbling activity decreased as YR increased and also decreased within years as number of days into call count surveys increased. GOBPOP was collinear with YR because the gobbler population was declining throughout this study (Palmer et al. 1993, Lint et al. 1995). As DAYS increased, GOBPOP decreased because gobblers were harvested and NONESTS increased because more hens were incubating. Because DAYS and YR were the most significant variables, they were retained in analyses and represent a linear combination of other variables. Therefore, it appears that gobbling activity declined throughout call count periods partially due to decreases in the gobbler population and increases in number of hens incubating. The negative relation of WND to NOCALL and NOGOBS may have resulted from turkeys gobbling less or observers being less able to hear gobblers (Kienzler et al. 1996). Although mechanisms governing the relation between DEWPT and NOGOBS are not clear, gobbling activity was probably influenced by some combination of temperature and humidity. Hunters were more likely to hunt when gobbling activity was higher. Kienzler et al. (1996) determined hunting depressed gobbling activity in Iowa, although they did not present values to assess strength of this correlation. Differences observed may be related to hunter densities.

Environmental and population variables did not enter among-year models. Because gobbler population did not enter the model, we agree with Palmer et al. (1990) and Lint et al. (1995) that gobble call counts have limited application to indexing wild turkey populations in central Mississippi. Even accounting for variations in weather, population levels, and reproductive parameters, gobbling activity could not be predicted by these variables. Relationships between NOGOBS and NOCALL with EFFORT and HUNT only indicate that, in years when gobbling activity was high, more hunters were pursuing turkeys with higher success.

Management Implications

Within-year gobbling activity was influenced by a complex interaction of population and environmental conditions, some measured and some not, that cannot be modeled easily. This resulted in low predictable power of our within-year models. Additionally, variables representing population dynamics and weather did not enter among-year population models. Finally, an index of number of 2-year-olds in the population was demonstrated to positively affect gobble call counts among years.

As yet unmeasured factors (e.g., presence of hens, individual gobbler behavior, gobbler condition) may affect gobbling activity in central Mississippi. As such, interpretation of results from gobbler call count surveys should be viewed with caution. Some researchers have adjusted gobbler call count models to account for weather factors (Kienzler et al. 1996) or conduct gobble call counts only during similar weather conditions. However, we determined that too many other factors affect gobbling activity to make such adjustments useful in our study.

Decreases in within-year gobble call counts also may be related to hunting activity. Hunting effort declined with call counts on TWMA. A possible relationship may be that hunters are harvesting vocal birds, especially those located close to roads. This would lead to observers and hunters being less likely to hear gobbling birds, resulting in less hunting effort and lower call counts. Relationships among these factors should be investigated. Future research also should attempt to understand relationships among age structure, environmental conditions, and gobbler condition on gobble call counts. Researchers also should investigate factors presented here in other locations to determine replicability of our results.

Future research with respect to understanding the behavior of gobbling may be best undertaken with captive flocks of wild birds. This would allow experimental replication of many potential factors influencing gobbling (e.g., gobbler condition, presence/number of hens, etc.) that would be very difficult to obtain under field conditions. A captive situation also could account for known weather vagaries and other possible environmental influences. However, inferences from such an experimental study may have limited applicability to usefulness of gobble call counts to index turkey populations given the results of our study. Until further studies can clarify the relationship of gobbling activity to population trends, researchers and managers should consider methods such as harvest information (Palmer et al. 1990) rather than call counts to determine wild turkey densities.

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