Raccoon Abundance and Rio Grande Wild Turkey Production in Central Texas

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Abstract: An understanding of spatial and temporal dynamics of wild turkey *(Meleagris gallopavo)* populations is essential in setting management goals. In central Texas, raccoon *(Procyon lotor)* populations have increased in recent years, causing concern that they may be limiting Rio Grande wild turkey *(M. g. intermedia)* production. We used two long-term data sets in central Texas to explore the relationship between raccoon abundance and Rio Grande wild turkey production at the regional, county, and local scale. We found no evidence that natural variation in raccoon abundance was associated with Rio Grande wild turkey production. Although further research is warranted, we suggest that raccoons may influence broad-scale Rio Grande wild turkey production in central Texas less than expected.

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Managing wildlife populations requires an understanding of factors influencing those populations, including predation. However, assessing the effect of predation on a species is considered difficult because of the many factors that affect the predation process and the long time periods required determine relationships (Leopold and Chamberlain 2001). If predation is found to negatively affect population management objectives, it may be mitigated by various management approaches, including direct reduction of predator effects through predator removal (Beasom 1974) and indirect reduction of predator effectiveness through habitat manipulation (e.g., improving prey cover; Jimenez and Conover 2001). Also, to adequately evaluate management alternatives, biologists must consider the full range of possible limiting factors, even for management activities not directly targeting predators. Even in situations where management of predators is not desirable or feasible, predation is an important consideration insofar as it influences populations of the species of interest, and thus may ultimately influence the outcome of management practices. Finally, predator issues, regardless of biological consequence, tend to be controversial (Kellert 1985, Conover 1994, Messmer et al. 1999, Reiter et al. 1999) and may distract stakeholders from other concerns if the role of predators in the system is not adequately understood and explained.

One way that predators influence prey species is by destroying nests of ground-nesting birds such as wild turkeys *(Meleagris gallopavo),* thus potentially limiting recruitment (Miller and Leopold 1992). Nest success has been suggested as one of the most important variables influencing wild turkey population dynamics (Roberts and Porter 1996). In Texas, nest predation accounts for substantial loss of Rio Grande wild turkey (*M. G. intermedia;* hereafter RGWT) nests (Cook 1972, Reagan and Morgan 1980, Ransom et al. 1987). Moreover, investigators have identified raccoons *(Procyon Lotor)* as one of the most culpable nest predator of ground-nesting birds in Texas (Hernandez et al. 1997). Although evidence suggests that medium-sized carnivores such as raccoons influence wild turkey population dynamics at small scales (Beasom 1974), their effect on turkey populations at broader spatial scales is less understood. The role of raccoons as RGWT nest predators might be especially important because raccoons often are the most numerous medium-sized carnivores in the predator community and because raccoon abundance has increased in at least part of the wild turkey range in recent decades (Hamilton and Vangilder 1992, Landholt and Genoways 2000, T. W. Schwertner, unpub. data)

As part of a larger study addressing population dynamics of RGWTs in the Edwards Plateau of Texas, we investigated the role of raccoons in influencing RGWT populations at broader spatial scales than previously reported. Because of their role as nest predators, we hypothesized that raccoons might inhibit RGWT population growth by destroying nests, and thus reducing poult recruitment. Our objective was to test this hypothesis by comparing indices of annual raccoon abundance and RGWT production. A negative correlation would be consistent with a prediction that increases in raccoon abundance were associated with lower turkey production.

A second test of our hypothesis was to determine whether RGWT production exhibited long-term decreases in areas where raccoon abundance had increased over the same time period. Analysis of Texas Parks and Wildlife Department (TPWD) carnivore survey data indicated that, while overall raccoon abundance increased throughout central Texas from 1976 through 2003, raccoon abundance trends varied among specific localities depending upon the spatial scale at which abundance was viewed (T. W. Schwertner, unpub. data). Fifteen of 38 (39%) counties in our study region exhibited positive trends in raccoon abundance from 1978 to 2003. Moreover, 18 of 53 (34%) survey routes in the region exhibited positive raccoon abundance trends. Neither positive nor negative trends were detected in the remaining counties and routes. These results allowed us to compare RGWT production between areas where raccoon abundance had increased and areas where it had not. If raccoons negatively affected RGWT production, we expected to see that RGWT production had decreased more over time in areas where raccoon abundance had increased compared to areas where it had not.

