Relationships of Fur Market Conditions to Texas Quail Populations

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Abstract: Quail are declining throughout much of their range in the southeastern United States. The reason for this decline is unknown. However, the decline of fur prices during the late 1980s fueled a hypothesis that furbearer harvest has decreased, which in turn led to an increase in furbearer abundance, and a subsequent decrease in quail numbers. To evaluate this hypothesis, we attempted to correlate raccoon *(Procycon lotor)* fur prices, furbearer and raccoon harvest, and furbearer and raccoon abundance with abundance of northern bobwhite *(Colinus virginianus)* and scaled quail *(Callipepla squamata)* for 1980–1999 in 3 ecological regions of Texas. Data supported the hypothesis that declining fur prices were associated with decreasing furbearer harvest. However, there was no increase in furbearer abundance and no correlation between raccoon fur prices, furbearer harvest, or furbearer density with quail abundance. We conclude that available data do not support the assumption that a decline in fur prices and the subsequent decrease in furbearer harvest has led to an increase in furbearer numbers and a subsequent decrease in quail numbers.

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There is considerable evidence that quail abundance is declining. In recent decades, nearly range-wide declines in abundance of both northern bobwhite (Brennan

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1991, Church et al. 1993, Brady et al. 1998) and scaled quail (Church et al. 1993) have been documented. An analysis (Bridges 1999) of long-term trends in quail numbers in the South Texas Plains and Rolling Plains ecoregions of Texas (Gould 1975) indicated that northern bobwhite have not exhibited long-term population trends in these areas since 1978. Scaled quail numbers have shown no long-term population trend in the South Texas Plains, but have declined to near extinction in the Rolling Plains. Several studies have examined scaled quail in the rolling Plains in recent years, but the extent and causes of decline remain controversial. Poor nesting success is one possible factor. Nest predation accounts for the greatest share of nest failures in the Rolling Plains of Texas (Hernandez 1999). Although it is fair to say that bobwhite and scaled quail abundance have declined over much of their range, can we be equally certain that predation is the ultimate or even the proximate cause of these declines?

Rollins (1993) proposed that predation on quail nests was an important factor limiting quail abundance. A corollary to this concept is the assumption that predator communities have changed over the last 20 years, with a "mesomammal release" associated with the demise of the fur market in the 1980s (Rollins 1999). Under this hypothesis, the collapse in fur prices led to greater predator densities, which in turn led to decreased quail numbers. If the demise of the fur market led to decreased quail abundance, then one would expect that furbearer harvest would be correlated inversely with furbearer abundance, which in turn would be correlated inversely with quail density. For this to be true, one must show a decrease in fur prices during the 1980s, a decrease in furbearer harvest by trappers, and an increase in furbearer numbers following mesomammal release.

Consequently, we determined if data are consistent with this hypothesis for northern bobwhite and scaled quail within 3 ecological regions (Rolling Plains, Edwards Plateau, and South Texas Plains) of Texas. Specifically, we assessed if raccoon fur prices, furbearer and raccoon harvest, and estimates of furbearer and raccoon abundance in Texas decreased in the 1980s. Secondarily, we assessed the degree of correlation among statewide raccoon fur prices, furbearer and raccoon harvest, and estimates of furbearer and raccoon abundance. To do this, we assessed the degree of correlation among these variables statewide from 1980–1999. We then determined if raccoon harvest and density are correlated with northern bobwhite and scaled quail abundance in the 3 ecological regions during the same years.

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Methods

We used data compiled by TPWD during 1980–1999 to calculate regional quail abundance indices. During the first 2 weeks of August each year, TPWD biologists run a series of 32.2-km census routes selected randomly and placed permanently

throughout the ecological regions of Texas (Peter and Perez 2000). Observations began either 1-hour before sunset or at sunrise when weather met a predetermined set of conditions. Observers drove at 32 km/hour and recorded number of quail of each species visually observed (divided into singles, pairs, and coveys) and approximate age of quail based on body size. We calculated abundance indices as mean number of quail seen/route/ecological region during a given year.

