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A COMPARISON OF TWO QUAIL ABUNDANCE INDICES AND THEIR RELATIONSHIP TO QUAIL HARVEST IN TEXAS

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ABSTRACT

Surveys are used to monitor status and trends of animal populations. However, different surveys may give conflicting results for the same species and population being surveyed. Therefore, we compared results of the North American Breeding Bird Survey (BBS) and Texas Parks and Wildlife (TPW) roadside counts for scaled quail (*Callipepla squamata*) and northern bobwhite (*Colinus virginianus*) in Texas. Surveys were compared on both an ecoregion and statewide basis. The BBS and TPW surveys gave similar trends for bobwhites and scaled quail for 5 of 8, and 3 of 5 ecoregions, respectively. Survey trends differed at the statewide scale for both species. We compared estimated statewide harvest as an independent index of quail population status in Texas with results from both surveys. The TPW roadside survey was more closely related to estimated statewide harvest for northern bobwhites (R^2 = 0.86, P = ≤0.001) and scaled quail (R^2 = 0.75, P = ≤0.0001) than the BBS survey (R^2 = 0.60, P = 0.001; and R^2 = 0.35, P = <0.0001, respectively). Survey methods, sampling frameworks, and issues of scale are important variables to consider when interpreting survey results. The BBS provides useful data on quail populations at a multi-state or national scale. However, most state wildlife agencies require surveys that provide information at finer spatial scales.

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Key words: Breeding Bird Survey, *Callipepla squamata, Colinus virginianus,* index, northern bobwhite, roadside survey, scaled quail, Texas

INTRODUCTION

Most state wildlife agencies use surveys to monitor wildlife populations. Such surveys are biologically necessary and sometimes legally required to determine trends of game species abundance in many states. Various state wildlife agencies have used male-whistle counts (Bennitt 1951, Reeves 1954, Rosene 1957, Brown et al. 1978), roadside surveys (Peterson and Perez 2000), and morning covey-call counts (Davis 1979:57–58, Roseberry 1982, Guthery 1986:138–141, DeMaso et al. 1992) to monitor northern bobwhite populations.

Since the early 1990s, BBS data have been used to describe quail population trends at statewide, regional, and national scales in North America (Church et al. 1993, Capel et al. 1995). Different surveys, however, may give conflicting results for the same populations being surveyed. This could result from differences in survey methodologies, data analysis, the scale at which surveys were conducted, or the scale at which survey results were extrapolated as well as erroneous interpretation of survey data and subjective biases of the interpreters.

Our primary objective was to compare the BBS and TPW quail survey in Texas and determine which survey was more closely related to estimated statewide quail harvest. We hypothesized that both surveys would give similar results at the ecoregion and statewide spatial scales. We then discuss some of the problems and conflicting results that may arise from improperly defining survey objectives, scale issues, sample sizes, and the time frame when surveys are conducted.

METHODS

Breeding Bird Survey

The BBS is an avian-survey program initiated in 1966 to monitor the status and trends of breeding bird populations across North America (Sauer et al. 1999). Started in Maryland and Delaware, this survey now covers the continental United States and Canada. Currently, the BBS is coordinated by the United States Geological Service's Patuxent Wildlife Research Center and the Canadian Wildlife Service.

The BBS has about 4,100 permanent, active routes of which approximately 3,000 are surveyed annually in early summer. Each route is 39.4 km (24.5 mile) long, with 3-minute point counts conducted at 0.8 km (0.5 mile) intervals for a total of 50 point count stops/route. All birds heard or seen within a 0.4 km (0.25 mile) radius of each stop are recorded. Surveys begin 30 minutes before sunrise and normally require 4–5 hours for completion. Sky condition, wind speed, and temperature also are recorded at the beginning and end of each survey. Over 2,500 skilled amateur birders and professional biologists participate in the program each year. See Droege (1990) for more detail regarding the BBS.

