

**THE TEXAS QUAIL INDEX: EVALUATING PREDICTORS OF QUAIL  
ABUNDANCE USING CITIZEN SCIENCE**

A Thesis

by

KELLY SHANE REYNA

Submitted to the Office of Graduate Studies of  
Texas A&M University  
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2008

Major Subject: Wildlife and Fisheries Sciences

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Approved by:

Co-Chairs of Committee,	Dale Rollins Michael Morrison
Committee Members,	Urs Kreuter Dean Ransom
Head of Department,	Thomas Lacher, Jr.

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## ABSTRACT

The Texas Quail Index: Evaluating Predictors of Quail Abundance Using Citizen Science. (August 2008)

Kelly Shane Reyna, A.S., Georgia Military College; B.S., Tarleton State University

Co-Chairs of Advisory Committee: Dr. Dale Rollins  
Dr. Michael Morrison

Annual abundance of northern bobwhite (*Colinus virginianus*) and scaled quail (*Callipepla squamata*) fluctuates drastically in Texas, which complicates a quail manager's ability to forecast quail abundance for the ensuing hunting season. The Texas Quail Index (TQI) was a 5-year citizen-science project that evaluated several indices of quail abundance and habitat parameters as predictors of quail abundance during the ensuing fall. I found that spring cock-call counts explained 41% of the variation in fall covey-call counts for all study sites in year 1–4, and 89% of the variation in year 5. Further investigation revealed that year 5 was a drought year and had a significantly lower percentage of juveniles in the hunter's bag. These results suggest that during drought years, fall quail abundance is more predictable than during non-drought years and that low breeding success may be the reason. If these data are correct, quail managers should have a better ability to predict the declines of their fall quail abundance in the dry years.

The TQI relied on citizen scientists (cooperators) to collect data. Since most (66.1%) cooperators dropped out of the program, and <8% of all data sets were

complete, I surveyed the cooperators by mail to determine the rate and cause of cooperator decline and to identify characteristics of a reliable cooperator (i.e., one that did not drop out of the study). I found that cooperator participation declined earlier each year for year 1–4, and that year 5 demonstrated a steady trend with the least amount of cooperators. Most respondents who dropped out (61.5%) reported their motive for leaving was that it was too time consuming. I found no difference in mean cooperator demographics, satisfaction, or landownership goals between those respondents who dropped out and those that did not. However, 38% of those who dropped out were not completely satisfied with communication from TQI coordinators compared to only 15% of those who did not drop out, indicating that communication, or perhaps overall volunteer management, might have been improved. Future studies should maintain better communication with participants, require less time, and provide an incentive for retention.

## **DEDICATION**

To Debbie and Colton:

Thank you for everything, especially your patience,  
unprecedented sacrifice, and dedication.

I love you.

## ACKNOWLEDGMENTS

First, I thank Dr. Dale Rollins for recruiting me for this project and for guiding me along the way. In addition, I thank my committee co-chair Dr. Michael Morrison as well as my committee members, Dr. Urs Kreuter and Dr. Dean Ransom, for their time, guidance, and loyalty. I also extend my gratitude to Dr. Markus Peterson, my colleagues, and the department faculty and staff for making my time at Texas A&M remarkable. I really appreciate all the effort spent on grooming me as a scientist and developing this project.

Thanks also to Dr. Rollins, Dr. Ransom, Ken Cearley, and Ben Taylor for establishing and maintaining the Texas Quail Index and to the Quail Decline Initiative and Texas AgriLife Extension for funding. I also thank all of the cooperators and technicians for their hard work, perseverance, and time while collecting data. Without your tremendous effort, the Texas Quail Index would not exist. To all the landowners, ranch managers, and support staff, thank you for your accommodations, cooperation, and work. You are a great asset to Texas and are really appreciated.

Finally, thanks to my friends and family for your support and words of encouragement. I am thankful to have steadfast friends and for being a part of two magnificent families. Thank you for believing in me.

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## CHAPTER I

### INTRODUCTION

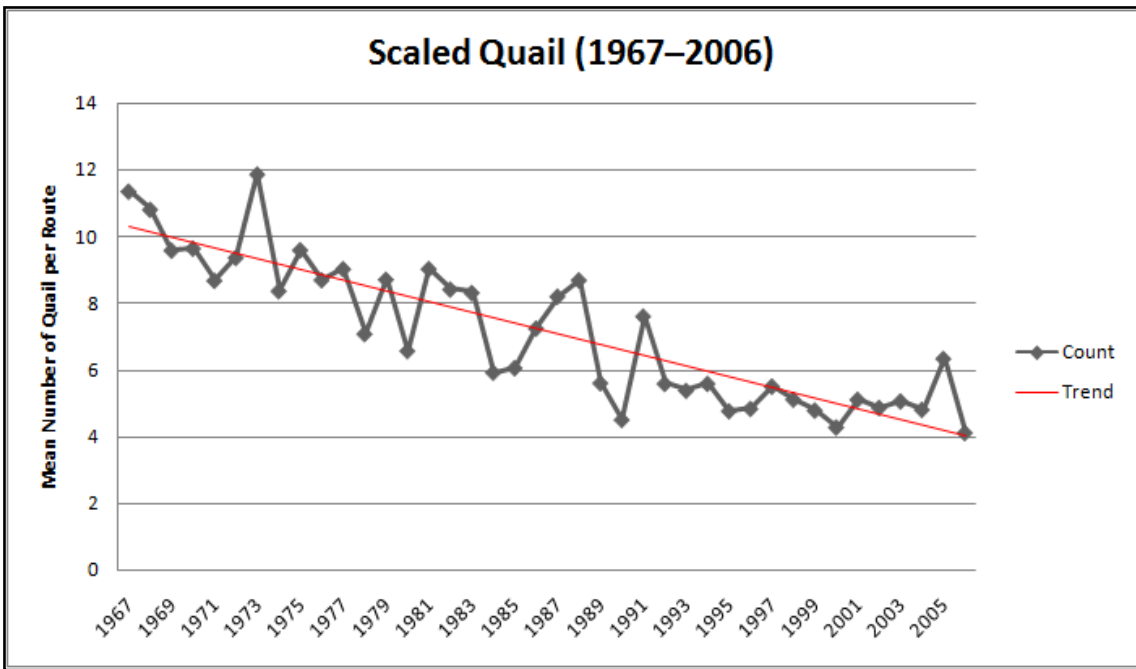
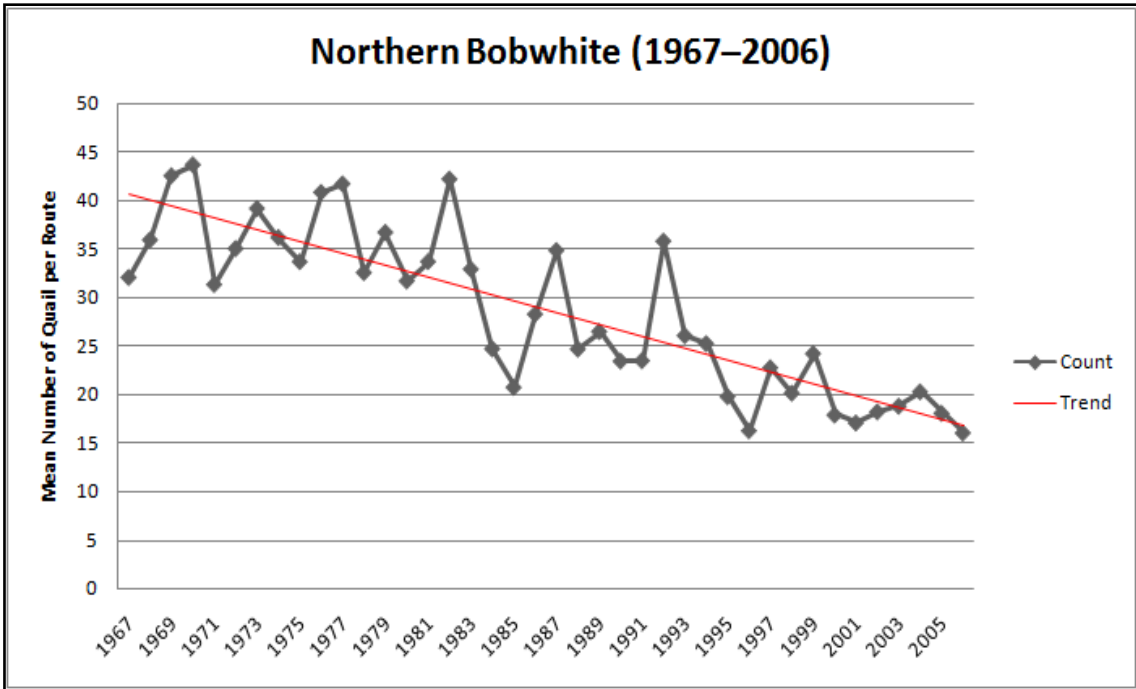
#### BACKGROUND

Annual abundance of northern bobwhite (*Colinus virginianus*; hereafter bobwhite) and scaled quail (*Callipepla squamata*) fluctuates drastically in Texas (Lehmann 1984: 157, Peterson 2001; Figure 1.1), particularly in semiarid regions (Bridges et al. 2001, Lusk et al. 2005). These fluctuations complicate a quail manager's ability to forecast quail abundance for the ensuing hunting season. Quail managers, who lease trespass-rights to quail hunters, typically schedule clients  $\geq 6$  months in advance. Accordingly, they need a practical and reliable method to forecast quail abundance for the upcoming hunting season earlier in the year (i.e., by July).

Previous studies evaluated the efficacy of various indices of quail abundance such as spring cock-call counts (Bennitt 1951, Reeves 1954, Rosene 1957, Brown et al. 1978), roadside counts (Peterson and Perez 2000), and morning covey-call counts (Roseberry and Klimstra 1984, Guthery 1986: 138–141, DeMaso et al. 1992). Although the value of such indices has been criticized as measures of abundance (Norton et al. 1961, Anderson 2001), they may enable detection of relative differences in populations among areas or years (Guthery 2000: 103, Engeman 2003).

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This thesis follows the style of the Journal of Wildlife Management.



**Figure 1.1.** Bobwhite and scaled quail population trends in Texas from the North American Breeding Bird survey, 1967–2006 (Sauer et. al 2007).

My research project, the Texas Quail Index (TQI), was a long-term (2002–2006) citizen-science project that evaluated the above indices, plus other related measures (e.g., habitat parameters) possibly impacting quail abundance, as predictors of quail abundance during the ensuing fall hunting-season. Citizen-science projects typically use trained volunteers to collect data for use in research projects or for monitoring abundance of species. In return, participants have the opportunity to learn about and be involved in science. An ulterior objective of the TQI was to involve volunteers in monitoring quail and habitat parameters and thus empower them to become more active in quail management efforts at the local scale.

In addition to evaluating indices of quail abundance, I also assessed the citizen-science aspect of the TQI. Trained volunteers (hereafter cooperators) recorded all data during the project. Due to unforeseen complications of using cooperators (e.g., missing data, low volunteer retention rate) I also surveyed all cooperators by mail to determine the rate and cause of cooperator decline (i.e., dropout rate), and to identify characteristics of a reliable cooperator (i.e., one that did not drop out of the study).

## **OBJECTIVES**

My objectives were to: (1) determine which, if any, TQI index or indices predict(s) quail abundance during the ensuing hunting-season; (2) identify characteristics of a reliable cooperator; and (3) determine the cause of cooperator decline.



## STUDY AREA

Personnel from the Texas AgriLife Extension office in San Angelo, Texas sent an invitation to county Extension agents, agency biologists (e.g., Texas Parks and Wildlife Department), and interested landowners across the state to participate in the TQI. The invitation was sent internally to county Extension agents and via an annual press release from 2002–2006 (D. Rollins, Texas AgriLife Extension, personal communication). Throughout the 5-year project, a total of 65 ranches and 6 Texas Parks and Wildlife (TPW) Wildlife Management Areas (WMA) responded and served as study sites. Those sites were located in 59 Texas counties (Figure 1.2) encompassing 5 ecoregions (Gould 1975; Figure 1.3). The majority of sites were in west-central Texas with 23 counties in the Rolling Plains, 13 in the Edwards Plateau, 11 in the Cross Timbers and Prairies, 10 in the South Texas Plains, and 2 in the Trans-Pecos ecoregion.

The Rolling Plains landscape is flat to rolling, with natural vegetation of mixed-grass plains dominated by mesquite (*Prosopis glandulosa*) grasslands. Rangelands and croplands comprise about 65% and 35% of the region respectively. Bobwhite abundance in the region is relatively stable and scaled quail abundance has declined (Sauer et al. 2007; Figure 1.4). This ecoregion supports both bobwhite and scaled quail hunting resulting in many landowners incorporating fee-lease hunting as part of their income (Rollins 2007). Fee-lease hunting entails hunters paying landowners a fee for access to their land, usually for a hunting day, season, or for yearly access.