The western extent of northern bobwhite and eastern extent of scaled quail ranges fall within the Rolling Plains, Edwards Plateau, and South Texas Plains ecological regions of Texas (Reid 1977). Therefore, all routes in these regions are not within the range of both species. If either northern bobwhite or scaled quail had never been observed on a given route since its inception (1978), we considered that route outside the species range and excluded it when calculating mean abundance/ecological area. In this way, mean values are not artificially low in areas at the fringe of a given species' range, thus allowing these values to be compared across physiographic regions.

We conducted power analyses (MINITAB 1998) to ensure that biologically significant fluctuations in mean abundance could be detected. They revealed that a doubling in mean quail abundance (100%) could be detected in all ecological regions at the $1\text{-}\beta \geq 0.80$ probability level ($\alpha = 0.05$).

We acquired fur price data from 2 TPWD telephone surveys of fur buyers during December–January of each year to obtain pelt value data for all species. Furbearer harvest data were acquired from the TPWD statewide trapper survey initiated following the 1976–77 trapping season. This questionnaire was mailed annually to a randomly selected group (10%–100%) of all trappers licensed in Texas. Questions addressed if the respondent trapped during the past fur season and, if they did, their primary trapping location (by Texas county), number of days spent trapping, methods used, preferred trapping method, and number of each species collected. For this study, we used the estimated harvest of furbearers by Texas ecological region for the trapping seasons 1979–80 through 1998–99.

We also obtained annual indices to carnivore abundance (1980–1999) from TPWD. These indices (carnivores/160 km by county) were obtained from standardized TPWD spotlight counts along 24.1 km permanently marked roadways surveyed 1 hour after sunset during August–October. Carnivores surveyed included raccoon, opossum *(Didelphis virginiana),* striped skunk *(Mephitis mephitis),* gray fox *(Urocyon cinereoargenteus),* coyote *(Canis latrans),* and bobcat *(Lynx rufus).*

Analyses

Time-series regression (MINITAB 1998) was used to detrend data because trends in quail and furbearer abundance, annual raccoon fur prices, and furbearer harvest could confound correlative analyses. Spearman's rank order correlation (MINITAB 1998) of these detrended data was used for all correlation analyses because residents associated with these analyses were not always distributed normally. All tests were evaluated at $\alpha = 0.05$.

We used a Student's *t*-test for hypothesis testing of statewide period comparisons of the various furbearer indices (Table 1). Data from 1980–1988 and 1989–1999 were

Table 1. Texas raccoon fur price, furbearer and raccoon harvest, and carnivore and raccoon trends in abundance (animals/160 km) by year.

Year	Raccoon fur price	Harvest		Abundance	
		Furbearer	Raccoon	Carnivore	Raccoon
1980	20.00	1,272,462	465,145	25.6	14.6
1981	11.00	991,426	402,864	14.2	5.9
1982	14.50	889,207	403,464	26.7	8.0
1983	13.50	917,205	409,119	21.7	11.8
1984	12.25	646,330	287,022	41.5	24.0
1985	14.50	705,332	365,459	37.4	18.0
1986	10.50	623,747	302,975	27.3	18.0
1987	14.25	911,261	461,365	25.4	13.4
1988	10.00	867,893	419,848	17.7	9.3
1989	4.25	325,060	60,268	12.6	7.4
1990	3.50	156,682	69,787	16.7	10.5
1991	3.00	104,812	48,077	18.9	12.7
1992	3.35	129,684	57,901	25.6	18.1
1993	2.75	122,671	49,507	26.8	20.8
1994	6.00	128,766	58,098	25.8	17.9
1995	6.10	170,846	88,527	20.0	14.1
1996	NA[a]	120,673	67,236	20.1	12.8
1997	NA	315,784	181,896	23.5	14.9
1998	6.75	268,034	132,146	37.6	23.2
1999	3.20	127,193	58,771	15.2	9.9

a. Not available.