All BBS data were obtained from the BBS web site (*http://www.mp2-pwrc.usgs.gov/bbs/*). Data from the BBS, both at the ecoregion and statewide spatial scales, are presented as the mean number of quail seen or heard/route.

TPW Quail Roadside Survey

Since 1978, quail population trends in Texas have been monitored using randomly selected 32.2-km (20-mile) roadside-survey lines [see Perez (1996) for the development of this technique and its application]. Currently, 158 survey lines are located in the Gulf Prairies, Cross Timbers, Edwards Plateau, High Plains, Rolling Plains, South Texas Plains, and Trans Pecos ecological areas (Gould 1975). Surveys in the Blackland Prairies and Pineywoods were discontinued in 1988 because of a budget cut. We report all data at the ecoregion scale, even if the number of years when surveys were conducted is not equal. Data reported at the statewide scale only contain surveys that have an equal, complete time series.

Routes are sampled once each August by TPW biologists, either at sunrise (E to W) or 1 hour prior to local sunset (W to E; Peterson and Perez 2000). Survey routes are driven at 32.2 km/hr (20 miles/hr) and all quail observed are recorded by species for each 1.6-km (1 mile) interval. The number of chicks/brood and approximate Size of broods also is recorded. Data for the index, both at the ecoregion and statewide scale, are presented as the mean number of quail observed/route.

Quail Harvest

Quail harvest estimates for Texas were determined for 1981–83 and 1986–99 as part of the annual Small Game Harvest Survey conducted by TPW (Texas Parks and Wildlife Department 2000). This survey was mailed to 15,000 randomly-selected individuals holding a Texas hunting license (Peterson and Perez 2000). Survey questions included the species hunted, total number harvested, number of days spent hunting, and the Texas county where the person hunted the species most often. Non-respondents were mailed a second and third notice for an overall mean response of about 56.6%.

Analysis of Survey and Harvest Data

Northern bobwhite and scaled quail trends were determined by graphing BBS and TPW data by year for the 8 ecoregions having bobwhites and the 5 ecoregions where scaled quail occur. The Blackland Prairies and Pineywoods ecoregions did not have TPW survey data since 1988. However, we used all available data in our trend analysis. Trends also were determined statewide for both species.

Linear regression analysis was used to determine if slopes of trend lines were different from 0.0 (i.e, trends were increasing, decreasing, or stable). This and all subsequent statistical tests with a $P \leq 0.05$ were considered significantly different. Ninety-five percent confidence intervals were calculated for each slope to determine differences between survey types (if confidence intervals overlapped, we considered there was no significant difference). Annual percent change in quail abundance was calculated as the percent change from the first data point (1978) to the last data point (1999) in the time period, based on the regression equation for that survey type, divided by the number of years in the time interval. However, caution should be used when interpreting results from ecoregions where sample sizes are small. We compared estimates of statewide harvest from 1986–99 for bobwhites and scaled quail with estimates obtained from BBS and TPW surveys. We considered the statewide harvest data as an independent index of population status for each species. We graphed survey type (independent variable) and estimated statewide harvest (dependent variable), then conducted regression analysis to determine which survey had the strongest relationship with estimated statewide harvest (i.e., the population status).

RESULTS

The BBS and TPW survey gave similar trends for bobwhites in 5 of 8 ecoregions (Table 1, Fig. 1). The surveys also gave similar trends in 3 of 5 ecoregions for scaled quail (Table 1, Fig. 2). The statewide trends, however, differed between the surveys for both quail species (Table 1, Fig. 3)

Slopes of regression lines using BBS data were equal to 0.0 in 2 of 8 ecoregions for bobwhites, and 2 of 5 ecoregions for scaled quail (Table 2). Slopes using TPW data differed from 0.0 in 3 of 8 ecoregions for bobwhites and 3 of 5 ecoregions for scaled quail (Ta-