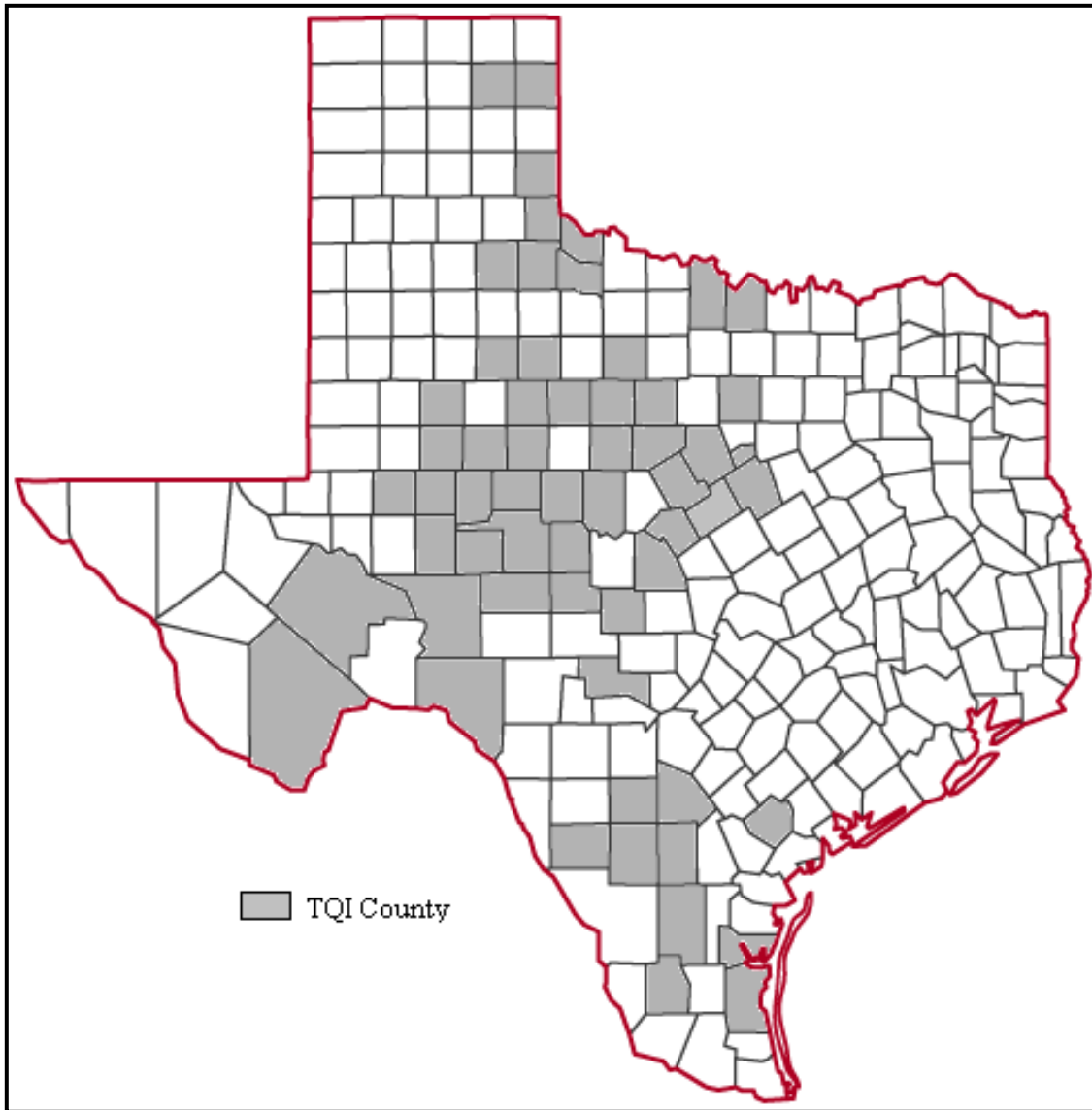
The Edwards Plateau region comprises an area of central Texas commonly known as the Texas Hill Country. It is a land of many springs, streams, stony hills, and steep canyons. Native vegetation consists of oak-pecan (*Quercus spp.*, *Carya spp.*) or oak-juniper (*Juniperus spp.*) woodlands, mesquite-mixed brush savannah, and grasslands. The central and western portion remains a relatively flat elevated plateau whereas the southern and eastern portion is deeply eroded (Baccus and Eitniewski 2007). Although both bobwhite and scaled quail are in decline in the region (Saur et al. 2007; Figure 1.5), the western portion supports hunting of both species.

The Cross Timbers and Prairies region can be described as oak savannah. The region supports bobwhites only, which have been on the decline since 1980 (Figure 1.6) and has the least amount of fee-lease hunting of the areas studied (DeMaso and Dillard 2007).

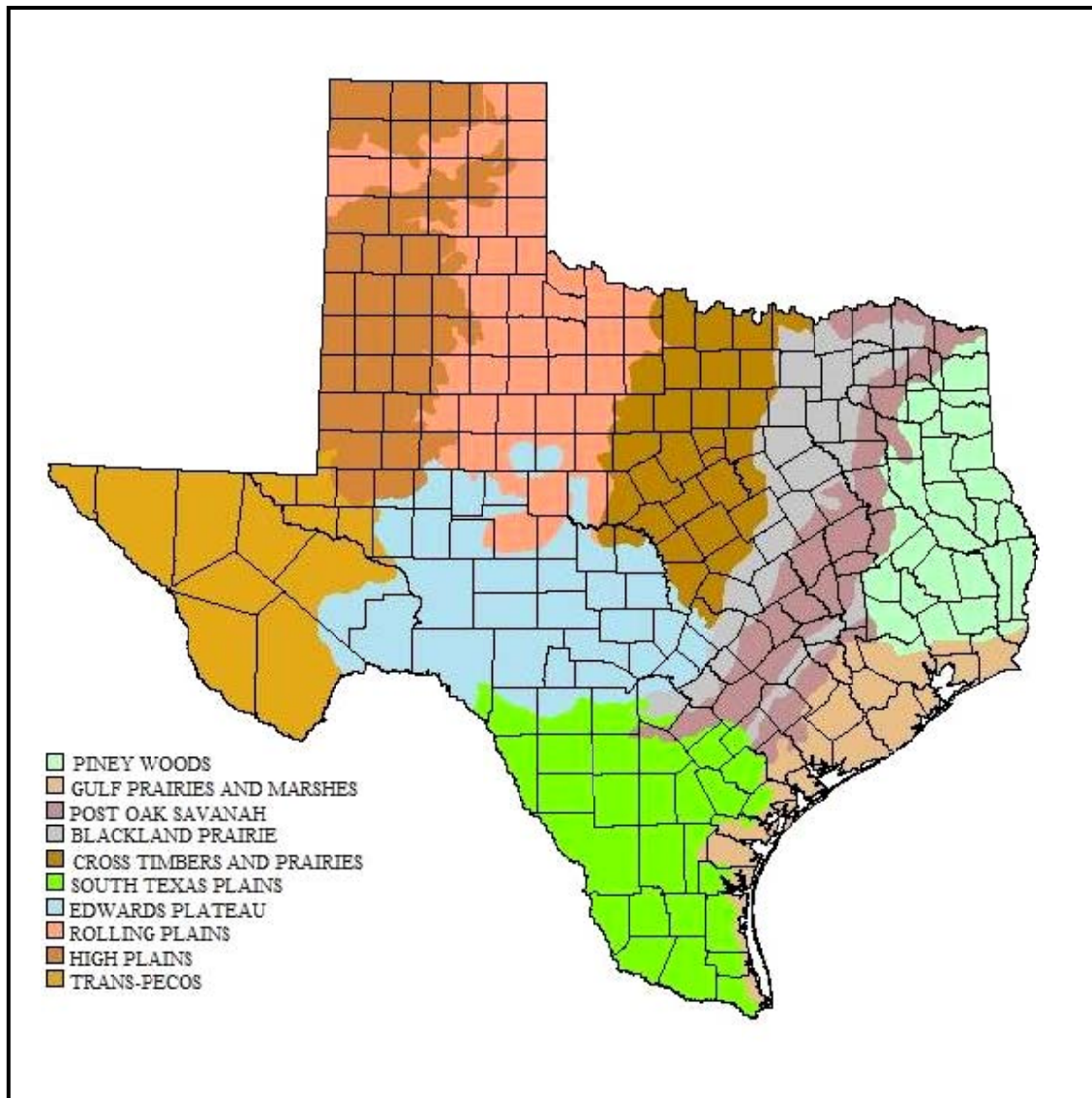
The South Texas Plains is commonly referred to as the Texas brush country and is characterized by plains of thorny shrubs, recent agricultural fields, some grasslands, oak-forest, and tall riparian forests (Hernandez et al. 2007). The region supports both bobwhite and scaled quail, and although both are declining in the area (Saur et al. 2007; Figure 1.7), it is known for good quail hunting. Accordingly, many landowners provide fee-lease hunting as a means to supplement their income.

The Trans-Pecos region is the only part of Texas where mountain and desert habitats are found. Creosote bush (*Larrea tridentate*) and tarbush (*Flourensia cernua*) comprise >80 percent of the plant communities (Harveson 2007). Scaled quail in the

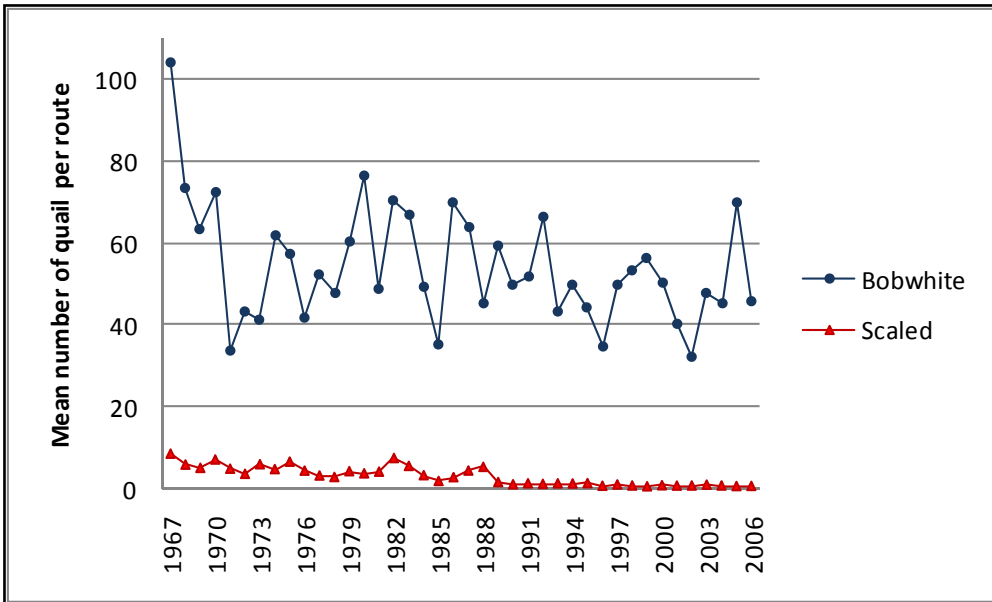
region remained steady or slightly increased while bobwhites are scarce and on the decline (Figure 1.8). Both species attract many hunters to the area (Harveson 2007).



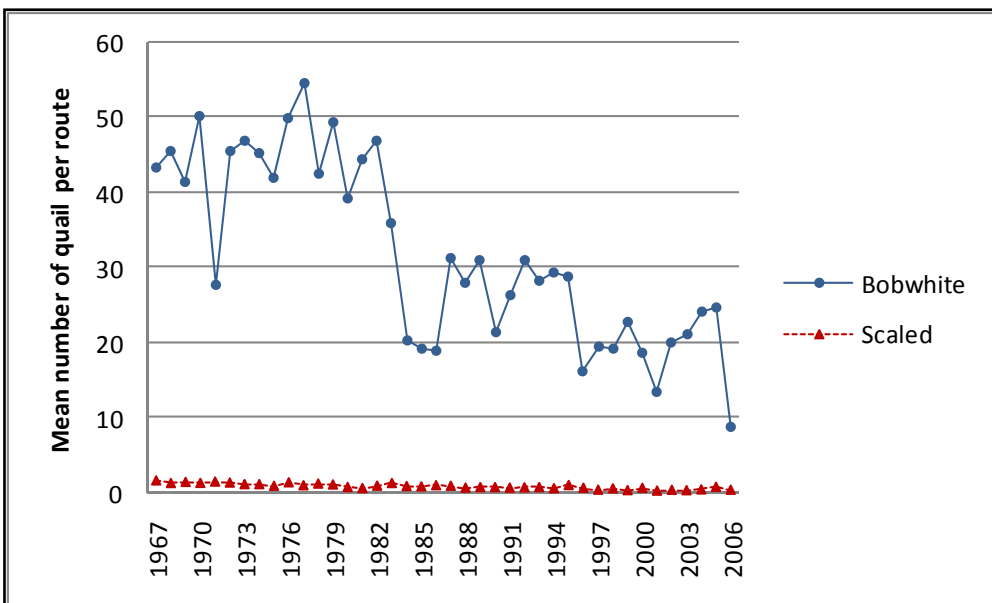
**Figure 1.2.** Distribution of Texas Quail Index study sites by county, 2002–2006.



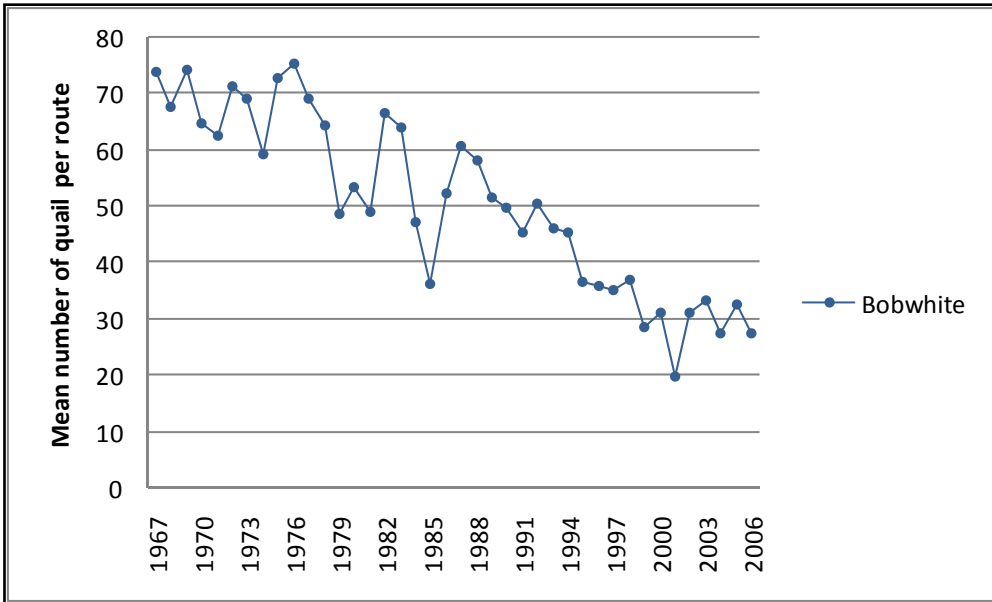
**Figure 1.3.** The 10 ecoregions of Texas as described by Gould (1975).



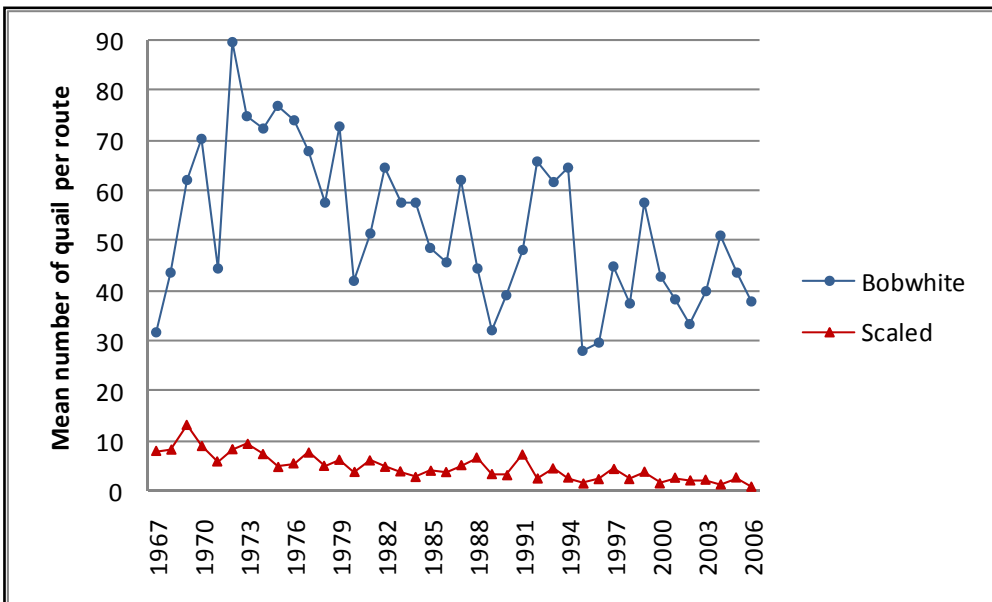
**Figure 1.4.** Bobwhite and scaled quail population trends in the Rolling Plains of Texas based on North American Breeding Bird Surveys (BBS), 1967–2006. The Rolling Plains region is referred to as the Rolling Red Plains by the BBS and includes data from Oklahoma and Texas.