Methods

We evaluated RGWT production and raccoon abundance in a 38-county region of central Texas. This region was comprised of the Edwards Plateau the southern portion of the Cross Timbers ecological regions (Gould 1975). Topography ranged from rolling to steep, with primarily shallow, rocky soils. Historically, the region was a grassland or open savannah, but woodlands and brushlands presently dominate.

We used annual poult production, estimated using TPWD's annual brood-count data (Schwertner et al. 2003), as an index of RGWT production. Personnel from TPWD collected brood observations from 1 June–15 August 1976–2000. Observers recorded all RGWT hens and poults seen during routine daily activities. Counts were not conducted along standardized routes; rather, observers were encouraged to observe 10–25 hens per county during each two-week period. Observations were recorded by county and, after 1980, latitude-longitude coordinates to the nearest 5' (Berger and George 2003).

We estimated annual raccoon abundance using data collected during annual TPWD spotlight-furbearer surveys conducted from 1978–2003 (Berger and George 2003). To our knowledge, this survey provides the only long-term continuous index of broad-scale raccoon abundance in Texas. Individual counties and survey routes were categorized as having raccoon abundance that either increased or remained stable (no counties with decreasing raccoon abundance were identified) from 1978–2003 (T. W. Schwertner, unpubl. data).

Data Analysis

Comparison of Annual RGWT Production and Raccoon Abundance.—We estimated annual RGWT production (hereafter "poult proportion") across central Texas by first calculating total number of hens and poults observed per year in the region. We then calculated annual production across the region *(p)* as

$$p = \frac{n_p}{(n_p + n_h)},$$

where n_p = number of poults and n_h = number of hens.

Winter and early spring survival of raccoons typically is high in the southern United States (Chamberlain et al. 1999, Gehrt and Fritzell 1999). Thus, raccoon abundance during autumn should be a good indicator of the following spring population, when raccoons would be expected to most affect turkey production. Moreover, summer RGWT brood counts are estimates of production during spring of the current year. Therefore, we compared RGWT production with the previous autumn's raccoon abundance.

Because both RGWT production and raccoon abundance might be serial correlated, we detrended both data sets using the first differences method (Ott and Longnecker 2001). The results of a Ryan-Joiner test indicated that residuals of raccoon abundance data were normally distributed. Therefore, we compared raccoon abundance and poult proportion using Pearson's product moment correlation (Ott and Longnecker 2001). For all statistical tests, we considered results significant where $P \leq 0.05$. We performed all statistical tests using Minitab (Minitab, Inc., State College, Pennsylvania).

Turkey Production Between Areas Based on Raccoon Trends

We compared RGWT production trends between areas of central Texas that we categorized as having either stable or increasing raccoon abundance. We chose to define these areas at the scale of both county and survey-route (hereafter "local level") because of tradeoffs between the two scales of observation. At the county level, we were able to use the entire turkey brood-count data set, thus increasing the sample size used in the calculation of poult production. However, we consequently included many areas which were distant from raccoon survey routes, and thus were not necessarily represented accurately by the raccoon abundance data. We also conducted analyses using only data from the vicinity of the raccoon survey routes. By doing so, we evaluated RGWT production in locales which were likely more accurately represented by raccoon abundance data, but some RGWT production information was lost due to a substantially reduced sample size.