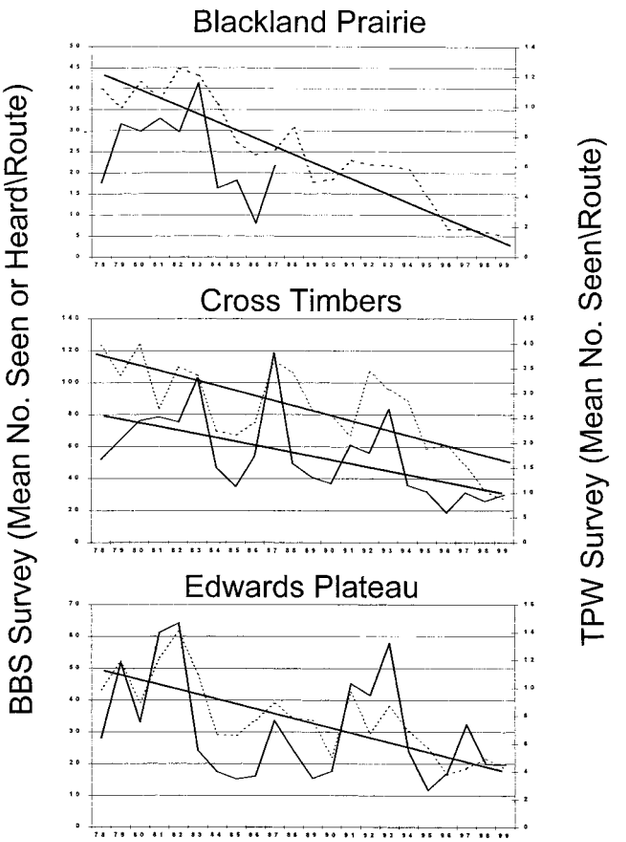
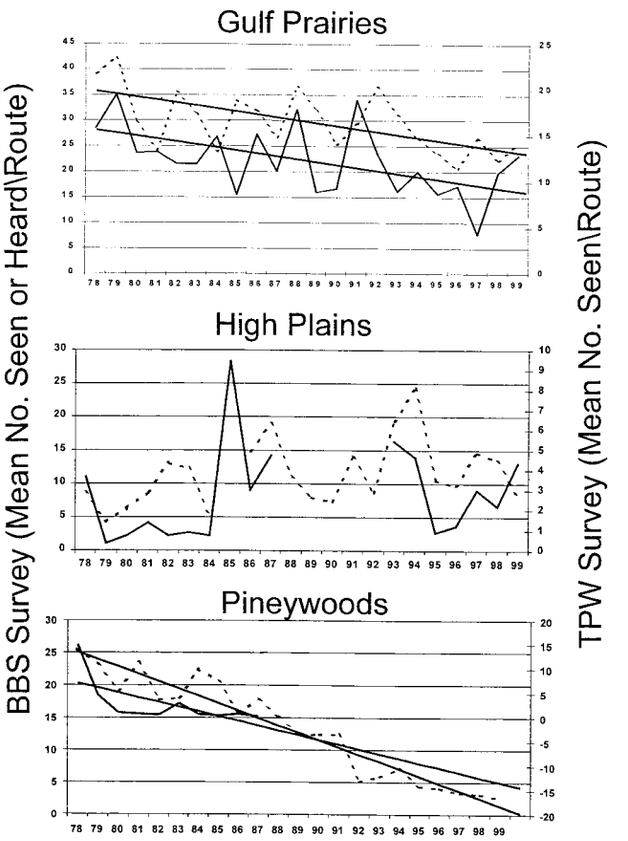


Fig. 1. Comparison of North American Breeding Bird Survey (dashed line) and Texas Parks and Wildlife roadside survey (solid line) of northern bobwhite abundance trends in Texas, by ecoregion. Trend line indicates the slope is different ($P < 0.05$) from 0.0.



