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THIRTY–YEAR CASE STUDY SHOWING A NEGATIVE RELATIONSHIP BETWEEN POPULATION AND REPRODUCTIVE INDICES OF EASTERN WILD TURKEYS IN GEORGIA

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ABSTRACT

Some Eastern wild turkey (*Meleagris gallopavo silvestris*) studies have interpreted low reproductive success in an established population as support for the idea that as populations stabilize reproduction decreases. However, no study has previously documented a negative relationship between population size and reproductive success for the wild turkey. Thus, we examined the hypothesis that reproduction (poults/hen) decreased as population size (turkeys seen/hour) increased in Georgia. Using 30 years of data collected by two independent survey methods, linear regression analysis indicated a negative relationship between population size and reproduction ($r^2 = 0.6389$, $P \leq 0.001$) for wild turkeys in Georgia from 1979 through 2008. Findings of a negative relationship such as in our case study adds more information and justification for researchers to further investigate the potential mechanisms of density–dependent processes in turkey reproduction through designed experiments with controls.

Key Words: correlation, Eastern Wild Turkey, Georgia, Indices, *Meleagris gallopavo silvestris*

INTRODUCTION

The Eastern wild turkey (*Meleagris gallopavo silvestris*; henceforth turkey) experienced a population decline through the 19th century and into the 20th century. Early restoration efforts began with releasing pen–raised turkeys during the 1950s with no success (1). After the pen raising efforts were abandoned in the 1960s a more pragmatic restoration effort was initiated in 1973 with the capture and relocation of wild turkeys (1).

Not long after restoration efforts were initiated using wild turkeys, the

Georgia Department of Natural Resources (DNR) started two independent annual turkey surveys in 1979, which coincided with Eberhardt's (2) recommendation that both reproduction and population size be estimated independently. The two independent surveys used by DNR were: 1) an annual survey conducted during the spring harvest season to assess and index the turkey population (turkeys seen/hour) and 2) an annual survey conducted in the summer to assess and index turkey reproduction (poults/hen). These two surveys began prior to the peak of DNR turkey restoration efforts in the early 1980s. After decades of survey data, we have observed a growing turkey population, but turkey reproduction has been declining since very early in the survey. Therefore, we have questioned if turkey population size could be having an impact on the amount of reproduction observed during the course of our surveys.

Some turkey studies have interpreted low reproductive success in an established population as support for the idea that as populations stabilize reproduction decreases (3, 4). Other studies have shown recruitment is greatest at low population densities (5). However, no previous study has documented a significantly negative relationship between population size and reproduction for the turkey (6, 7). Reasons for the failure to observe a statistically significant negative relationship could be because previous studies have observed a narrow range of population densities (8) or too short a time period (9, 10).

Knowing the expected effects of population size on reproduction may provide managers with the information to better evaluate and manage for sustained turkey harvests (6, 11). Also, this information could provide more insight into turkey ecology and lead to more in-depth study designs for future turkey research. Therefore, our objectives were to formally investigate the relationship between population and reproductive indices of the turkey in Georgia.

MATERIALS AND METHODS

Study Site - Our study area was the state of Georgia (14,997,947 ha). Mean annual temperature during our study ranged from 16.8°C to 18.8°C, and mean monthly temperature ranged from 4.8°C to 28.7°C (12). Mean annual rainfall during our study ranged from 99.3 cm to 159.7 cm, and mean monthly rainfall ranged from 0.7 cm to 31.3 cm (12). Both surveys were carried out across the entire state, in all physiographic regions (Ridge and Valley, Blue Ridge Mountains, Piedmont, Upper and Lower Coastal Plain), in every county (n = 159), on Wildlife Management Areas, and on private lands. For more detailed descriptions of Georgia's diverse habitats, please see Wharton (13) and DNR (14).

Data Collection - The turkey population index survey was conducted during Georgia's turkey harvest season (e.g., the first Saturday after March 19th through May 15th of each year) from 1979 to 2008. Cooperators participating in the survey came from three sources: DNR personnel, volunteers, and randomly chosen members of the Georgia Chapter of the National Wild

Turkey Federation starting in 1990. The survey form was mailed out annually before the turkey harvest season. Each cooperator received a newsletter explaining the historical data and importance, a memo explaining how to conduct the survey, and a harvest survey card. Specific information requested on the harvest survey card for each hunting trip included: date; county; hours hunted; number of turkeys seen; number of gobblers heard; number of gobblers killed; and whether the cooperator was the hunter or the guide. We annually summarized totals for all categories and calculated turkeys seen/hour by dividing total number of turkeys seen by total number of hours hunted across all cooperators. Previous studies have used an effort–based index to measure relative population abundance, because they believed there was a relationship between time required to harvest a turkey and turkey abundance (5, 15). In addition to the DNR turkey population index, we summarized turkey population data from the Breeding Bird Survey (BBS: www.pwrc.usgs.gov/BBS) and the Christmas Bird Count (CBC: www.audubon.org/bird/cbc) during the same time period.