County level.—We compared annual production between counties with different raccoon abundance trends by dividing turkey brood-survey data into two groups based on the raccoon abundance trend of the county in which the observation was made. We pooled observations across all counties within each group and determined total number of hens and poults observed per year in each group. We calculated annual RGWT production (p_c) for each group as

$$p_c = \frac{n_{pc}}{(n_{pc} + n_{hc})},$$

where, n_{pc} = number of poults and n_{hc} = number of hens in group c. Regression residuals of production data were normally distributed, so we estimated production trends over time in each group of counties and compared trends between county groups having different raccoon trends using analysis of covariance, with year as the independent variable and county group as the covariate (Ott and Longnecker 2000).

Local level.—For our local-level analysis, we evaluated RGWT production only for areas within <12.3 km raccoon survey routes. We overlaid a map of the study region with latitude and longitude lines at 5' intervals using ArcView GIS 3.3 (Environmental Systems Research Institute, Inc., Redlands, California) to form a grid corresponding to the 5'×5' system used in recording RGWT brood observations. For grid cells intersected by a spotlight-survey route, we categorized the cell as increasing or stable in raccoon abundance as determined by its associated survey route. We disregarded cells not intersected by a survey route. We were unable to use data collected prior to 1981 because coordinates of turkey observations were not reported prior to that time.

We censored all brood observations not collected in cells intersected by a spotlight-survey route and divided the observations into 2 groups based on the raccoon-abundance trend (increasing or stable) of the cell in which the observation was made. We pooled brood observations across all cells within each group and determined the number of hens and poults observed per year in each group. We calculated annual RGWT poult production (p_r) for each group as

$$p_r = \frac{n_{pr}}{(n_{pr} + n_{hr})},$$

where n_{pr} = number of poults and n_{hr} = number of hens in group r. Regression residuals of production data were normally distributed, so we estimated trends over time in each group of cells and compared trends between cell groups having different raccoon trends and raccoon trends using analysis of covariance, with year as the independent variable and cell group as the covariate (Ott and Longnecker 2000).

Results

We detected no significant correlation ($r = 0.094$, $P = 0.684$) between annual RGWT production and annual raccoon abundance across central Texas. Further, we detected no difference ($t = 0.054$, $df = 46$, $P = 0.9571$) between the slope of the regression line for poult proportion against year for the group of counties with increasing raccoon abundance and that for the group of counties with stable raccoon abundance (Fig. 1). Finally, we detected no difference ($t = 0.429$, $df = 36$, $P = 0.6705$) between the slope of the regression line for poult proportion against year for the group of cells having increasing raccoon abundance and that for the group of cells with stable raccoon abundance (Fig. 2). Taken together, the results of the analyses revealed no evidence that turkey production was related to raccoon abundance regardless of the scale at which it was measured.

Discussion

Our hypothesis that raccoon densities are associated with RGWT production in central Texas predicted that RGWT production (1) should be correlated with raccoon abundance and (2) should have declined more in areas where raccoon abundance has increased than in areas where raccoon abundance has not increased. However, our analysis did not suggest that either of these phenomena has occurred, weakening the argument that raccoon densities are associated with RGWT production in central Texas.

Although many studies have shown that predators destroy a large proportion of individual turkey nests (Miller and Leopold 1992), few have addressed whether nest predation has significant population-level effects. Those that have addressed whether nest predation is important at the population level typically have done so by evaluating the response of turkey production to intensive predator removal. The results of these studies have been equivocal. Beasom (1974) reported substantially higher poult:hen ratios on his study site in south Texas following intensive predator removal than on an untreated control site. Speake (1980) intensively removed predators for five years from his study site in Alabama and reported 55.1% of hens on the experimental site were accompanied by poults, whereas 24.4% of hens were accompanied by poults on a site where predators were not removed. However, Guthery and Beasom (1977) conducted a similar study in south Texas and did not conclude that predator removal significantly increased production.