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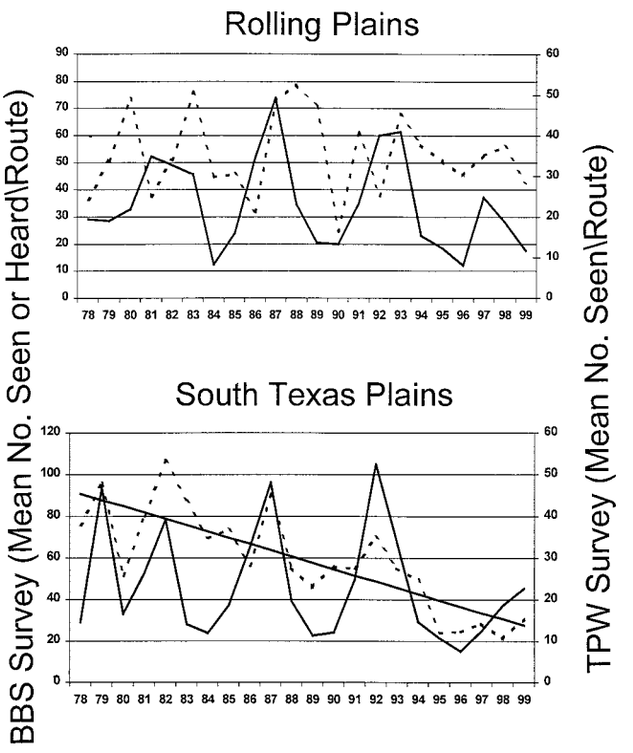
ble 2). Statewide slopes differed between surveys for both quail species (Table 2).

Slopes for bobwhite trends differed between survey types in the Blackland Prairies, Cross Timbers, Edwards Plateau, South Texas Plains, and statewide (Table 3). No differences were found between surveys for scaled quail at the ecoregion or statewide scale (Table 3).

Correlation coefficients ranged between 0.22 and 0.73 for bobwhites among ecoregions, and the statewide coefficient was 0.36 (Table 4). Scaled quail correlation coefficients ranged from 0.17 to 0.64 among the ecoregions, and was 0.63 at the statewide level (Table 4). Survey types were positively correlated for both northern bobwhites and scaled quail (Table 4), but the BBS provided a more negative trend.

Annual percent change for bobwhites within ecoregions, based on BBS counts ranged from −4.3% to 1.6% (Table 5). Seven of the 8 ecoregions indicate annual declines. Similarly, TPW counts indicate annual declines in most ecoregions (Table 5). Annual percent change for scaled quail was similar among ecoregions, between survey types (Table 5).

The TPW roadside survey was more related to estimated statewide harvest for northern bobwhites ($R^2 = 0.86$, $P = <0.0001$) and scaled quail ($R^2 = 0.75$, P



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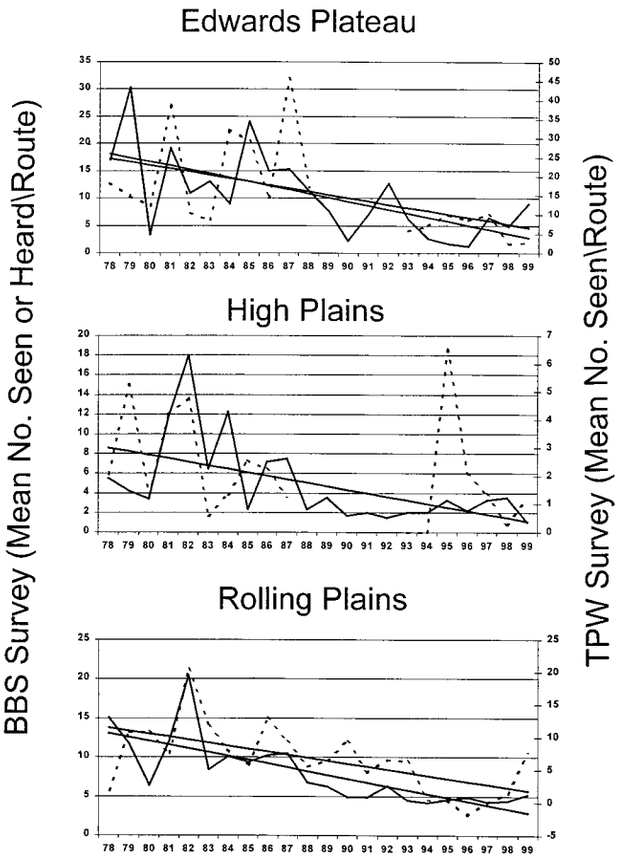