Table 2. Raccoon harvest, carnivore and raccoon abundance (animals/160 km), and northern bobwhite and scaled quail abundance (birds/32.2 km) data for the Edwards Plateau ecological region of Texas by year.

Year	Raccoon harvest	Abundance			
		Carnivore	Raccoon	Northern bobwhite	Scaled quail
1980	NA[a]	95.3	48.8	7.6	4.8
1981	NA	81.9	24.2	14.0	27.4
1982	98,244	109.4	32.2	14.7	15.6
1983	61,723	76.4	20.7	5.5	18.6
1984	86,091	93.9	32.7	4.0	12.9
1985	78,982	96.8	37.3	3.5	34.4
1986	112,851	86.6	22.0	3.7	21.4
1987	84,825	74.1	18.2	7.7	21.8
1988	19,770	80.1	35.3	5.5	16.3
1989	21,064	81.7	19.2	3.5	11.1
1990	13,146	49.8	17.8	4.1	3.2
1991	19,781	80.0	31.7	10.3	10.1
1992	17,071	92.3	36.6	9.5	18.2
1993	19,861	85.9	51.0	13.2	8.9
1994	20,808	91.0	49.4	5.4	3.7
1995	28,147	109.1	63.5	2.7	2.4
1996	66,542	95.6	44.8	3.9	1.7
1997	51,727	61.1	34.6	7.4	9.2
1998	15,580	116.5	52.0	4.6	6.9
1999	NA	84.9	41.2	4.5	12.8

a. Not available.

Table 3. Raccoon harvest, carnivore and raccoon abundance (animals/160 km), and northern bobwhite and scaled quail abundance (birds/32.2 km) data for the Rolling Plains ecological region of Texas by year.

		Abundance			
Year	Raccoon harvest	Carnivore	Raccoon	Northern bobwhite	Scaled quail
1980	NA[a]	106.9	16.8	21.9	2.7
1981	NA	89.6	36.4	34.7	9.4
1982	12,104	102.8	23.7	32.6	19.5
1983	8,004	66.0	16.2	30.3	5.1
1984	7,782	104.3	29.2	8.3	7.1
1985	9,024	55.2	21.9	16.0	6.2
1986	12,265	89.8	32.9	34.4	7.3
1987	10,289	79.3	12.8	49.3	7.6
1988	3,019	75.5	22.7	23.1	3.0
1989	2,161	80.3	20.6	13.7	2.5
1990	2,007	69.9	25.1	13.4	0.9
1991	2,609	116.9	42.2	23.2	0.9
1992	749	46.6	17.3	40.0	2.6
1993	2,229	39.9	19.6	41.0	0.4
1994	1,291	37.3	20.2	15.4	0.0
1995	905	27.2	9.5	12.3	0.4
1996	6,105	36.1	15.5	8.1	0.9
1997	6,562	44.7	2.6	24.9	0.1
1998	4,173	46.0	24.4	18.7	0.3
1999	NA	45.2	16.8	11.7	1.2

a. Not available.

used to identify the periods. We chose these periods because a large decline in fur prices was observed in the raw data between 1988 and 1989 (Table 1). Raccoons were the single most valuable furbearer in total dollars expended. When the fur market declined in the late 1980s, fur buyers discontinued buying furs of many species; therefore, we used fur prices for raccoons for our comparisons.

We used Spearman's rank order correlation tests to test the relationships of raccoon fur prices with statewide annual raccoon harvest and number of raccoons observed along transect routes in Texas from 1980–1999. We also used this test to determine the relationship between annual raccoon harvest and number of raccoons observed along annual transect routes. In addition, we tested the hypothesis that regional furbearer harvest could account for a significant portion of variation in northern bobwhite and scaled quail abundance among years in the Edwards Plateau (Table 2), Rolling Plains (Table 3), and South Texas Plains (Table 4) ecological regions of Texas. We choose these regions because they are the only physiographic regions in Texas where northern bobwhite and scaled quail are sympatric. In addition, scaled quail have declined in the Rolling Plains and the Edwards Plateau.