The turkey reproduction survey was conducted annually during the months of June, July, and August from 1979 to 2008. Cooperators involved in data collection for this survey were DNR and Georgia Forestry Commission field personnel. Observations were made during the course of regular field duties. No targeted efforts were made to locate turkeys for the survey. Protocol included recording data for each day afield, and not double counting the same brood. Birds seen in the same area at approximately the same time on different days were ignored to reduce double counting biases. Records were collected for hens with poults, number of broods, number of poults, hens without poults, and hens uncertain of poults (i.e., hens where the observer could not determine if the hen had poults or not). We annually summarized totals for all categories. We then calculated poults/hen by dividing total number of poults by total number of hens (includes hens with poults, hens without poults and hens uncertain of poults) across all cooperators. Brood survey data provide a reliable index to annual reproduction (7, 15).

Data Analysis - Data from all three population indices (DNR, BBS and CBC) and turkey reproduction survey were analyzed using the linear model function in Program R version 2.6.2 (R Foundation for Statistical Computing, Vienna, Austria) to determine if population size and reproduction were negatively correlated. Because this was a case study, we believed that linear models to detect whether simple linear relationships existed in the datasets were deemed most appropriate.

RESULTS

Between 1979 and 2008, turkeys seen/hour ranged from 0.32 to 0.71 ($\bar{x}$= 0.51, SE = 0.02, n = 30), and number of cooperators for the population survey ranged from 145 to 526 ($\bar{x}$= 339, SE = 25, n = 30). The number of cooperators selected for the survey increased from 450 cooperators (1979 to 1989) to 2,000 cooperators from 1990 to 2008. Poults/hen ranged

from 1.1 to 4.7 ($\bar{x}$ = 3.0, SE = 0.2, n = 30; Figure 1), and the number of cooperators for the reproduction survey ranged from 108 to 956 ($\bar{x}$ = 572, SE = 35, n = 30).

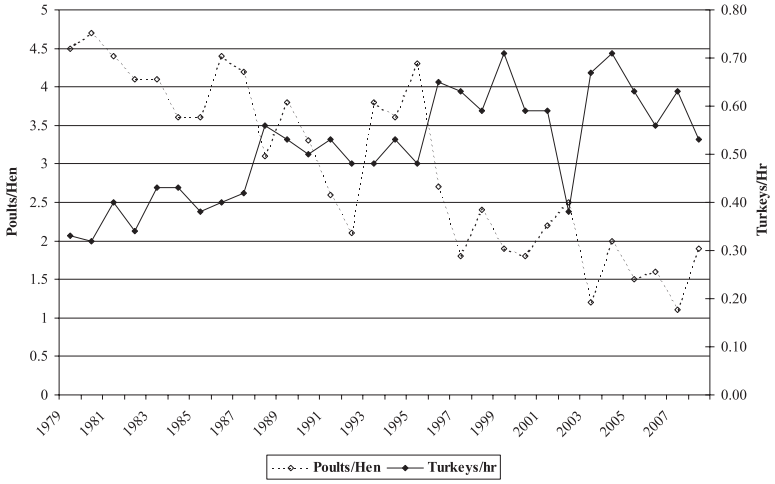

Figure 1. Time series of Eastern Wild Turkey population index (turkeys/hr) and reproduction index (poults/hen) in Georgia, 1979-2008.

Our population index correlates well with the BBS (r^2 = 0.608, P < 0.001) and the CBC (r^2 = 0.723, P < 0.001) over the entire time period (Figure 2). Therefore, we believe that our population index is representative of the changes that occurred in the turkey population during the time of this study.

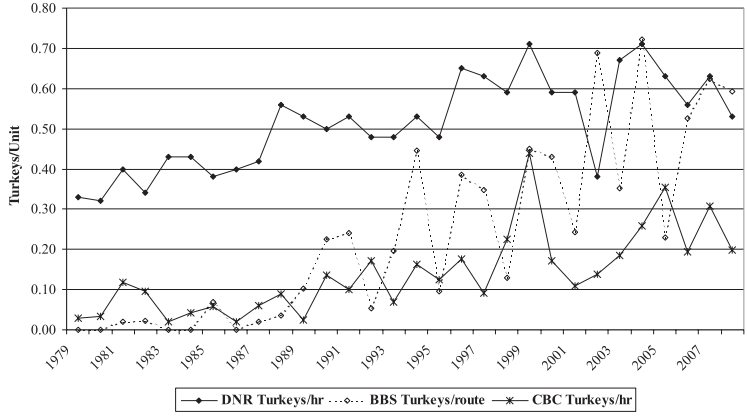

Figure 2. Time series of three different Eastern Wild Turkey population indices (DNR survey, Breeding Bird Survey, and Christmas Bird Count) in Georgia, 1979-2008.