Fig. 2. Comparison of North American Breeding Bird Survey (dashed line) and Texas Parks and Wildlife roadside survey (solid line) of scaled quail abundance trends in Texas, by ecoregion, 1978–99. Trend line indicates the slope is different ($P < 0.05$) from 0.0.

$= <0.0001$) than was the BBS survey ($R^2 = 0.60$, $P = 0.0012$; and $R^2 = 0.35$, $P = 0.0197$, respectively) (Fig. 4).

DISCUSSION

Sauer et al. (1994) compared mourning dove (*Zenaida macroura*) call-count surveys and the BBS and found that population estimates differed between surveys in 11 of 48 states and these differences were probably the result of the BBS having smaller ecoregion and statewide sample sizes. We found no other literature that reported comparisons of BBS counts with a similar population index for any other upland game bird species. We found that the BBS and TPW survey gave similar trends for most ecoregions, but differed at the statewide scale in Texas. Similar to many other states, parts of Texas have increasing, stable, and decreasing quail populations. However, regardless of which survey is used, quail numbers are declining if Texas is considered as a whole.

When making comparisons between surveys, it is important to understand differences in survey methodology that could influence survey results. For example, TPW uses wildlife biologists and technicians

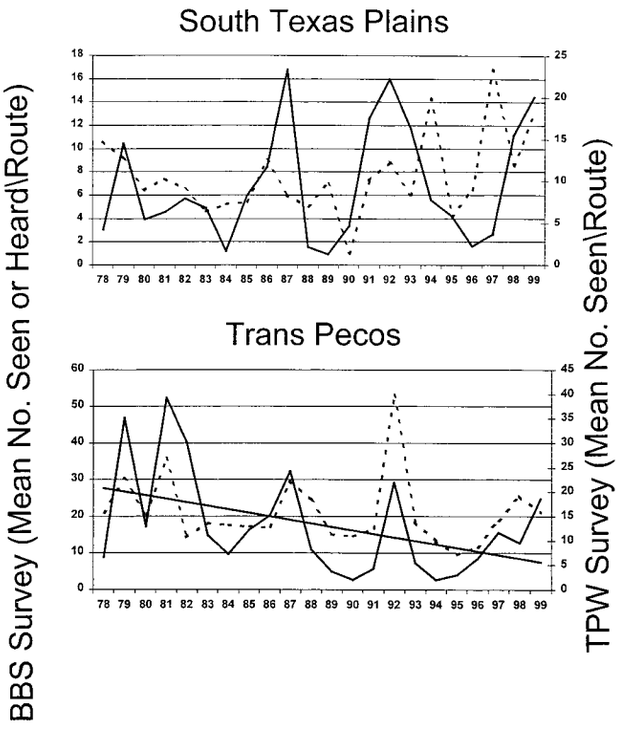

Fig. 2. Continued.

to conduct its survey and only counts quail visually observed along survey routes. The BBS uses amateur birders and professionals to conduct surveys and all species of birds seen or heard at stops are recorded. Observer experience and the density of bird species occurring only at stops could bias BBS counts.

Another important difference between surveys is that not all BBS routes are surveyed annually. Depending on the availability of volunteers, sample sizes within an ecoregion may differ annually, and sometimes are quite small.

Table 1. Quail population trends in Texas from the North American Breeding Bird Survey (BBS) and Texas Parks and Wildlife (TPW) quail roadside survey, 1978–99.