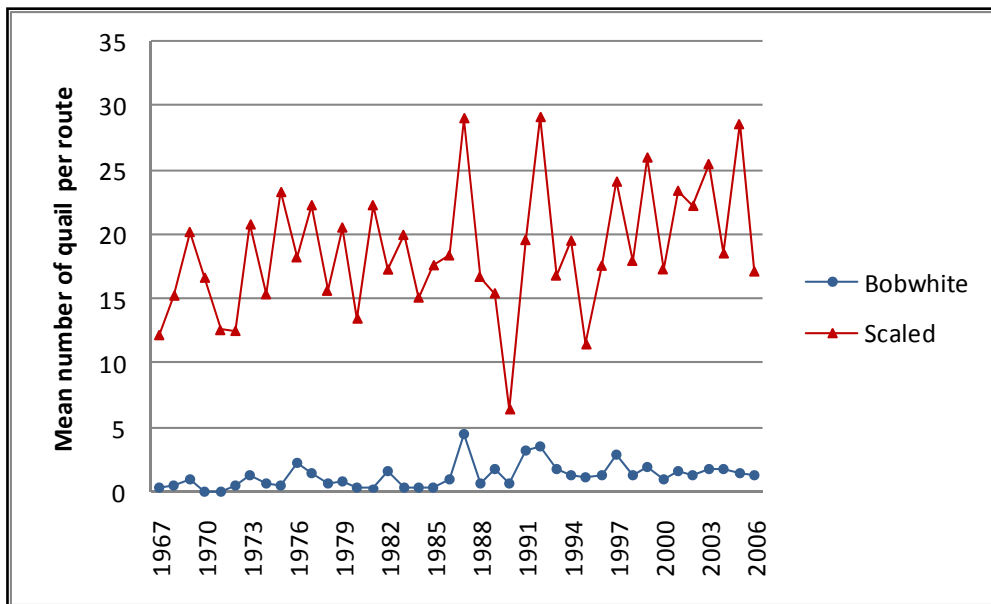
**Figure 1.5.** Bobwhite and scaled quail population trends in the Edward's Plateau based on North American Breeding Bird Surveys, 1967–2006.



**Figure 1.6.** Bobwhite population trends in the Cross Timbers and Prairies based on North American Breeding Bird Surveys (BBS), 1967–2006. The Cross Timbers and Prairies region is referred to as the Osage Plain-Cross Timbers by the BBS and includes data from Missouri, Nebraska, Oklahoma, and Texas.



**Figure 1.7.** Bobwhite and scaled quail population trends in the South Texas Plains based on North American Breeding Bird Surveys, 1967–2006.



**Figure 1.8.** Bobwhite and scaled quail population trends in the Trans Pecos based on North American Breeding Bird Surveys (BBS), 1967–2006. The Trans Pecos region is referred to as the Chihuahuan Desert region by the BBS and includes data from New Mexico and Texas.

## **CHAPTER II**

### **THE TEXAS QUAIL INDEX**

#### **INTRODUCTION**

The Texas Quail Index was a 5-year, citizen-science project where 76 cooperators recorded 3 indices of quail abundance (i.e., spring cock-call counts, roadside counts and fall covey-call counts), 2 habitat parameters (i.e., habitat photo points and species richness of forbs), and 3 other quail-related variables (i.e., simulated-nest fate, potential nest sites, and scent-station visitations). Cooperators also recorded 2 production variables: (1) number of coveys ( $\geq 6$  grouped quail) flushed per hour of hunting effort; and (2) percent juveniles in the hunter's bag. Of the variables recorded, spring cock-call counts, habitat photo points, forb species-richness, simulated-nest fate, predator scent-stations, and potential nest sites were used as independent variables (i.e., predictors of quail abundance in the fall). Dependent variables collected were number of coveys flushed per hour of hunting effort, roadside counts, and fall-covey counts. In this chapter I test the hypothesis that  $\geq 1$  index of spring or summer quail abundance is a reliable predictor of quail abundance during the ensuing hunting season.

#### **OBJECTIVE**

My objective was to determine which, if any, TQI index (or indices) was predictive of quail abundance during the ensuing hunting season.



## METHODS

### Cooperator training

In April of each year (2002–2006), new cooperators attended a 2-day training session involving classroom instruction and hands-on simulations in the field. Each cooperator received detailed instructions and materials necessary to conduct TQI protocols on their respective properties. A website ([teamquail.tamu.edu](http://teamquail.tamu.edu)) provided all pertinent literature and data sheets for cooperators' use.



**Figure 2.1.** Texas Quail Index cooperators are standing next to visual marker 2. Each visual marker served as a data collection point and was constructed using a steel t-post with a numbered sign attached.

### **Establishing permanent transect**

Each cooperator established a 16.0-km permanent transect on their respective property with visual markers (i.e., numbered signs attached to steel t-posts, Figure 2.1) at 1.6-km intervals (Bennitt 1951, Brown et al. 1978). Each visual marker served as a data collection point for the duration of the study and had an implied radius of audibility (maximum distance at which humans can hear calling quail) of 600 m (Rollins et al. 2005). Transects were typically established along existing ranch roads (i.e., not always a straight line transect) and were situated so that the radius of audibility of each visual marker did not overlap with others, in order to minimize redundancy between successive stations during call counts (e.g., spring cock-call counts; Hansen and Guthery 2001). Cooperators were instructed to select a transect location far enough removed from a heavily-traveled road to minimize interference from traffic noise and to install the transect in a manner proportional to the habitat types represented on the property.

### **Spring cock-call counts**

Spring cock-call counts are an inexpensive way to index quail populations over an extensive area (Hansen and Guthery 2001, Rollins et al. 2005), but results differ as to whether spring cock-call counts are effective predictors of quail abundance of the ensuing hunting season (Rosene 1957, Norton et al. 1961, Ellis 1972, Snyder 1984). For the TQI, spring cock-call counts began at, or just prior to, official sunrise (Bennitt 1951, Norton et al. 1961, Hansen and Guthery 2001) and continued until counts were conducted at all visual markers (approximately 1.5 hours). Cooperators recorded the

number of calling males heard at each visual marker during a 5-minute span (Reeves 1954: 25–26, Rosene 1957, Hansen and Guthery 2001) and the approximate location (distance and direction from the visual marker) of each male to prevent double-counting (Guthery 1986: 139–141, Rollins et al. 2005). Call counts were not conducted during rain or when winds exceeded 16 km/hr. Counts were replicated 3 or 4 times (Smith and Gallizioli 1965) from 1 May–1 June (typically the peak quail calling period) for each TQI site to increase the probability of detection since the peak of calling activity can vary (Brown et al. 1978). Each cooperator reported the average of the replications as the spring cock-call index (number of calling roosters/113 ha).

### **Roadside counts**

Cooperators drove their 16.0-km route in early-morning and late-afternoon hours (Peterson and Perez 2000) during the first 2 weeks of September (before hunting season) to count and record any quail observed. Starting and ending points (i.e., direction of travel) alternated between successive counts to account for any possible diel bias. Cooperators maintained a speed  $\leq 33.3$  km/hr to minimize evasion of quail due to vehicle noise (Peterson and Perez 2000) and replicated counts 3 or 4 times over a 2-week period to increase the probability of detection. The average of all counts comprised the roadside count index.

### **Fall covey-call counts**

Fall covey-calls of bobwhites (scaled quail do not elicit a fall covey call) primarily function to announce a covey's location to neighboring coveys (Wellendorf

and Palmer 2004). Stoddard (1931), Roseberry (1982), and DeMaso et al. (1992) utilized fall covey-call counts to estimate fall quail abundance and spatial distribution. Cooperators randomly selected 4 visual markers at which to conduct the counts. Fall covey-call counts could only be conducted at 1 visual marker per morning since fall covey-calls are elicited for <20 minutes during the early morning. Counts began approximately 40 minutes before official sunrise (typical covey calling time; Rosene 1957). Cooperators recorded the number of coveys calling and the approximate location (distance and direction from the visual marker) of each covey calling. Call counts were not conducted during rain or when winds exceeded 16 km/hr. Cooperators repeated the fall covey-call count at 2 to 4 remaining randomly-selected visual markers on separate mornings between 1 October and 15 November (Wellendorf and Palmer 2004). Cooperators recorded the average of the 4 counts as the fall covey-call index (number of coveys calling/113 ha).

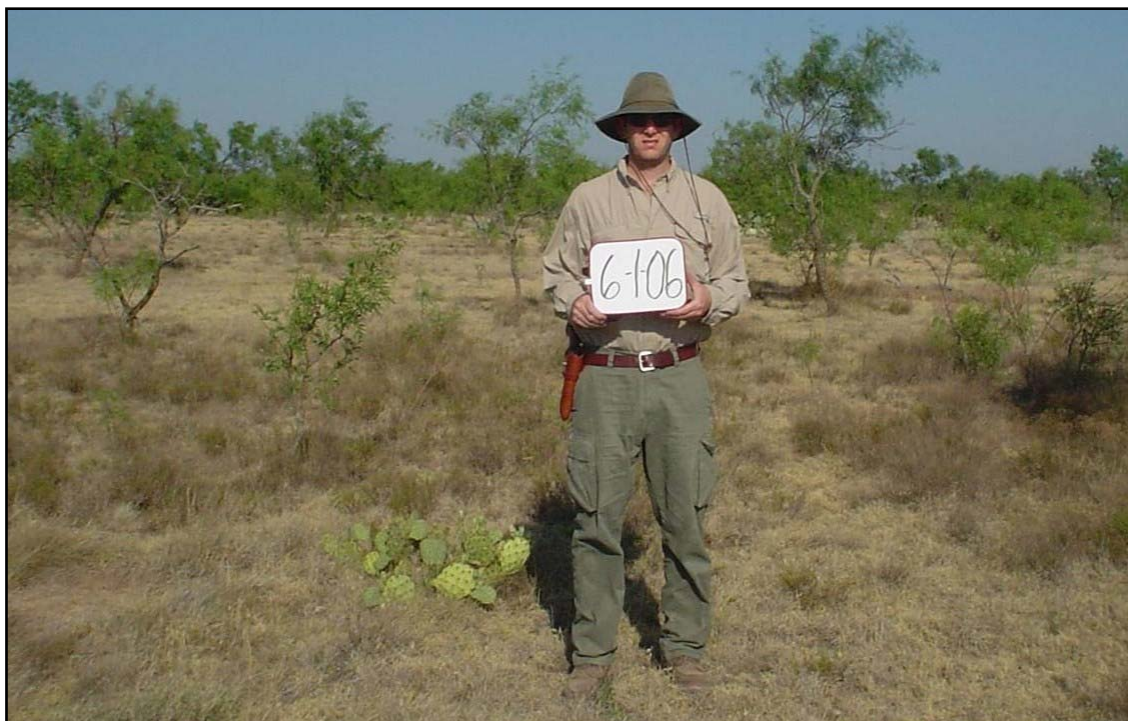
### **Habitat photo points**

Fixed photo points are used to determine changes in landscape characteristics over time (Skovlin et al. 2000). To determine if quail-related habitat parameters change over time, cooperators recorded a pair of habitat photographs from both sides of each visual marker (perpendicular to the transect; 22 photographs total) in May. An enamel board with the visual marker number, direction from visual marker (1=right side, 2=left side), and year was included in each photograph for identification purposes (Figure 2.2). Cooperators mailed the 22 photographs to D. Rollins, TQI coordinator in San Angelo,

Texas, who evaluated and scored each photograph. Rollins based the habitat score on 4 criteria: (1) diversity of escape cover species (1 point per species for a maximum of 3 points; Brennan 1991); (2) estimate of the herbaceous standing crop (1 point per species for a maximum of 3 points; Slater et al. 2001); (3) interspersion of escape cover and herbaceous vegetation ( $\leq 3$  points possible; Guthery 2000: 89–91); and (4) an intangible characteristic, i.e., his desire to hunt the area with his bird dogs (1 point), based on a subjective measure of “huntability” (D. Rollins, Texas AgriLife Extension, personal communication). Rollins recorded the average of all 22 photographs as the habitat-photo index for each site.

### **Forb species richness**

Forbs produce seeds and host insects used as food by quail (Stoddard 1931), and vital to chick survival (Guthery 2000). Accordingly, cooperators recorded species richness of the forb component at each visual marker once during May. Approximately 25 m away, and perpendicular to the transect route, cooperators faced the visual marker and tossed a 0.85-m circular quadrat over their shoulder to get a random sampling point. Cooperators recorded the number of forb species rooted within the quadrat. Cooperators recorded the average of all visual markers as the forb diversity index.



**Figure 2.2.** A Texas Quail Index cooperater displays an enamel board identifying the location (visual marker 6), direction (1= right of transect), and year (06 = 2006) for a photo point. Photographs were taken annually for use in fixed-photo analysis; a habitat evaluation technique. This photograph was given a score of 5 (escape cover = 2 points, herbaceous vegetation = 1 point, and interspersion = 2 points).

### **Simulated-nest fate**

Simulated quail-nest (simulated-nest) fate provides an index of actual bobwhite and scaled quail nest success (% nests intact) relative to habitat and predator contexts (Hernandez et al. 2001, Slater et al. 2001, Buntyn 2004). To evaluate simulated-nest fate, cooperators established 6 transects of simulated-nests at randomly-selected visual markers in June (peak of quail nesting season) of each year. Each simulated-nest transect consisted of 6 simulated-nests spaced 50-m apart. To establish the transects,

cooperators walked 50 m away from the visual marker, perpendicular to the permanent transect (alternating sides of the permanent transect at consecutive visual markers), and marked the location (e.g., N1T1 for nest 1, transect 1) on flagging tape (<25cm in length; Slater et al. 2001). From that point, cooperators established a simulated-nest  $\geq 10$  m away, along a 90° azimuth (right for odd-numbered nests, and left for even-numbered nests), in a suitable nesting substrate, typically a bunchgrass about 0.4 m in diameter (e.g., little bluestem [*Schizachyrium scoparium*]), or a clump of prickly pear (*Opuntia* spp.) about 1.0 m in diameter (Hernandez et al. 2001, Slater et al. 2001). Cooperators then walked back to the flagging tape and repeated the above procedure for all 6 simulated-nests. Each nest included 3 medium-sized chicken eggs and a steel washer (2.0-cm diameter) that increased the probability of finding the nest bowl when eggs were missing. Cooperators refreshed eggs in non-disturbed nests at 14 days to avoid spoiled eggs and wore latex gloves while handling eggs to minimize human scent. Whelan et al. (1994) found that any measure to minimize human scent in the vicinity of the nest should decrease the negative influence of observer presence. Cooperators recorded fate of simulated- nests as intact or depredated at 14 and 28 days after establishment (encompassing the approximate incubation period of 23 days for bobwhites; Burger et al. 1995) and recorded the percentage of nests intact at 14 days as the simulated-nest index.