We observed a negative relationship between population size and reproduction (DNR: $r^2 = 0.6389$, $p \leq 0.001$; Figure 3). The calculated regression equation was as follows:

DNR: poults/hen = –7.9287 × turkeys seen/hour + 7.0327

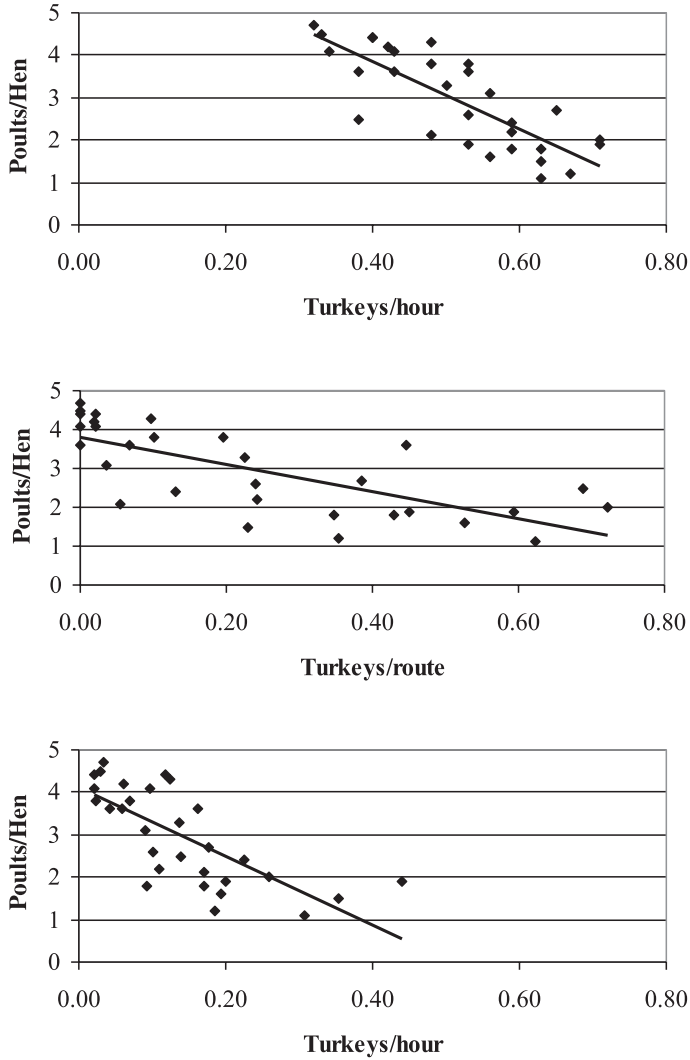

Figure 3. Scatter plots and linear regression lines (all P < 0.001) of Eastern Wild Turkey population indices (DNR top, BBS middle, and CBC bottom) against reproduction index (poults/hen) in Georgia, 1979-2008.

Additionally, we observed a similar relationship between reproduction and both the BBS data ($r^2 = 0.5271$, $P \leq 0.001$) and CBC data ($r^2 = 0.5351$, $P \leq 0.001$; Figure 3). Their respective regression equations are as follows:

BBS: poults/hen = –3.5367 × turkeys/route + 3.8140
CBC: poults/hen = –8.0777 × turkeys/hour + 4.0936

DISCUSSION

According to Roberts and Porter (16) and McGee *et al*. (17) recruitment is the most important factor in determining annual population change. Therefore, it should be expected that larger, stable populations would have smaller recruitment while smaller, increasing populations would have greater recruitment. However, previous studies have not documented a significantly negative relationship between population size and reproductive success for the turkey (6, 7). If this relationship exists, there are two reasons why previous studies may not have detected it: short duration of studies (10) and relatively stable population levels during the studies (7, 8). McGhee and Berkson (7) examined poult:hen ratios and harvest–based population indices from 29 regions over an average 8–year time period, but did not detect a significantly negative correlation between the two. We believe the duration of their study and the relatively small changes in turkey populations observed may have masked any effect of population on reproduction and that a population index based on the total population (*e.g.*, turkeys seen/hour) may be less biased than a harvest–based index because adult gobblers are more vulnerable to harvest than juveniles (18). Long–term datasets may yield results that are undetected in shorter studies (9), and tests done over a short time span may reflect episodes in a population's history that may be easily misconstrued (10).

In a 10–year radio–telemetry study, Vangilder and Kurzejeski (19) stated that population levels may not have varied enough during their study to result in compensatory recruitment, whereas we observed large population variation in our study using 30 years of data. We had two independent surveys in our case study that provided data on turkey population and reproduction over a 30–year period that began during the restocking era. During our study population levels varied by over 120% and reproductive levels varied by over 320%. We believe that our study covered a long enough time period and a large enough variation in population size to substantiate a significantly negative relationship between population size and reproduction.

For state agencies and wildlife managers, this analysis underscores the importance of continuing long–term monitoring and research programs. Findings of a negative relationship such as in our case study adds more information and justification for researchers to further investigate density–dependent processes that may control the growth of turkey populations, which is an important gap in our knowledge (6). Future research should examine the existence and potential mechanisms of density dependence in turkey reproduction through designed experiments with controls.

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