Species Ecoregion	BBS	TPW
Northern Bobwhite		
Blackland Prairie	Decreasing	Stable
Cross Timbers	Decreasing	Decreasing
Edwards Plateau	Decreasing	Stable
Gulf Prairies	Decreasing	Decreasing
High Plains	Stable	Stable
Pineywoods	Decreasing	Decreasing
Rolling Plains	Stable	Stable
South Texas Plains	Decreasing	Stable
Statewide	Decreasing	Stable
Scaled Quail		
Edwards Plateau	Decreasing	Decreasing
High Plains	Decreasing	Stable
Rolling Plains	Decreasing	Decreasing
South Texas Plains	Stable	Stable
Trans Pecos	Stable	Decreasing
Statewide	Stable	Decreasing

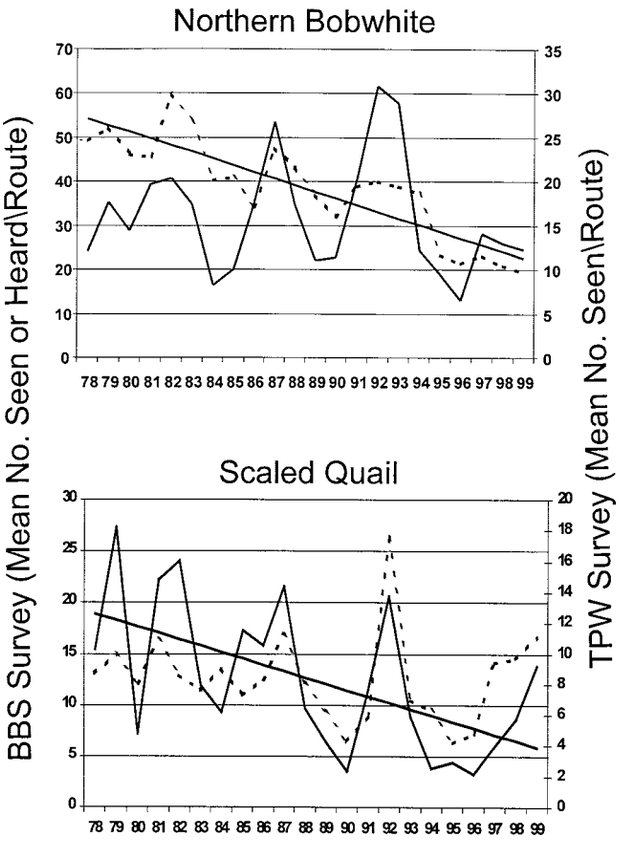

Fig. 3. Statewide comparison of North American Breeding Bird Survey (dashed line) and Texas Parks and Wildlife roadside survey (solid line) of northern bobwhite and scaled quail abundance trends in Texas, by ecoregion, 1978–99. Trend line indicates the slope is different ($P < 0.05$) from 0.0.

Table 3. Ninety-five percent confidence intervals for slopes of regression lines for quail trends in Texas, by species, ecoregion, and survey type, 1978–99.

Species / Ecoregion	BBS Lower	BBS Upper	TPW Lower	TPW Upper
Northern Bobwhite				
Blackland Prairie	−2.12	−1.50	−0.96	0.19
Cross Timbers	−4.39	−1.86	−1.18	−0.24
Edwards Plateau	−1.98	−0.94	−0.43	0.04
Gulf Prairies	−0.84	−0.19	−0.50	−0.06
High Plains	−0.26	0.61	−0.10	0.23
Pineywoods	−1.28	−0.99	−1.76	−0.18
Rolling Plains	−1.08	0.99	−1.12	0.38
South Texas Plains	−4.00	−2.03	−1.34	0.42
Statewide	−1.90	−1.13	−0.50	0.33
Scaled Quail				
Edwards Plateau	−1.12	−0.08	−1.60	−0.48
High Plains	−0.63	−0.08	−0.21	0.05
Rolling Plains	−0.62	−0.15	−0.80	−0.36
South Texas Plains	−0.07	0.39	−0.21	0.71
Trans Pecos	−0.86	0.42	−1.37	−0.07
Statewide	−0.36	0.23	−0.68	−0.14

Another difference between the 2 surveys is that they each use different regional boundaries within a state. We used the ecoregions delineated by Gould (1975), whereas BBS uses the regions described by Bailey (1978). These different systems do not overlap exactly. A better comparison would have been to choose regional boundaries *a priori*, then place survey routes for each survey type in the appropriate region.