### **Potential nest sites**

Once all simulated-nests were established along the simulated-nest transect, cooperators walked back to the visual marker (300 meters from the last simulated-nest)

holding their arms out straight and recorded the number of potential nests sites (i.e., suitable nesting substrates) rooted within their arms' span (approximately 2 m for a person who stands 2 m tall; Rollins et al. 2005). I multiplied the resulting number by 19.77 to calculate the estimated number of potential nest sites/hectare.

### **Scent-station visitations**

Due to the elusiveness of most carnivores, reliable estimates of abundance are difficult and expensive to obtain (Sargeant et al. 2003). Accordingly, many biologists rely on indices of relative abundance (i.e., scent-station visitation rates; Travaini et al. 1996, Warrick and Harris 2001) with varying degrees of success (Conner et al. 1983, Minser 1984, Nottingham et al. 1989, Diefenbach et al. 1994, Sargeant et al. 2003). The TQI scent-station protocol followed Linhart and Knowlton's (1975) general methodology and incorporated Roughton and Sweeny's (1982) recommended modifications. At each visual marker in May, cooperators removed all vegetation and debris from a circular area of 0.85 m in diameter, then covered the area with a smooth layer of tracking substrate (i.e., flour). Flour enabled detection of visitation to a scent lure (fatty-acid scent-tablet; Pocatello Supply Depot, Pocatello, Idaho USA) placed in the center of the station. The following morning, cooperators recorded presence of tracks of individual carnivore species (Figure 2.3). Cooperators repeated the process for 2 consecutive nights replenishing flour and lure as needed for Day 2. The average of the 2 nights comprised the predator scent-station index (number of visits/100 scent-station



nights [SSN]). Occasionally precipitation, wind, and non-target animals (e.g., livestock) obliterated stations; these occurrences were censored in my analysis.



**Figure 2.3.** Cooperators of the Texas Quail Index utilized scent-stations as an index of the relative abundance of mesomammal nest predators. This scent-station shows evidence of visitation by at least one raccoon.

### **Harvest data**

The ratio of juveniles to adults in the fall harvest is often used as an index of production (Flanders-Wanner et al. 2004). Guthery (2000: 86–87) recommended using

an index of quail population density (e.g., hunting success rates) in conjunction with age ratios because age ratios can be misleading since they reflect relative survival of adults as well as their productivity. Accordingly, cooperators recorded 2 production variables during quail hunts from November–February: (1) number of coveys flushed per hour of hunting effort; and (2) percentage of juveniles in the hunter’s bag. Cooperators aged quail in the bag by an examination of the primary coverts (Guthery 2000: 86–87).

### **Statistical analysis**

I used Statistical Package for the Social Sciences (SPSS; Chicago, Illinois, USA) version 15.0 to analyze data from each study site. An observation consisted of 1 year of data per study site. I performed a multiple regression analysis with stepwise inclusion of variables (Ott and Longnecker 2001: 707–726) to evaluate several spring and summer indices as predictors of hunting-season quail abundance. The assumptions for multiple regression analysis are: (1) no other independent variables need to be included in the model; (2) errors all have constant variance ( $\text{var } \varepsilon_i = \sigma_e^2$  for all  $i$ ); (3)  $\varepsilon_i$ ’s are independent; and (4)  $\varepsilon_i$ ’s are normally distributed.

My candidate independent variables were spring cock-call counts (SC), habitat photo points (HP), forb species-richness (FD), simulated-nest fate (SN), predator scent-stations (PS), and potential nest sites (PN). Dependent variables collected were number of coveys flushed/hour of hunting effort (CF), roadside counts (RC), and fall-covey counts (FC). Due to the variation of RC (coefficient of variation = 1.30) and the low sample size of CF ( $n = 33$ ), I used FC as the dependent variable for my analysis.

A Kolmogorov-Smirnov test indicated that FC was not normally distributed ( $P < 0.0001$ ); until it was transformed ( $FC_t = \ln [FC + 1]$ ;  $P = 0.200$ ). A Breusch-Pagan (1979) test indicated that  $FC_t$  met constant variance assumptions ( $P = 0.2880$ ,  $\alpha$ -level = 0.01). All tests used an  $\alpha$ -level of 0.05 to denote statistical significance unless otherwise stated. I used  $FC_t$  as my dependent variable for an initial regression equation of

$$FC_t = \beta_0 + \beta_1(SC) + \beta_2(HP) + \beta_3(FD) + \beta_4(SN) + \beta_5(PS) + \beta_6(PN) + \varepsilon,$$

where  $\beta_0$  is the intercept,  $\beta_1$ – $\beta_6$  are slopes of the corresponding indices, and  $\varepsilon$  is error.

An  $\alpha$ -level of 0.05 was used for inclusion of variables, and 0.10 for removal of variables.

I used an analysis of covariance (Ott and Longnecker 2001: 943–974; ANCOVA) to test for year and ecoregion effects. The test equation was

$$FC_t = \beta_{0i} + \beta_{1i}(SC) + \varepsilon,$$

where  $i = 1$ – $5$  for year effect (corresponding to years 2002–2006 respectively), or  $i = 1$ – $4$  for ecoregion effect (1= Rolling Plains, 2= Edwards Plateau, 3= Cross Timbers, 4= South Texas Plains). Finally, after determining a year effect existed, I used a Fisher's least significant difference procedure (Ott and Longnecker 2001: 440–444; LSD) to determine which years were significantly different.

## **RESULTS**

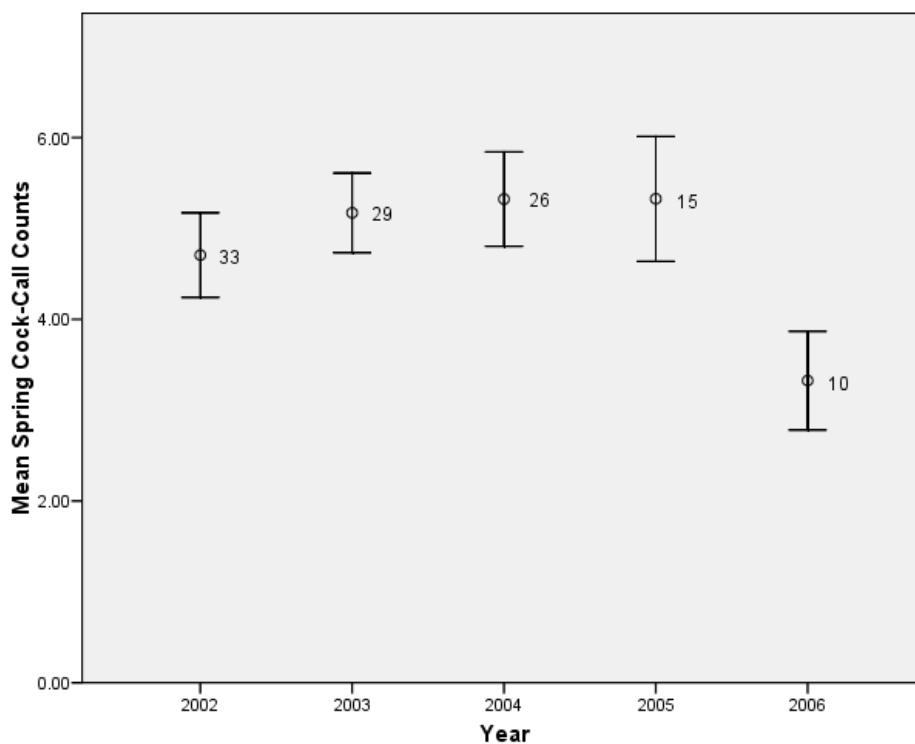
### **Data collection**

After 5 years of data collection, 76 cooperators returned 165 data sets. Only 7.8% of the data sets were complete, and <70% ( $n = 117$ ) contained  $\geq 1$  dependent

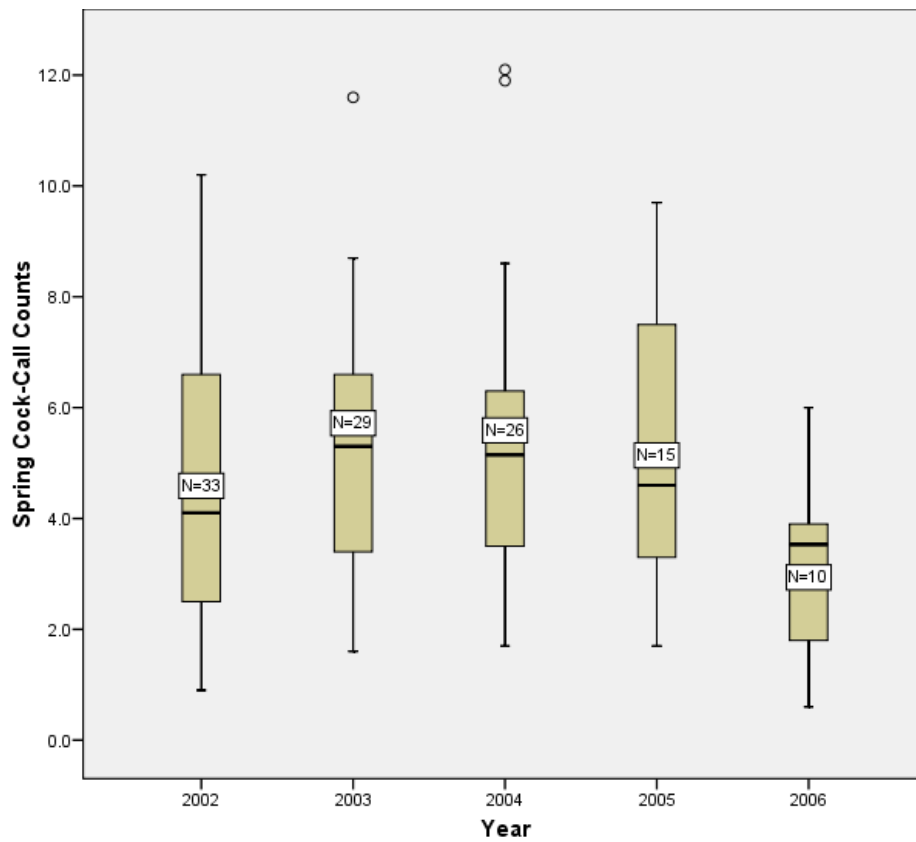
variable (68% contained roadside counts, 51% fall covey-call counts, and 23% covey flushes per hour of hunting effort).

### Spring cock-call counts

Mean ( $\pm$  standard error) spring cock-call counts increased from 4.71 ( $\pm$  0.47) roosters/113 ha in 2002, to 5.36 ( $\pm$  0.69) roosters/113 ha in 2005. Spring cock-call counts decreased to 3.33 ( $\pm$  0.54) roosters/113 ha in 2006 (Figure 2.4). The 5-year mean spring cock-call count across all sites and years was 4.9 ( $\pm$  0.24) roosters/113 ha (Table 2.1), and the data ranged from 0.6 to 10.2 roosters/113 ha (Figure 2.5).



**Figure 2.4.** Mean ( $\pm$  standard error) spring cock-call counts of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.5.** Distribution of spring cock-call counts of all Texas Quail Index sites for 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles.

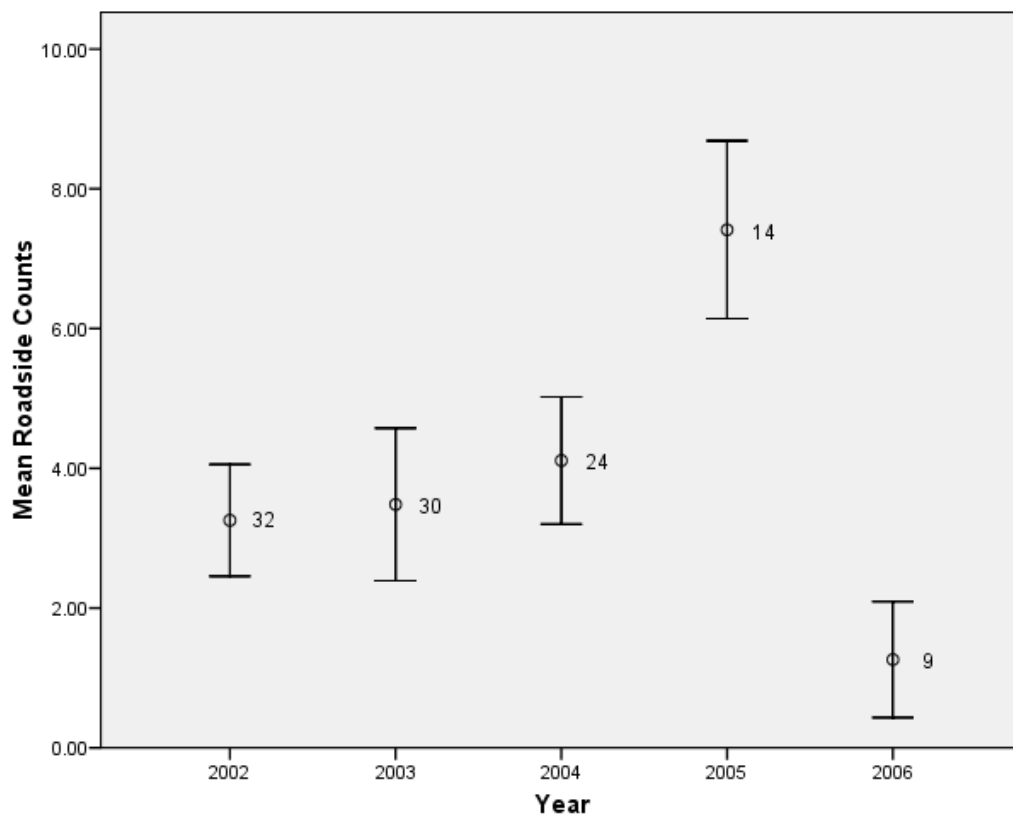
**Table 2.1.** Descriptive statistics of spring cock-call counts from 2002–2006, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