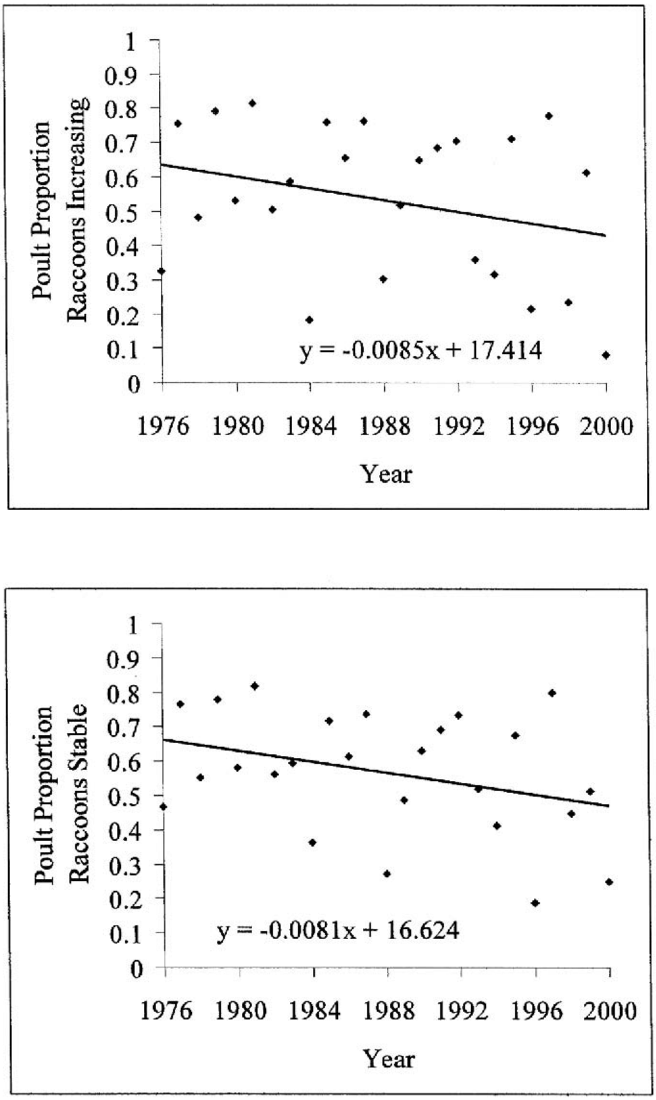
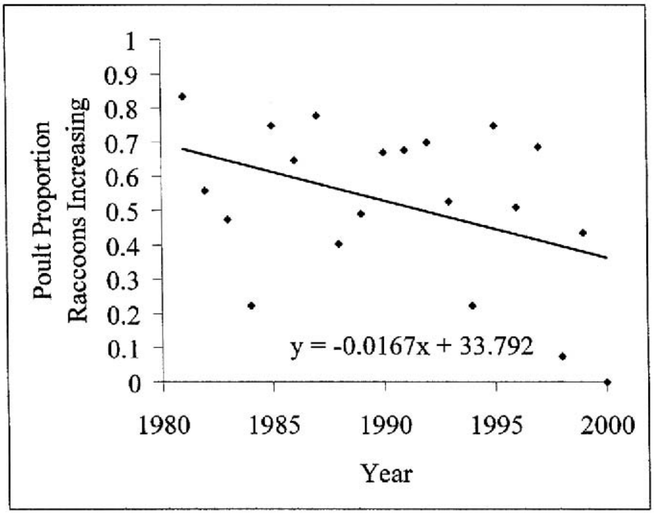


Figure 1. Rio Grande wild turkey production in counties where raccoon abundance increased (a) and remained stable (b), 1976–2000, showing no difference in turkey production trends between the 2 areas.