The season when surveys are conducted also could affect results. The BBS is conducted at the beginning of the quail's breeding season; at a time when quail populations are at their lowest. The TPW survey is conducted in August following the majority of quail reproduction in Texas, when quail numbers are at their highest. Therefore, the BBS does not address annual

Table 2. *P*-values for *t*-test testing if slopes are equal to 0.0 for quail trends estimated from the North American Breeding Bird Survey (BBS) and Texas Parks and Wildlife (TPW) quail roadside survey, 1978–99.

Species / Ecoregion	BBS	TPW
Northern Bobwhite		
Blackland Prairie	0.0001	0.2294
Cross Timbers	0.0001	0.0076
Edwards Plateau	0.0001	0.1233
Gulf Prairies	0.0052	0.0199
High Plains	0.4307	0.4262
Pineywoods	0.0001	0.0429
Rolling Plains	0.9330	0.3478
South Texas Plains	0.0001	0.3194
Statewide	0.0001	0.6928
Scaled Quail		
Edwards Plateau	0.0381	0.0017
High Plains	0.0186	0.2266
Rolling Plains	0.0045	0.0001
South Texas Plains	0.1789	0.2969
Trans Pecos	0.5042	0.0431
Statewide	0.6900	0.0072

Table 4. Regression slope, R^2, and Pearson correlation coefficient (r) for the North American Breeding Bird Survey (BBS) counts and Texas Parks and Wildlife (TPW) quail roadside counts, by quail species and ecoregion, Texas, 1978–99.

Species / Ecoregion	BBS Slope	BBS R^2	TPW Slope	TPW R^2	r
Bobwhite					
Blackland Prairie	−1.81	0.86	−0.38	0.07	0.70
Cross Timbers	−3.12	0.52	−0.71	0.27	0.67
Edwards Plateau	−1.46	0.59	−0.19	0.07	0.73
Gulf Prairies	−0.52	0.30	−0.28	0.21	0.48
High Plains	0.18	0.03	0.07	<0.01	0.68
Pineywoods	−1.13	0.92	−0.97	0.35	0.61
Rolling Plains	−0.04	0.04	−0.37	<0.01	0.22
South Texas Plains	−3.01	0.63	−0.46	<0.01	0.58
Statewide	−1.51	0.74	−0.09	<0.01	0.36
Scaled Quail					
Edwards Plateau	−0.60	0.20	−1.04	0.36	0.50
High Plains	−0.36	0.21	−0.08	0.04	0.29
Rolling Plains	−0.39	0.31	−0.58	0.55	0.64
South Texas Plains	0.16	0.04	0.25	<0.01	0.17
Trans Pecos	−0.22	0.05	−0.72	0.15	0.60
Statewide	−0.06	<0.01	−0.41	0.28	0.63

Table 5. Annual percent change in quail abundance from the North American Breeding Bird Survey (BBS) and Texas Parks and Wildlife (TPW) quail survey, 1978–99. Annual percent change calculated as percent change from first data point to last data point in the time period, based on the regression equation for that survey, divided by the number of years in the time period.