**Spring Cock-Call Counts**

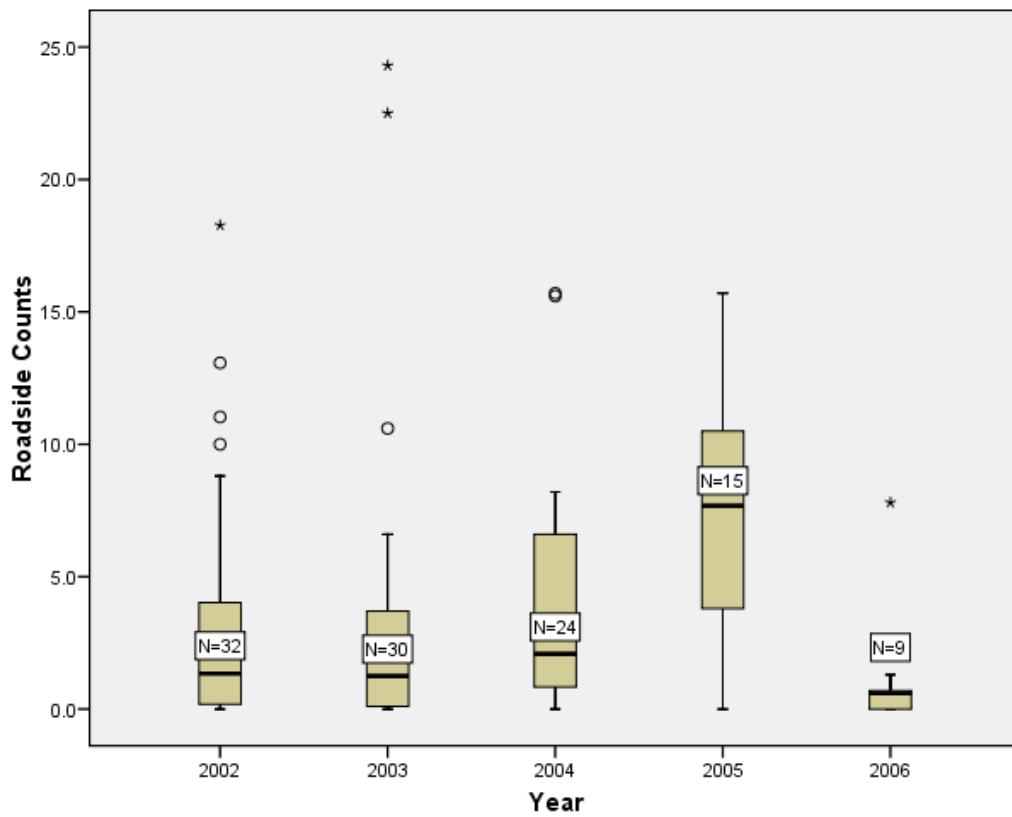
Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum	
2002	1	6.3680	15	.55744	3.30	10.20	
	2	4.3500	8	.94055	1.30	9.60	
	3	2.5333	6	.84090	.90	6.60	
	4	2.7667	3	.26667	2.50	3.30	
	5	1.5000	1	.	1.50	1.50	
	Total		4.7067	33	.46544	.90	10.20
2003	1	7.0242	12	.55464	4.40	11.60	
	2	4.4200	5	.85112	2.00	6.60	
	3	3.1000	7	.32440	1.90	4.10	
	4	5.0750	4	.87785	2.70	6.50	
	5	1.6000	1	.	1.60	1.60	
	Total		5.1721	29	.43776	1.60	11.60
2004	1	6.6085	13	.82446	2.90	12.10	
	2	4.3250	4	.77607	2.40	5.90	
	3	3.6714	7	.62971	1.70	6.20	
	4	4.7500	2	.55000	4.20	5.30	
	Total		5.3235	26	.51997	1.70	12.10
	2005	1	6.3737	8	.91963	2.60	9.70
2		6.3000	2	2.00000	4.30	8.30	
3		3.1750	4	.99111	1.70	6.00	
4		3.6000	1	.	3.60	3.60	
Total			5.3260	15	.68769	1.70	9.70
2006		1	2.9450	8	.56848	.60	5.70
	2	3.7000	1	.	3.70	3.70	
	3	6.0000	1	.	6.00	6.00	
	Total		3.3260	10	.54313	.60	6.00
Total	1	6.0763	56	.34765	.60	12.10	
	2	4.5250	20	.47765	1.30	9.60	
	3	3.2520	25	.33202	.90	6.60	
	4	4.1700	10	.47681	2.50	6.50	
	5	1.5500	2	.05000	1.50	1.60	
	Total		4.9281	113	.23875	.60	12.10

### Roadside counts

Mean ( $\pm$  standard error) roadside counts increased from 3.26 ( $\pm$  0.80) birds/1.6 km in 2002 to 7.41 ( $\pm$  1.27) birds/1.6 km in 2005, then decreased to 1.26 ( $\pm$  0.83) roosters/1.6 km in 2006 (Figure 2.6). The 5-year mean roadside count across all sites and years was 3.88 ( $\pm$  0.48) birds/1.6 km (Table 2.2), and the distribution ranged from 0 to 24.3 birds/1.6 km (Figure 2.7).



**Figure 2.6.** Mean ( $\pm$  standard error) roadside counts of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.7.** Distribution of roadside counts of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles and extreme outliers by asterisks.



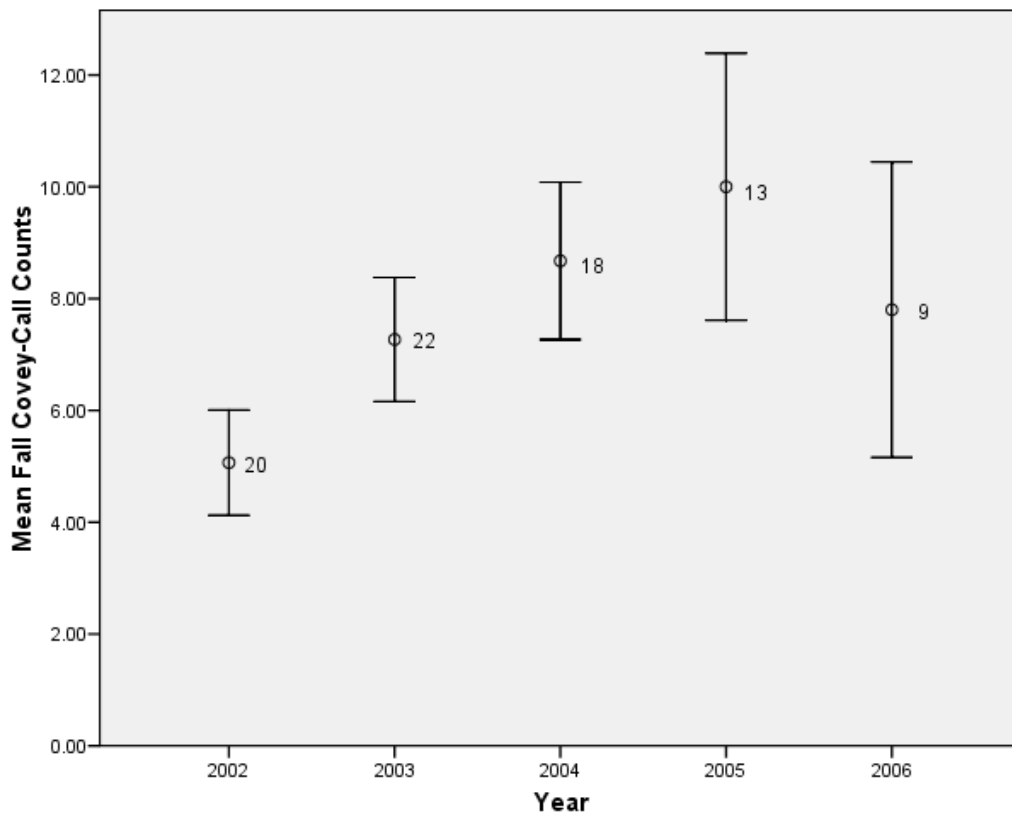
**Table 2.2.** Descriptive statistics of roadside counts from 2002–2006, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

**Roadside Counts**

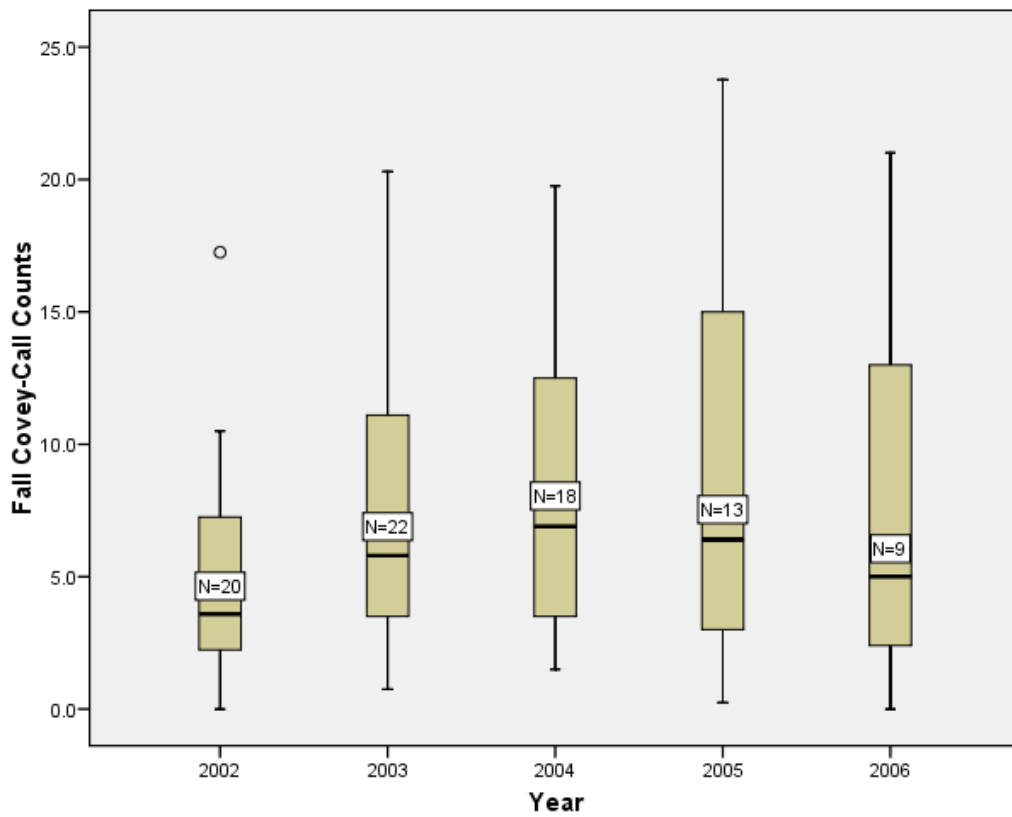
Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	5.0647	15	1.39356	.00	18.27
	2	2.0075	8	1.22497	.00	10.00
	3	.5800	5	.26943	.00	1.40
	4	3.0900	3	2.39118	.17	7.83
	5	.0000	1	.	.00	.00
	Total		3.2563	32	.80048	.00
2003	1	3.5545	11	.97853	.00	10.60
	2	1.0800	5	.55082	.00	3.00
	3	.4286	7	.20437	.00	1.50
	4	9.5000	6	4.47281	.00	24.30
	5	.0000	1	.	.00	.00
	Total		3.4833	30	1.09173	.00
2004	1	5.0817	12	1.23704	1.30	15.70
	2	3.4500	4	1.57083	.00	6.80
	3	1.3500	6	.79185	.00	5.00
	4	7.9000	2	7.70000	.20	15.60
	Total		4.1117	24	.90939	.00
2005	1	9.0812	8	1.25748	4.10	15.70
	2	8.3600	2	6.46000	1.90	14.82
	3	1.9333	3	1.09747	.00	3.80
	4	8.6300	1	.	8.63	8.63
	Total		7.4143	14	1.27283	.00
2006	1	.5096	7	.17302	.00	1.30
	2	7.8000	1	.	7.80	7.80
	3	.0000	1	.	.00	.00
	Total		1.2630	9	.82964	.00
Total	1	4.7598	53	.63160	.00	18.27
	2	2.9890	20	.90436	.00	14.82
	3	.9000	22	.28123	.00	5.00
	4	7.5583	12	2.51807	.00	24.30
	5	.0000	2	.00000	.00	.00
	Total		3.8766	109	.48143	.00

### Fall covey-call counts

Mean ( $\pm$  standard error) fall covey-call counts increased from 5.06 ( $\pm$  0.94) coveys/113 ha in 2002 to 10.00 ( $\pm$  2.38) coveys/113 ha in 2005, then decreased to 7.80 ( $\pm$  2.64) coveys/113 ha in 2006 (Figure 2.8). The 5-year mean fall covey-call count across all sites and years was 7.53 ( $\pm$  0.69) coveys/113 ha (Table 2.3). The distribution of fall covey-call counts ranged from 0 to 23.8 coveys/113 ha (Figure 2.9).



**Figure 2.8.** Mean ( $\pm$  standard error) fall covey-call counts of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.9.** Distribution of fall covey-call counts of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles.

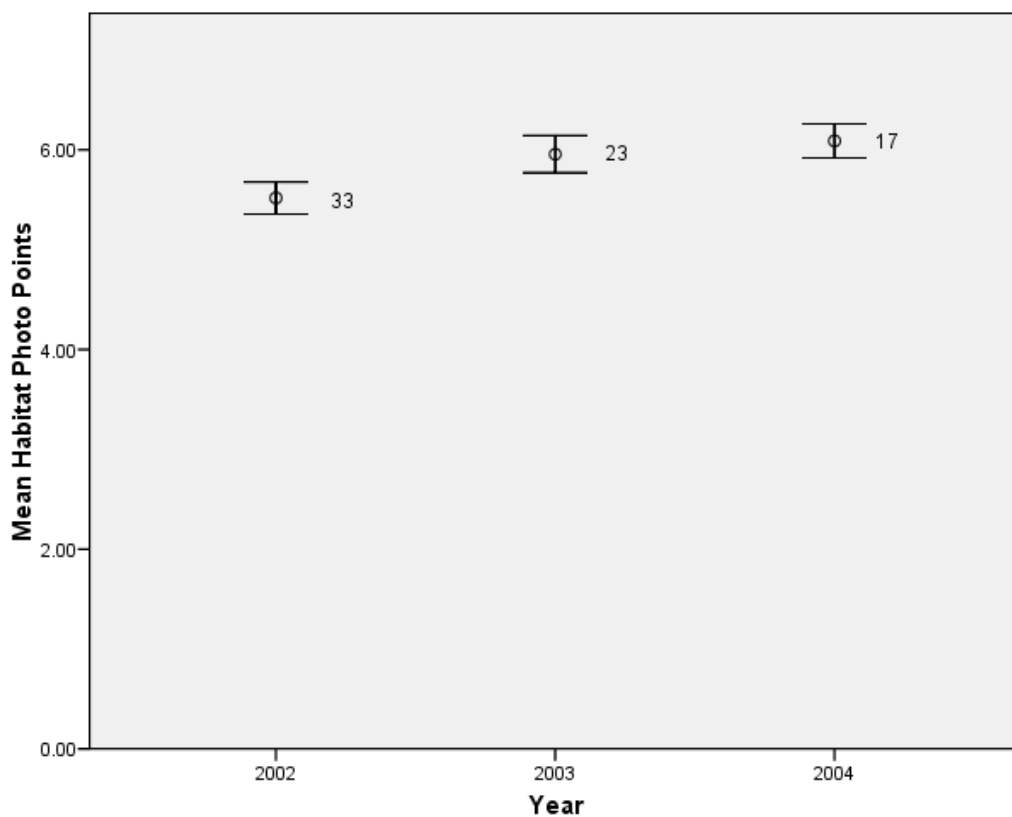
**Table 2.3.** Descriptive statistics of fall covey-call counts from 2002–2006, for 4 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, and ER4=South Texas Plains).