We used Spearman's rank order correlation to test relationships between furbearer harvest and annual carnivore indices. We assumed that an intensive harvest of furbearers during the previous winter-spring trapping season could produce a decrease in annual carnivore indices during subsequent summer surveys. The same test was

Table 4. Raccoon harvest, carnivore and raccoon abundance (animals/160 km), and northern bobwhite and scaled quail abundance (birds/32.2 km) data for the South Texas Plains ecological region of Texas by year.

		Abundance			
Year	Raccoon harvest	Carnivore	Raccoon	Northern bobwhite	Scaled quail
1980	NA[a]	NC[b]	NC	16.5	5.5
1981	NA	NC	NC	26.4	6.4
1982	78	NC	NC	39.2	7.9
1983	15,890	NC	NC	14.0	6.8
1984	20,584	44.4	5.6	12.0	1.7
1985	26,477	NC	NC	18.6	8.3
1986	30,193	NC	NC	32.5	11.7
1987	2,374	NC	NC	48.1	23.4
1988	2,188	NC	NC	19.6	2.1
1989	2,426	NC	NC	11.4	1.3
1990	1,683	NC	NC	12.0	4.7
1991	1,563	NC	NC	24.8	17.5
1992	2,374	44.1	25.0	52.5	22.2
1993	3,214	43.0	25.7	33.7	16.3
1994	3,107	44.7	27.4	14.7	7.8
1995	11,018	38.8	20.3	10.7	5.8
1996	5,856	27.3	10.7	7.4	2.2
1997	2,551	33.7	14.9	12.4	3.7
1998	NA	40.6	18.7	18.6	15.4
1999	NA	28.3	18.9	22.7	20.1

a. Not available.

b. Transects not conducted.

used to determine the relationship between raccoon harvest and northern bobwhite and scaled quail numbers in the South Texas Plains, Rolling Plains, and Edwards Plateau ecological regions. We also tested hypotheses that annual carnivore indices could account for a significant portion of variation in both northern bobwhite and scaled quail numbers within the Rolling Plains and Edwards Plateau. We assumed that high annual carnivore indices in summer would lead to reduced quail numbers in August. We could not perform a similar analysis for the South Texas Plains because annual carnivore data only were available for 1984 and 1992–1999.

Results

Raccoon fur prices declined from the 1980–1988 fur seasons ($\bar{x}$= \$13.39, SE = \$1.02/pelt) compared to the 1989–1999 fur seasons ($\bar{x}$= \$4.32, SE = \$0.51/pelt). Furbearer harvest also declined form the 1980–1988 ($\bar{x}$=869,428, SE =66,542 pelts) to the 1989–1999 seasons ($\bar{x}$=179,110, SE =24,910 pelts). However, carnivores observed on spotlight transects did not change between the 1980–1988 ($\bar{x}$ =26.4, SE =2.9 carnivores/1.6 km) and 1989–1999 seasons ($\bar{x}$=22.1, SE =2.1 carnivores/1.6 km). Raccoons harvested during 1980–1988 ($\bar{x}$=390,807, SE =20,789 pelts) compared to 1989–1999 ($\bar{x}$=79,292, SE =12,502 pelts) decreased. Raccoons

observed along spotlight transects prior to 1989 ($\bar{x}$=13.7, SE=1.9 carnivores/1.6 km) compared to 1989–1999 ($\bar{x}$=14.8, SE=1.5 carnivores/1.6 km) did not change.

Numbers of furbearers taken in the South Texas Plains and abundance of northern bobwhite (r=0.152, P=0.560) or scaled quail (r= −0.005, P=0.985) were not correlated. Likewise, numbers of furbearers taken and abundance of northern bobwhite (r=0.335, P=0.139) or scaled quail (r= −0.353, P=0.165) were not correlated in the Rolling Plains of Texas. Additionally, we found no relationship between number of furbearers taken in the Edwards Plateau and northern bobwhite (r=0.221, P=0.428) or scaled quail (r=0.382, P=0.159) abundance.