Species Ecoregion	BBS	TPW
Bobwhite		
Blackland Prairie	−3.92	−4.05
Cross Timbers	−2.56	−2.71
Edwards Plateau	−2.80	−1.96
Gulf Prairies	−1.43	−1.73
High Plains	1.61	3.84
Pineywoods	−4.29	−12.97
Rolling Plains	−0.09	−1.31
South Texas Plains	−3.15	−1.58
Statewide	−2.65	−0.46
Scaled Quail		
Edwards Plateau	−3.33	−3.82
High Plains	−3.85	−2.50
Rolling Plains	−2.75	−5.10
South Texas Plains	2.66	3.44
Trans Pecos	−0.89	−3.30
Statewide	−0.43	−3.05

production. Reproductive data are needed to aid state agencies in setting the fall hunting season.

The number of survey routes sampled also affects survey results. The TPW survey has about 150 survey routes statewide for northern bobwhites. The BBS has increased the number of routes in Texas, but averaged about 75 for the last 6 years. TPW routes for scaled quail in Texas ranged between 80 and 90. The BBS survey has less than 40 routes for scaled quail. Small sample sizes can increase variability associated with results.

Scale also is an important consideration when using surveys. Survey methodology needs to address the scale at which survey data will be extrapolated. The TPW survey was designed to be able to give information at ecoregion and statewide spatial scales. The BBS was designed for state, cross-state regions, and national scales. Most state wildlife agencies, however, need surveys that provide information at finer scales. Knowing the population status of a particular species within a given part of the state is an important aspect of conducting the states' business, providing hunting season forecasts, and setting hunting regulations.

CONCLUSIONS

The BBS was designed to represent bird populations at statewide, cross-state, regional, national, and multi-national spatial scales. Most state wildlife agencies, however, need surveys that provide information at finer scales, such as the ecoregion level, in order to track population trends, inform the regulatory process, and provide hunting season forecasts. Knowing the population status of a particular species within a given part of the state is an important part of managing quail populations, providing accurate information to the public, and responding to inquiries by other agencies. Therefore, the TPW production and harvest surveys should be continued in order to acquire these data.

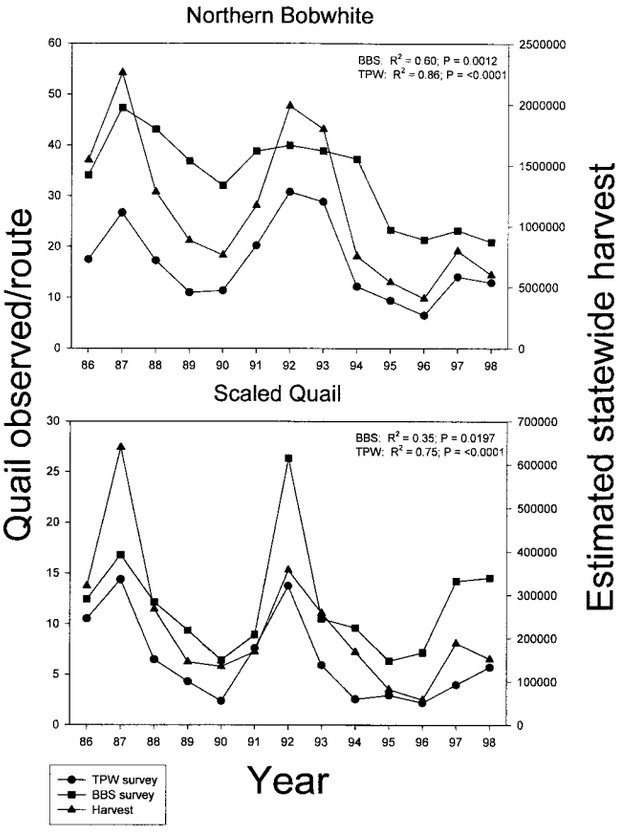

Fig. 4. Relationship between statewide North American Breeding Bird Survey, Texas Parks and Wildlife roadside survey, and estimated statewide harvest for northern bobwhites and scaled quail in Texas, 1986–99.

The availability of data on the Internet may make it tempting to use the most accessible data (BBS), rather than the data collected at the appropriate scale to address a particular question. Therefore, we must be cognizant of the limitations of different surveys and strive to use the most appropriate survey to address a particular question.

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