**Fall Covey-Call Counts**

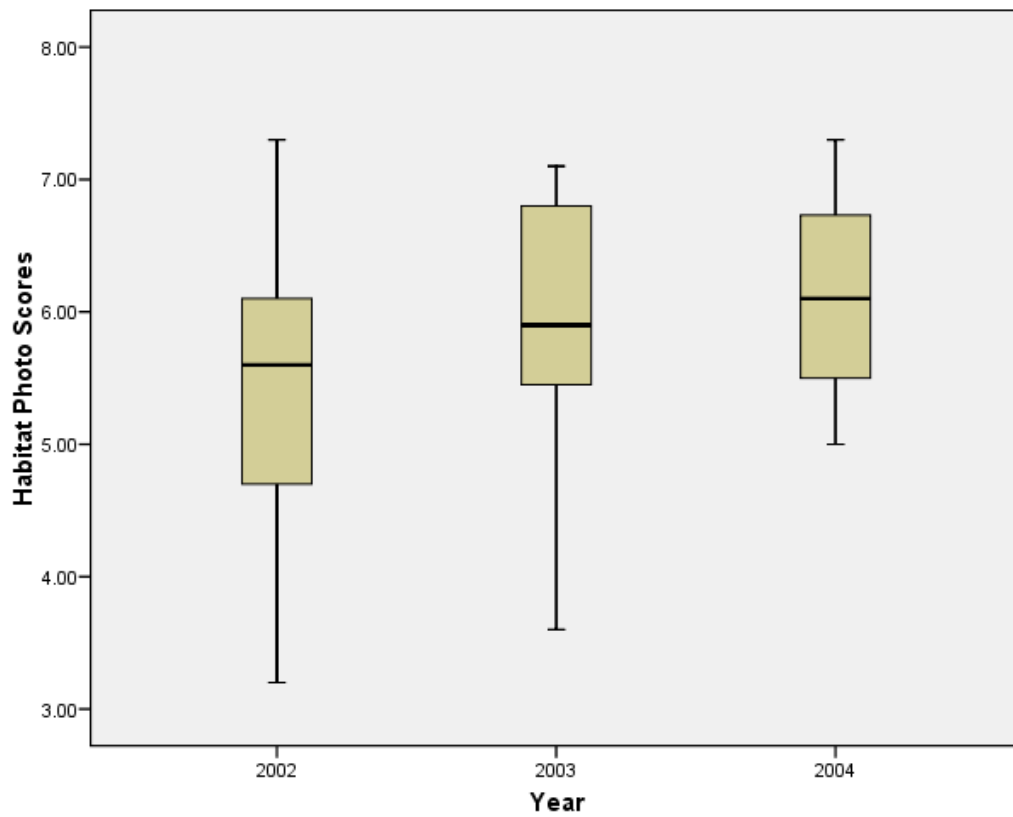
Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	7.2390	10	1.34251	3.00	17.25
	2	4.7225	4	2.07312	1.00	10.50
	3	1.4300	5	.42519	.00	2.33
	4	2.8800	1	.	2.88	2.88
	Total	5.0655	20	.94029	.00	17.25
2003	1	9.8750	10	1.75802	3.50	20.30
	2	7.1250	4	2.64114	1.00	13.90
	3	3.6917	6	1.35292	.75	9.50
	4	5.2500	2	.25000	5.00	5.50
	Total	7.2682	22	1.11059	.75	20.30
2004	1	8.0000	10	1.47573	3.00	18.30
	2	17.8250	2	1.92500	15.90	19.75
	3	6.7500	6	2.64105	1.50	19.00
	Total	8.6750	18	1.40831	1.50	19.75
2005	1	10.9886	7	2.67112	3.00	23.77
	2	22.4750	2	.47500	22.00	22.95
	3	2.0375	4	1.22021	.25	5.60
	Total	10.0015	13	2.38811	.25	23.77
2006	1	6.3950	8	2.53660	.00	21.01
	2	19.0500	1	.	19.05	19.05
	Total	7.8011	9	2.64228	.00	21.01
Total	1	8.4271	45	.84454	.00	23.77
	2	11.3108	13	2.23735	1.00	22.95
	3	3.7119	21	.94904	.00	19.00
	4	4.4600	3	.80308	2.88	5.50
	Total	7.5316	82	.68666	.00	23.77

### Habitat photo points

Mean ( $\pm$  standard error) habitat photo points increased from 5.52 ( $\pm$  0.16) in 2002 to 6.08 ( $\pm$  0.17) for 2004 (Figure 2.10). Data were only analyzed for the first 3 years of the TQI. The 3-year mean habitat photo score across all sites and years was 5.79 ( $\pm$  0.10; Table 2.4), and the distribution ranged from 3.2 to 7.3 (Figure 2.11).



**Figure 2.10.** Mean ( $\pm$  standard error) habitat photo scores of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.11.** Distribution of habitat photo scores of all Texas Quail Index sites from 2002–2004. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values.

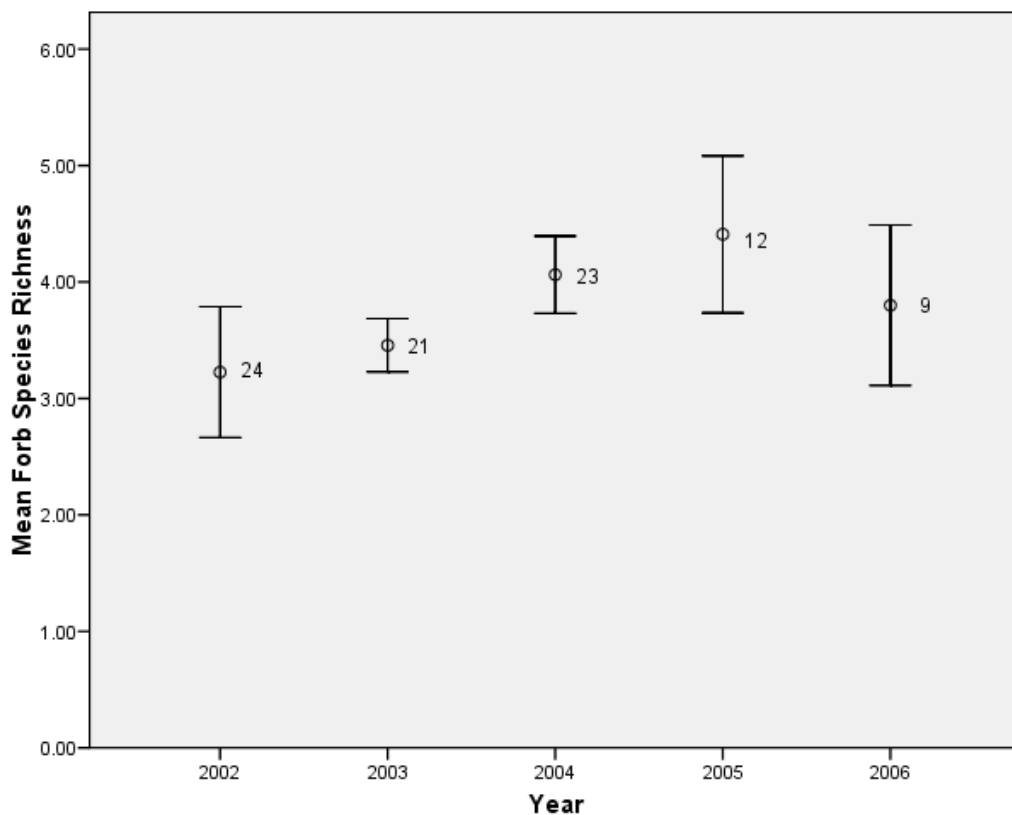
**Table 2.4.** Descriptive statistics of habitat photo points from 2002–2004, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

**Habitat Photo Points**

Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	5.8080	15	.25720	4.30	7.30
	2	5.3133	9	.19371	4.27	6.10
	3	5.6000	5	.31145	4.60	6.50
	4	4.9667	3	.88380	3.20	5.90
	5	4.2700	1	.	4.27	4.27
	Total		5.5185	33	.16097	3.20
2003	1	5.7625	8	.40086	3.60	6.80
	2	5.5600	5	.36277	4.20	6.30
	3	6.2333	6	.26034	5.40	6.80
	4	6.3667	3	.50442	5.40	7.10
	5	6.6000	1	.	6.60	6.60
	Total		5.9565	23	.18680	3.60
2004	1	6.2525	8	.26595	5.00	6.90
	2	5.7500	2	.65000	5.10	6.40
	3	5.7200	5	.16852	5.30	6.30
	4	6.7000	2	.60000	6.10	7.30
	Total		6.0894	17	.17112	5.00
Total	1	5.9110	31	.17389	3.60	7.30
	2	5.4450	16	.16567	4.20	6.40
	3	5.8750	16	.15559	4.60	6.80
	4	5.9250	8	.45267	3.20	7.30
	5	5.4350	2	1.16500	4.27	6.60
	Total		5.7895	73	.10466	3.20

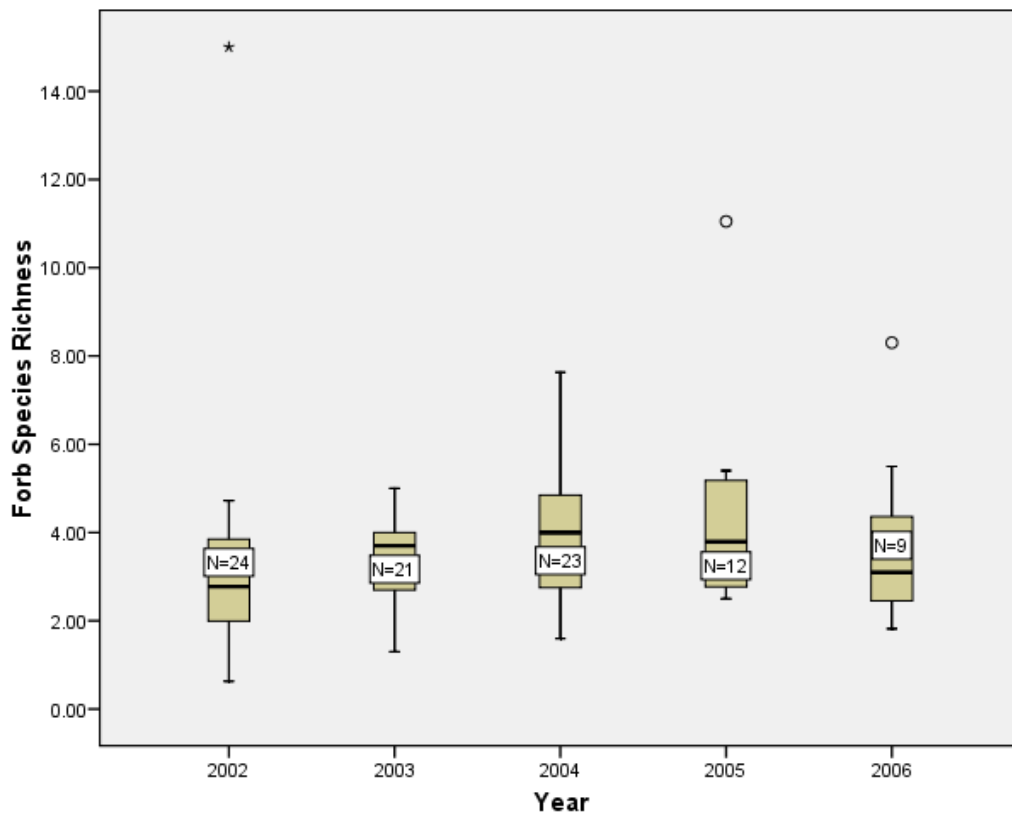
### Forb species richness

Mean ( $\pm$  standard error) forb species richness increased from 3.22 ( $\pm$  0.56) species/sample in 2002 to 4.40 ( $\pm$  0.67) species/sample in 2005 then decreased to 3.80 ( $\pm$  0.69) species/sample in 2006 (Figure 2.12). The 5-year mean forb species richness across all sites and years was 3.71 ( $\pm$  0.21) species/sample (Table 2.5), and the distribution ranged from 0.63 to 15.00 species encountered/sample (Figure 2.13).



**Figure 2.12.** Mean ( $\pm$  standard error) forb species richness of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.





**Figure 2.13.** Distribution of forb species richness of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles and extreme outliers by asterisks.

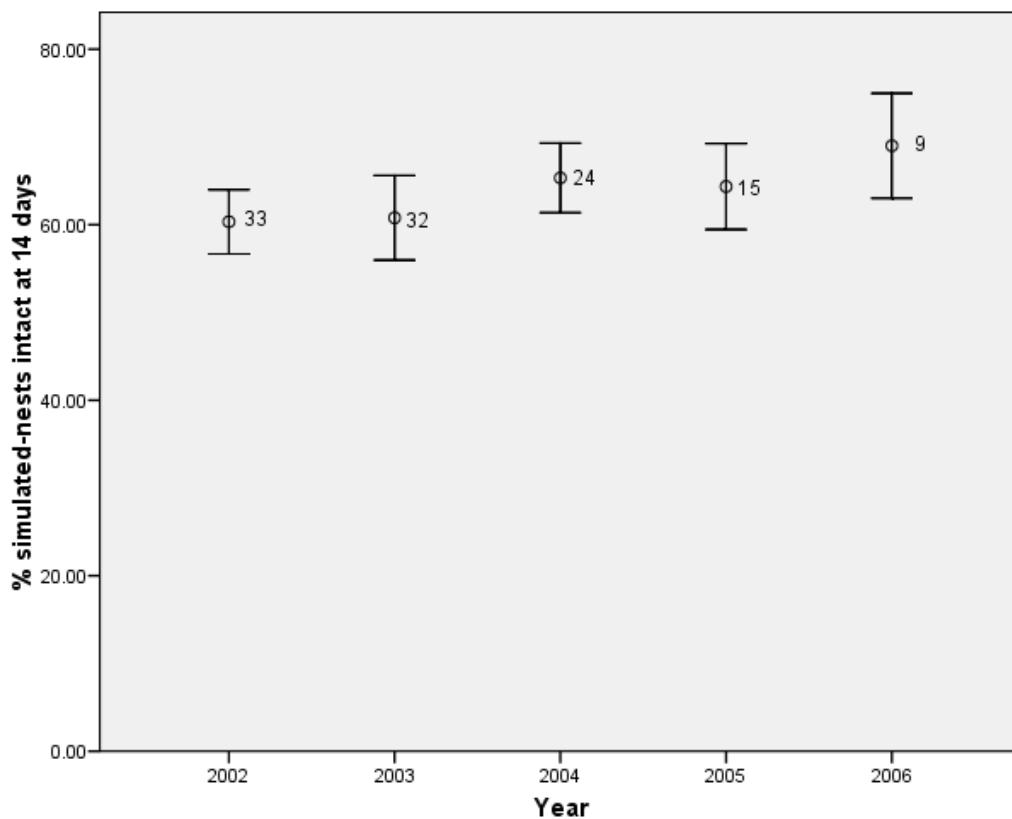
**Table 2.5.** Descriptive statistics of forb species richness from 2002–2006, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