Total harvest of furbearers was correlated with raccoon harvest in the South Texas Plains (r=0.833, P <0.001), Rolling Plains (r=0.904, P <0.001), and Edwards Plateau (r=0.857, P <0.001). Raccoon harvest in the South Texas Plains was not correlated with abundance of northern bobwhite (r=0.279, P=0.277) or scaled quail (r=0.211, P=0.417). There also was no correlation between raccoon harvest in the Rolling Plains and northern bobwhite (r=0.331, P=0.195) or scaled quail (r =0.232, P=0.371) abundance. Neither was there a correlation between numbers of raccoons harvested in the Edwards Plateau and northern bobwhite (r=0.400, P =0.140) or scaled quail (r=0.304, P=0.271) abundance.

Furbearer harvest and numbers of carnivores observed along transects were not correlated (r=0.158, P=0.505). Likewise, northern bobwhite (r=−0.416, P =0.077) or scaled quail (r=−0.174, P=0.477) abundance were not correlated with indices of carnivore abundance in the Edwards Plateau. Additionally, annual raccoon indices were not correlated with northern bobwhite (r= −0.235, P=0.333) or scaled quail (r= −0.319, P=0.183) abundance. In the Rolling Plains, neither northern bobwhite (r= −0.200, P=0.412) or scaled quail (r=0.276, P=0.252) abundance was correlated with annual carnivore indices. The annual raccoon index also was not correlated with northern bobwhite (r= -0.014, P=0.955) or scaled quail (r= −0.045, P =0.856) abundance in the Rolling Plains.

Discussion

It is clear that fur prices declined in Texas after the 1988–1989 fur season. Our findings supported the premise that a declining fur market led to decreased furbearer harvest. Rollins (1999) was correct in stating that a decline in fur prices led to a decline in furbearer harvest. However, our findings did not support Rollins' (1999) premise that a decrease in furbearer harvest led to a decrease in quail abundance. This held for both northern bobwhite and scaled quail abundance in all 3 ecological regions studied (Edwards Plateau, Rolling Plains, and South Texas Plains).

Because statewide furbearer and raccoon harvest were not correlated with statewide carnivore and raccoon census data, we suggest that fur trapping at the intensity observed during the study period probably did not affect carnivore populations significantly. The fact that statewide carnivore and raccoon census data did not increase following the decline in fur prices further suggests that furbearer harvest had little effect on numbers. In fact, when the landmass of Texas and the largest estimated an-

nual number of furbearers harvested in Texas is considered, mean number of furbearers harvested was 4.7/1.6 km^2. This translates into a meager harvest, considering that Lawrence and Silvy (1995) were able to harvest 106 furbearers (striped skunk, opossum, raccoon) from a single 1.6 km^2-study area in Texas between 10 February and 27 June 1980. We conclude that furbearer harvest, at the intensity observed since 1976–77, did not affect overall furbearer abundance in Texas.

The indices used in this paper are not adequate for understanding precise predator-prey dynamics. However, the fact that northern bobwhite populations in all 3 ecological regions and scaled quail in the South Texas Plains did not decrease following the decrease in fur prices sheds doubt on the mesomammal release hypothesis. Bridges (1999) indicated that scaled quail declined in the Edwards Plateau and Rolling Plains from 1978–1998. If furbearers were causing the scaled quail decline in these 2 areas, why were they not affecting northern bobwhite in these regions and northern bobwhite and scaled quail in the South Texas Plains?

Our findings supported the hypothesis that declining fur prices were associated with decreasing furbearer harvest. However, there was no increase in furbearer abundance and no correlation between raccoon fur prices, furbearer harvest, or furbearer density with quail abundance. We conclude that available data do not support the hypothesis that a decline in fur prices has led to a decline in quail numbers.

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