One possible reason our results differed from those reporting significant increases in production following predator removal is these other studies involved large reductions in predator density that probably exceeded the natural level of predator population variability. Speake (1980) removed an average of 318 nest predators—primarily Virginia opossums *(Didelphis virginiana)* and raccoons—annually for five years from a 4,471-ha study site in Alabama. Although he did not report a measure of



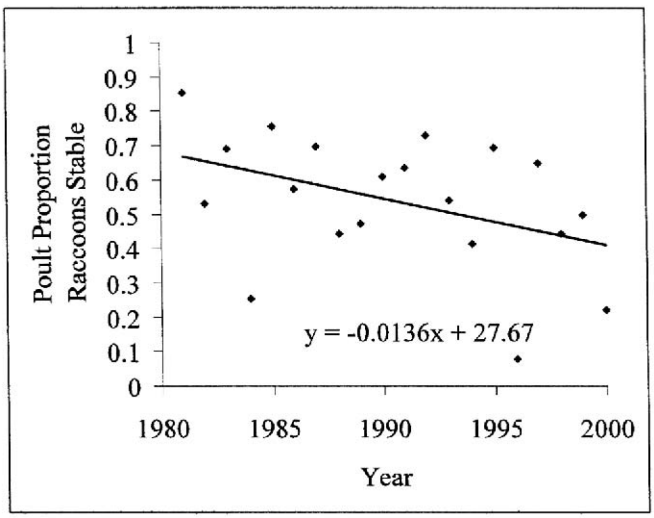


Figure 2. Rio Grande wild turkey production in 5'x5' cells intersected by Texas Parks and Wildlife Department carnivore survey routes where raccoon abundance increased (a) and remained stable (b), 1981–2000, showing no difference in turkey production trends between increasing and stable areas.

carnivore density, he did state that "almost no predator sign could be found" following removal (Speake 1980:89). Likewise, Beasom (1974) removed 65 raccoons from a 23.3-km^2 experimental site over two years, along with 188 coyotes, 120 bobcats, 46 striped skunks, and 38 other medium-sized carnivores. Although he did not report changes in raccoon density over time, it is reasonable to assume that raccoon density may have decreased more than the annual change of 25% that we observed in central Texas (T. W. Schwertner, unpub. data).

Another possible reason that our results differed from published reports is that our study is, to our knowledge, the first to address the association of predator abundance and RGWT production at spatial scales larger than a few square kilometers. Beasom (1974) suggested predator removal experiments had returned conflicting results because of differences in local conditions. Because raccoon and presumably RGWT population dynamics respond to local conditions, spatially asynchronous population dynamics might result that are undetectable when viewed at the relative broad scales we evaluated. We suggest that more research focusing on multiple study sites and spatial scales will be necessary to fully elucidate the relationship between RGWT production and predators.

We recognize several shortcomings in our study. First, our results are merely correlative and do not speak directly to cause and effect. However, manipulative experiments designed to reveal cause and effect relationships at the broad scales we treat here are impractical. Thus, analysis of historical data to test *a priori* hypotheses provides the only practical approach to examine the relationship between raccoon abundance and wild turkey predation. Moreover, we do not suggest that our results offer definitive proof that raccoon abundance does not affect turkey production, only that analysis of the available data fails to support the assertion that raccoon abundance and turkey production are related.

Second, the turkey production data used in the analysis suffers from the sampling design employed in its collection. As currently conducted, the TPWD brood survey does not use standard, randomized collection procedures. Instead, it is collected according to a "convenience sampling" (Morrison et al. 2001) scheme, whereby data is collected haphazardly incidental to TPWD personnel's other duties. This results in data that may not be representative of actual turkey production. However, other analysis of this data has shown a statistically significant correlation between precipitation and turkey production (T. W. Schwertner, unpub. data). Such a correlation would be unlikely if the production data did not represent, to some degree, an actual underlying biological pattern.

Rio Grande wild turkeys evolved with predation. Although abundance of raccoons in central Texas has increased in recent decades, we find no evidence to suggest that either historic levels of inter-annual variation or a long-term increase have been associated with RGWT production. Although managers should be aware of the possibility that raccoon predation could influence RGWT production at fine spatial scales, managers should be cautious in concluding that raccoon abundance influences turkey populations at broad scales.

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