**Forb Species Richness**

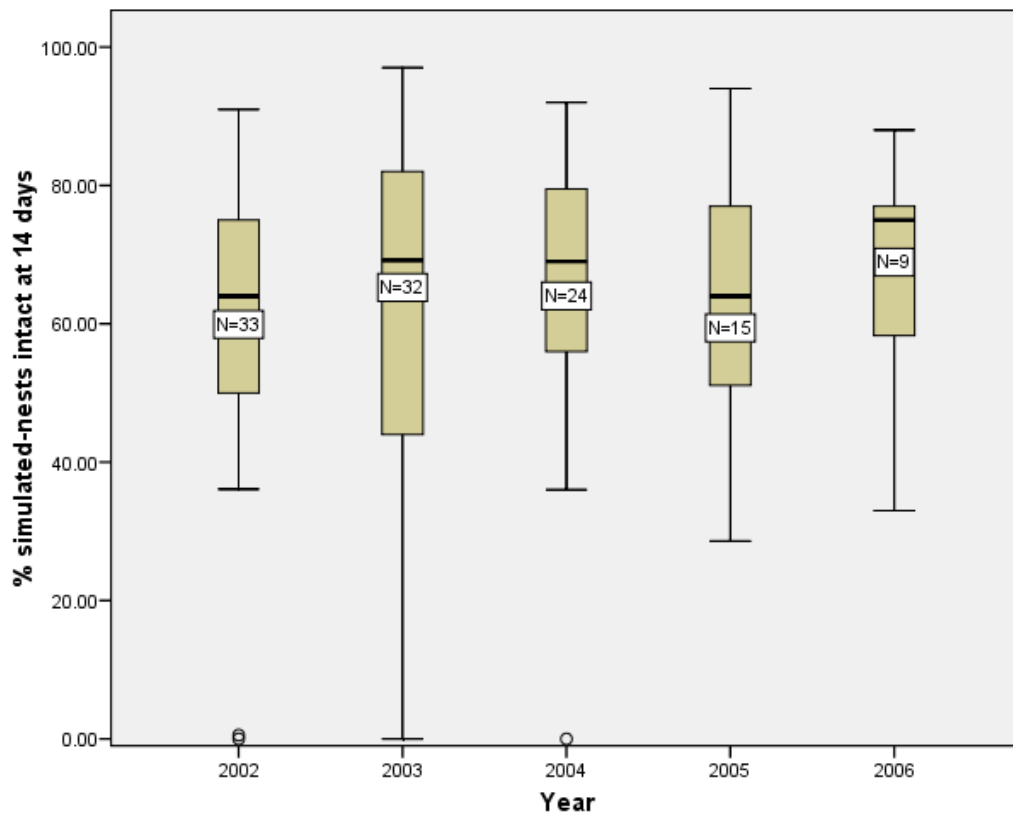
Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum	
2002	1	3.9882	11	1.13598	1.80	15.00	
	2	2.7983	6	.49713	1.20	4.40	
	3	2.4825	4	.81668	.68	4.50	
	4	3.1000	2	.00000	3.10	3.10	
	5	.6300	1	.	.63	.63	
	Total		3.2258	24	.56118	.63	15.00
2003	1	3.6063	8	.26159	2.20	4.80	
	2	4.1250	4	.42303	3.10	5.00	
	3	3.3833	6	.56060	1.30	4.90	
	4	2.6200	2	.08000	2.54	2.70	
	5	1.7000	1	.	1.70	1.70	
	Total		3.4567	21	.22837	1.30	5.00
2004	1	3.7864	11	.53773	1.60	7.63	
	2	3.5750	4	.39238	2.80	4.30	
	3	4.8557	7	.60499	2.50	6.90	
	4	3.5000	1	.	3.50	3.50	
	Total		4.0626	23	.33130	1.60	7.63
	2005	1	3.8257	7	.47037	2.50	5.40
2		3.6400	2	.24000	3.40	3.88	
3		6.2833	3	2.46650	2.80	11.05	
Total			4.4092	12	.67427	2.50	11.05
2006	1	3.9586	7	.85669	1.82	8.30	
	2	2.1300	1	.	2.13	2.13	
	3	4.3600	1	.	4.36	4.36	
	Total		3.8000	9	.68822	1.82	8.30
Total	1	3.8377	44	.33984	1.60	15.00	
	2	3.3529	17	.25446	1.20	5.00	
	3	4.1633	21	.49071	.68	11.05	
	4	2.9880	5	.16895	2.54	3.50	
	5	1.1650	2	.53500	.63	1.70	
	Total		3.7142	89	.21474	.63	15.00

### Simulated-nest fate

Mean ( $\pm$  standard error) simulated-nest fate at 14 days increased from 60.34 ( $\pm$  3.66) % nests intact in 2002 to 65.33 ( $\pm$  3.97) % nests intact in 2004, then decreased to 64.35 ( $\pm$  4.90) % nests intact in 2005 and increased again in 2006 to 69.00 ( $\pm$  5.98) % nests intact (Figure 2.14). The 5-year mean fate of simulated-nests across all sites and years was 62.75 ( $\pm$  2.07) % nests intact (Table 2.6), and the distribution of simulated-nest fates ranged from 0% to 97% nests intact (Figure 2.15).



**Figure 2.14.** Mean ( $\pm$  standard error) fate of simulated-nests at 14 days of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.15.** Distribution of simulated-nest fate at 14 days of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles.

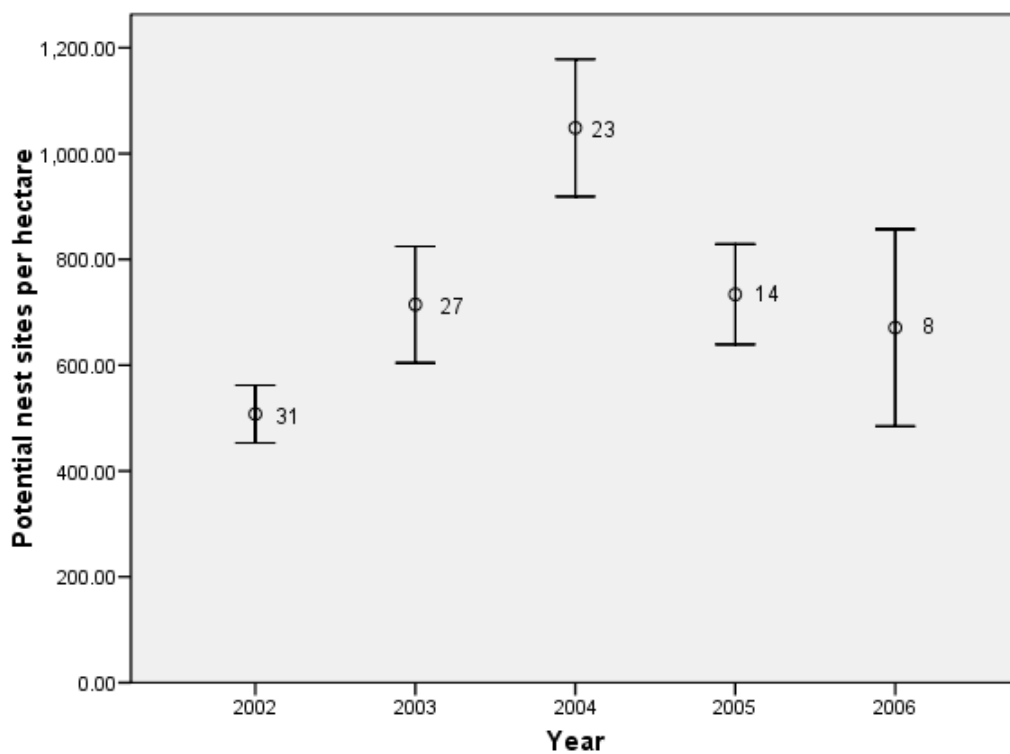
**Table 2.6.** Descriptive statistics of simulated-nest fate at 14 days from 2002–2006, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

**Simulated-nest Fate**

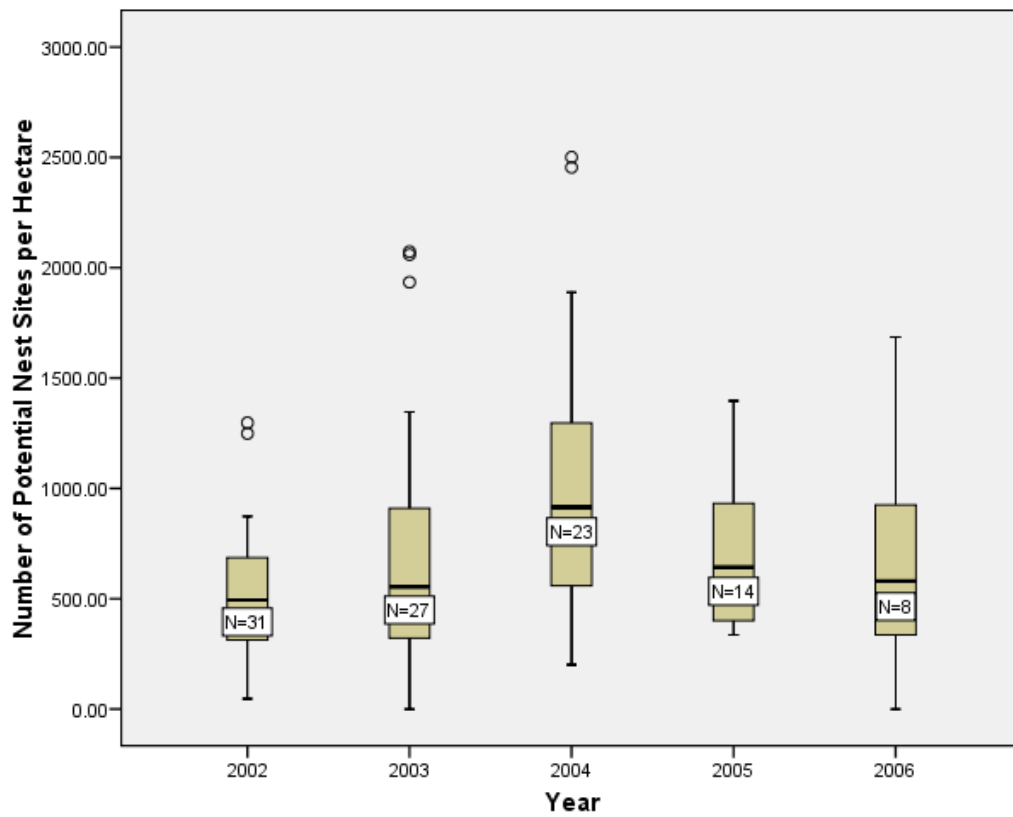
Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	59.9770	15	5.73039	.56	91.00
	2	63.8750	8	4.98368	42.00	83.00
	3	53.3333	6	11.92663	.00	83.00
	4	63.6667	3	13.66667	50.00	91.00
	5	69.4000	1	.	69.40	69.40
	Total		60.3350	33	3.66527	.00
2003	1	69.4077	13	6.65223	11.00	96.00
	2	33.2000	5	13.46625	.00	78.00
	3	62.6286	7	8.65612	33.00	97.00
	4	72.1667	6	4.92217	56.00	86.00
	5	5.5000	1	.	5.50	5.50
	Total		60.7875	32	4.81855	.00
2004	1	66.7500	12	7.69506	.00	92.00
	2	58.5000	4	3.57071	53.00	69.00
	3	65.3333	6	3.92994	50.00	78.00
	4	70.5000	2	1.50000	69.00	72.00
	Total		65.3333	24	3.97030	.00
2005	1	71.1000	8	7.75877	28.60	94.00
	2	69.5000	2	5.50000	64.00	75.00
	3	53.2750	4	4.97852	38.80	61.00
	4	44.4000	1	.	44.40	44.40
	Total		64.3533	15	4.89665	28.60
2006	1	68.6143	7	6.80240	33.00	88.00
	2	52.7000	1	.	52.70	52.70
	3	88.0000	1	.	88.00	88.00
	Total		69.0000	9	5.97585	33.00
Total	1	66.4010	55	3.06380	.00	96.00
	2	55.1350	20	4.78812	.00	83.00
	3	60.4792	24	4.17467	.00	97.00
	4	67.4500	12	4.41959	44.40	91.00
	5	37.4500	2	31.95000	5.50	69.40
	Total		62.7483	113	2.07311	.00

### Potential nest sites

Mean ( $\pm$  standard error) potential nest sites increased from 507.66 ( $\pm$  54.66) potential nests/ha in 2002 to 1048.56 ( $\pm$  129.78) potential nests/ha in 2004, then decreased to 670.91 ( $\pm$  186.16) potential nest sites/ha in 2006 (Figure 2.16). The 5-year mean potential nest sites was 726.12 ( $\pm$  50.97) potential nest sites/ha across all sites and years (Table 2.7), and the distribution ranged from 0 to 2500 potential nest sites/ha (Figure 2.17).



**Figure 2.16.** Mean ( $\pm$  standard error) potential nest sites/ha of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.17.** Distribution of potential nest sites/ha of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles.

**Table 2.7.** Descriptive statistics of potential nest sites from 2002–2006, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

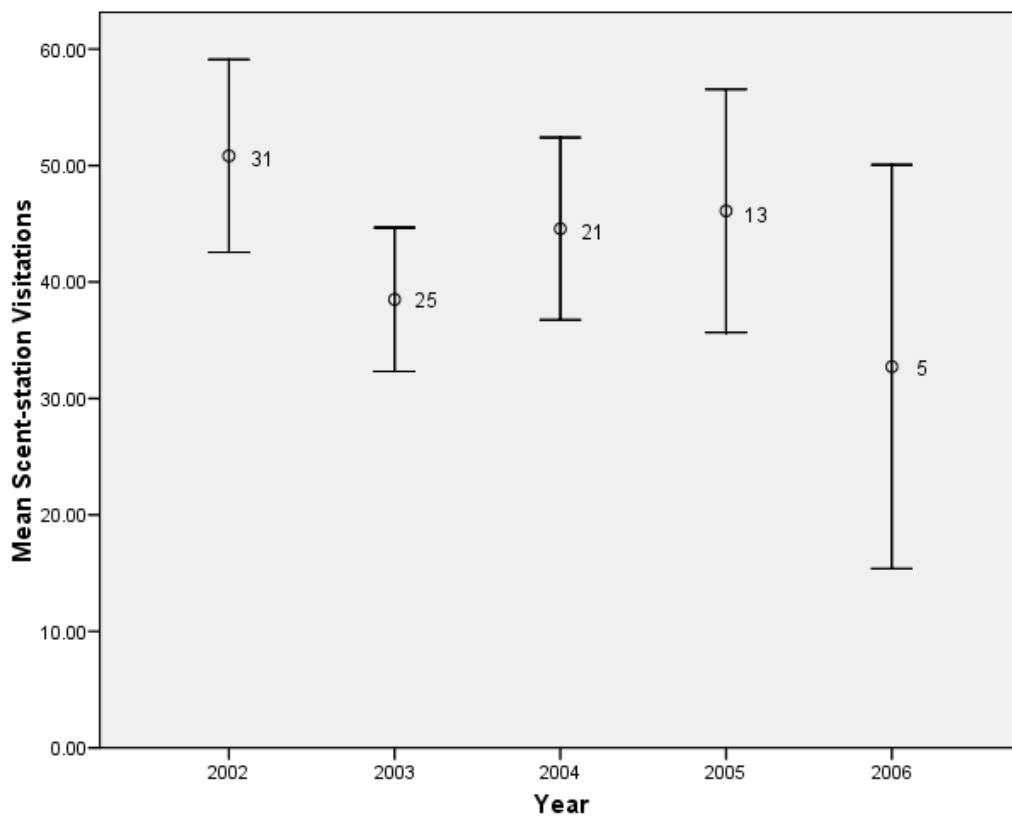
**Potential Nest Sites per Hectare**

Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	625.5887	15	87.91163	65.90	1297.41
	2	399.6247	7	61.79577	151.49	588.16
	3	387.8627	6	88.13333	98.85	696.89
	4	177.9300	2	130.97625	46.95	308.91
	5	873.0926	1	.	873.09	873.09
	Total		507.6559	31	54.65530	46.95
2003	1	940.1983	11	191.83654	269.37	2072.64
	2	405.4827	5	114.89100	184.60	778.44
	3	498.1628	6	152.91919	.00	923.01
	4	863.5783	4	412.21503	197.70	2059.29
	5	480.9053	1	.	480.91	480.91
	Total		714.5848	27	110.13324	.00
2004	1	1354.3124	11	214.62954	385.52	2500.90
	2	544.9106	4	109.82244	326.21	850.11
	3	988.7883	6	130.08003	471.27	1426.65
	4	553.5600	2	352.64738	200.91	906.21
	Total		1048.5621	23	129.78231	200.91
2005	1	845.4764	8	143.29250	336.09	1396.26
	2	486.8362	2	140.86125	345.98	627.70
	3	604.3030	3	169.13513	368.96	932.40
	4	724.0763	1	.	724.08	724.08
	Total		733.8906	14	94.73257	336.09
2006	1	717.3333	7	208.17268	.00	1685.39
	2	345.9750	1	.	345.98	345.98
	Total		670.9135	8	186.16309	.00
Total	1	892.4729	52	80.95489	.00	2500.90
	2	438.1093	19	44.70023	151.49	850.11
	3	621.9901	21	82.27270	.00	1426.65
	4	626.8188	9	203.08386	46.95	2059.29
	5	676.9989	2	196.09369	480.91	873.09
	Total		726.1148	103	50.96573	.00

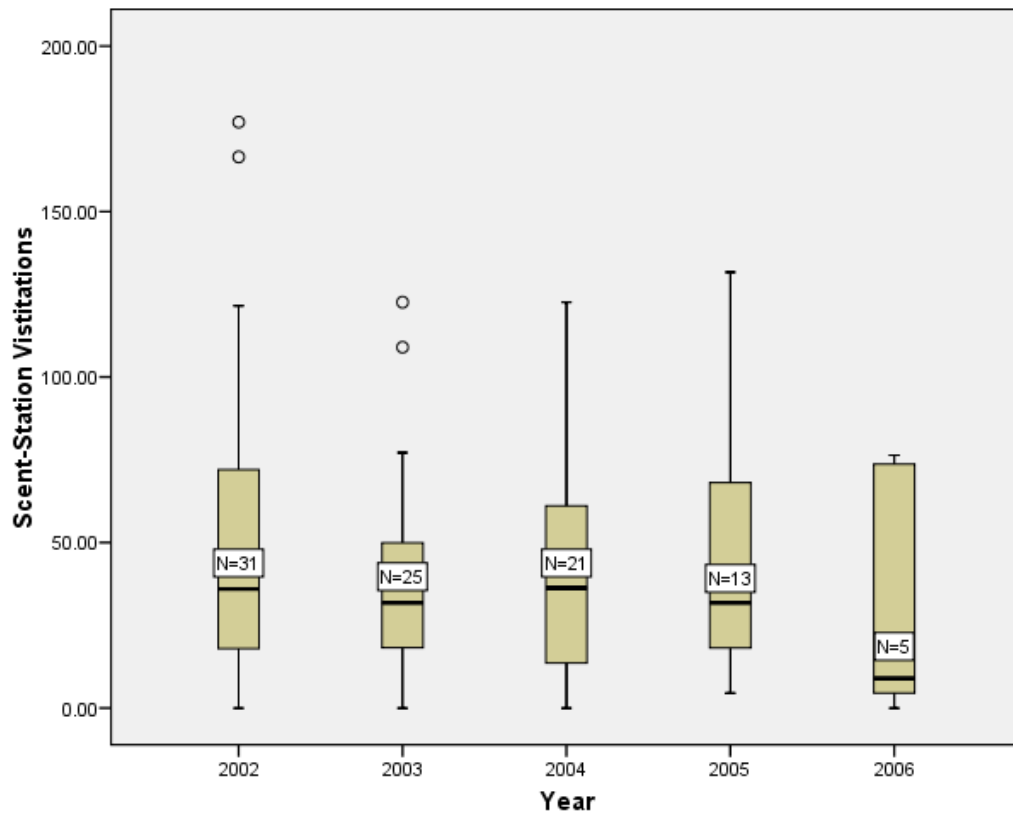


### Scent-station visitations

Mean ( $\pm$  standard error) scent-station visitations decreased from 50.83 ( $\pm$  8.27) visits/100 scent-station nights (SSN) in 2002 to 38.50 ( $\pm$  6.17) visits/100 SSN in 2003, then increased until 2005 (46.11  $\pm$  10.44 visits/100 SSN), finally decreasing to 32.73 ( $\pm$  17.34) visits/100 SSN in 2006 (Figure 2.18). The 5-year mean visitation of scent-stations across all sites and years was 44.60 ( $\pm$  3.93) visits/100 SSN (Table 2.8), and the distribution ranged from 0 to 177 visits/100 SSN (Figure 2.19).



**Figure 2.18.** Mean ( $\pm$  standard error) scent-station visitations of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean.



**Figure 2.19.** Distribution of scent-station visitations of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outliers are indicated by circles.

**Table 2.8.** Descriptive statistics of scent-station visitations from 2002–2006, for 5 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, ER4=South Texas Plains, and ER5=Trans Pecos).

**Scent-station Visitaions**

Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	32.7857	14	7.00367	.00	85.50
	2	84.2625	8	17.47256	13.10	166.50
	3	59.5000	6	26.29258	4.50	177.00
	4	38.2500	2	20.25000	18.00	58.50
	5	9.0000	1	.	9.00	9.00
	Total		50.8258	31	8.26966	.00
2003	1	24.0600	10	6.05162	.00	59.00
	2	70.3500	4	13.45204	49.90	109.00
	3	29.5167	6	5.47409	13.60	45.40
	4	61.3000	4	24.76614	9.10	122.60
	5	18.2000	1	.	18.20	18.20
	Total		38.5000	25	6.17053	.00
2004	1	51.2400	11	10.88824	.00	122.60
	2	55.6150	4	24.54506	4.54	99.88
	3	18.1640	5	6.26014	.00	31.80
	4	59.0000	1	.	59.00	59.00
	Total		44.5676	21	7.82642	.00
2005	1	38.2800	7	9.13045	13.62	81.72
	2	74.9100	2	56.75000	18.16	131.66
	3	30.2667	3	19.32095	4.54	68.10
	4	90.8000	1	.	90.80	90.80
	Total		46.1062	13	10.44538	4.54
2006	1	39.7750	4	20.45615	.00	76.40
	2	4.5400	1	.	4.54	4.54
	Total		32.7280	5	17.34164	.00
Total	1	36.7457	46	4.28343	.00	122.60
	2	70.1221	19	10.77778	4.54	166.50
	3	35.7860	20	8.87272	.00	177.00
	4	58.9375	8	13.41239	9.10	122.60
	5	13.6000	2	4.60000	9.00	18.20
	Total		44.6004	95	3.93214	.00

### **Harvest data**

Mean ( $\pm$  standard error) percent juveniles in the hunter's bag decreased from 74.67 ( $\pm$  11.07) % in 2002 to 63.23 ( $\pm$  4.55) % juveniles in 2004, then increased in 2005 (70.31  $\pm$  4.05 % juveniles in the hunter's bag), and then decreased markedly again to 16.75 ( $\pm$  2.13) % juveniles in the hunter's bag in 2006 (Figure 2.20). The 5-year mean percent juveniles in the hunter's bag across all sites and years was 61.60 ( $\pm$  4.62) % (Table 2.9), and the distribution of the percentage of juveniles in the hunter's bag ranged from 12 to 93% (Figure 2.21).

Mean ( $\pm$  standard error) covey flushes per hour of hunting effort decreased from 2.73 ( $\pm$  0.63) in 2002 to 2.25 ( $\pm$  0.46) in 2003, then increased in 2004 (2.79  $\pm$  0.70) and 2005 (4.45  $\pm$  0.66). Mean covey flushes per hour of hunting effort decreased to 2.15 ( $\pm$  0.62) in 2006 (Figure 2.22), which was below the 5-year mean number of covey flushes per hour of hunting effort across all sites and years (2.87  $\pm$  1.71; Table 2.10). The distribution of covey flushes per hour of hunting effort ranged from 0.5 to 6.6 (Figure 2.23).

### **Statistical analysis**

A multiple regression analysis with stepwise inclusion of variables removed all variables except spring cock-calls from the model (Table 2.11;  $P < 0.0001$ ,  $R^2 = 0.440$ ), indicating that spring cock-calls explained 44% of the variation in the data for all study sites across all years. An ANCOVA showed a year effect, ( $P = 0.004$ ,  $R^2 = 0.389$ ) but no

effect due to ecoregion ( $P = 0.244$ ). A Fisher's LSD indicated that year 5 was different than all other years ( $P = 0.008$ ), resulting in 2 distinct prediction models.

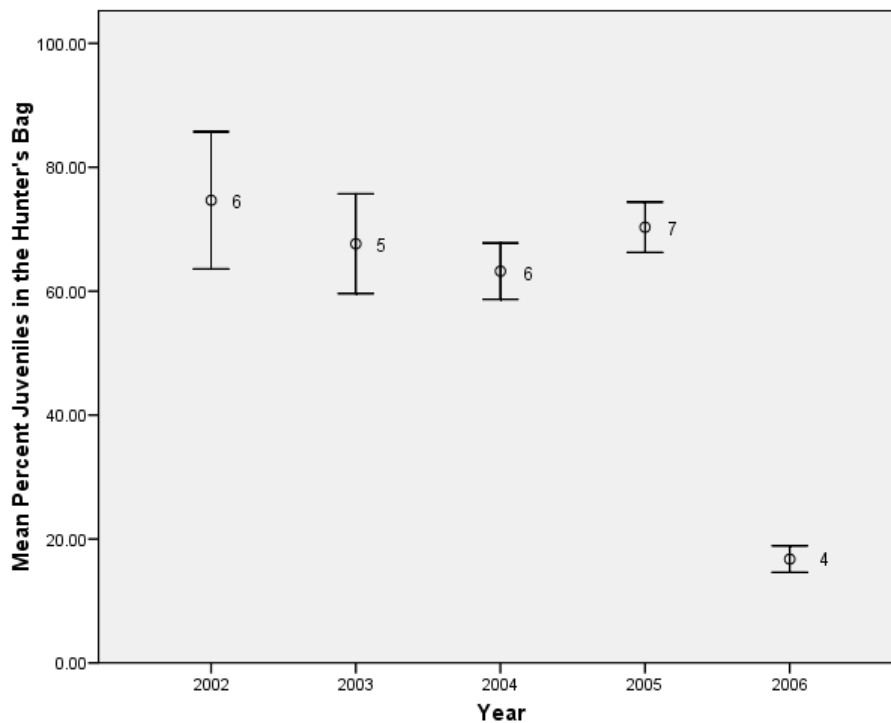
The model for years 1–4 was

$$FC_t = 0.81 + 0.20*SC$$

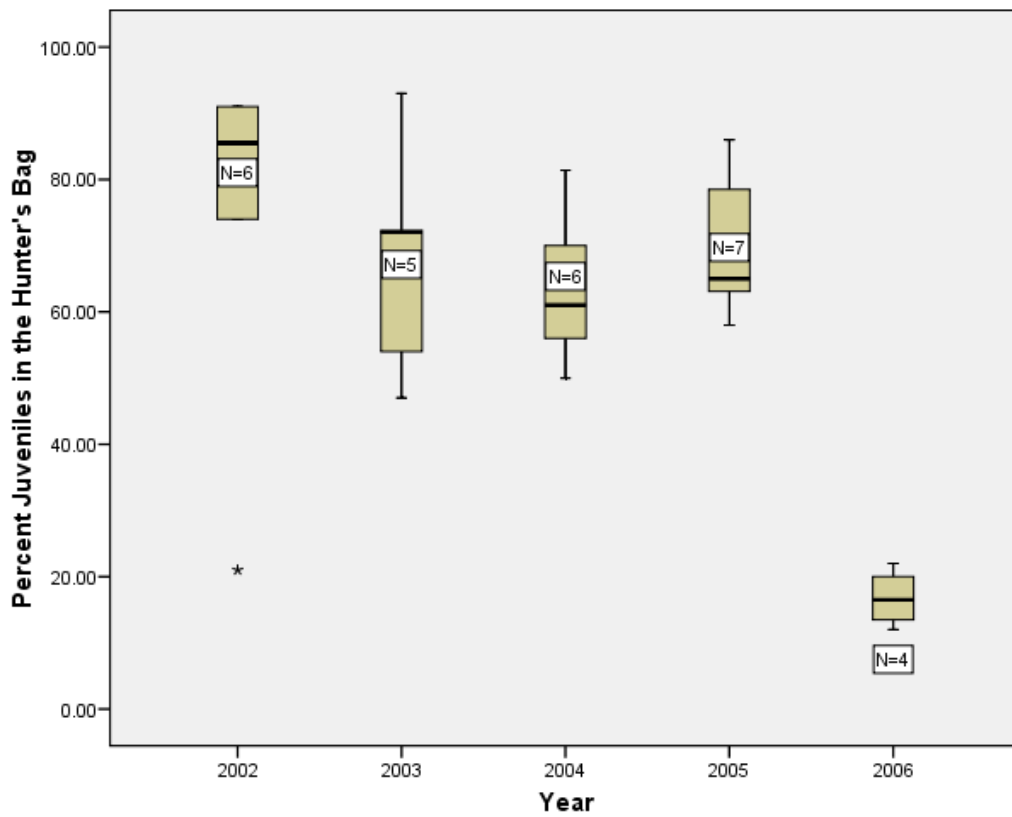
( $P < 0.0001$ ,  $R^2 = 0.41$ ; Figure 2.24), and the model for year 5 was

$$FC_t = -0.04 + .51*SC$$

( $P < 0.0001$ ,  $R^2 = 0.89$ ; Figure 2.25). According to the Palmer Drought Severity Index (Appendix A) year 5 was a drought year.



**Figure 2.20.** Mean ( $\pm$  standard error) percent juveniles in the hunter's bag of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean. Note low sample sizes reported for this variable.

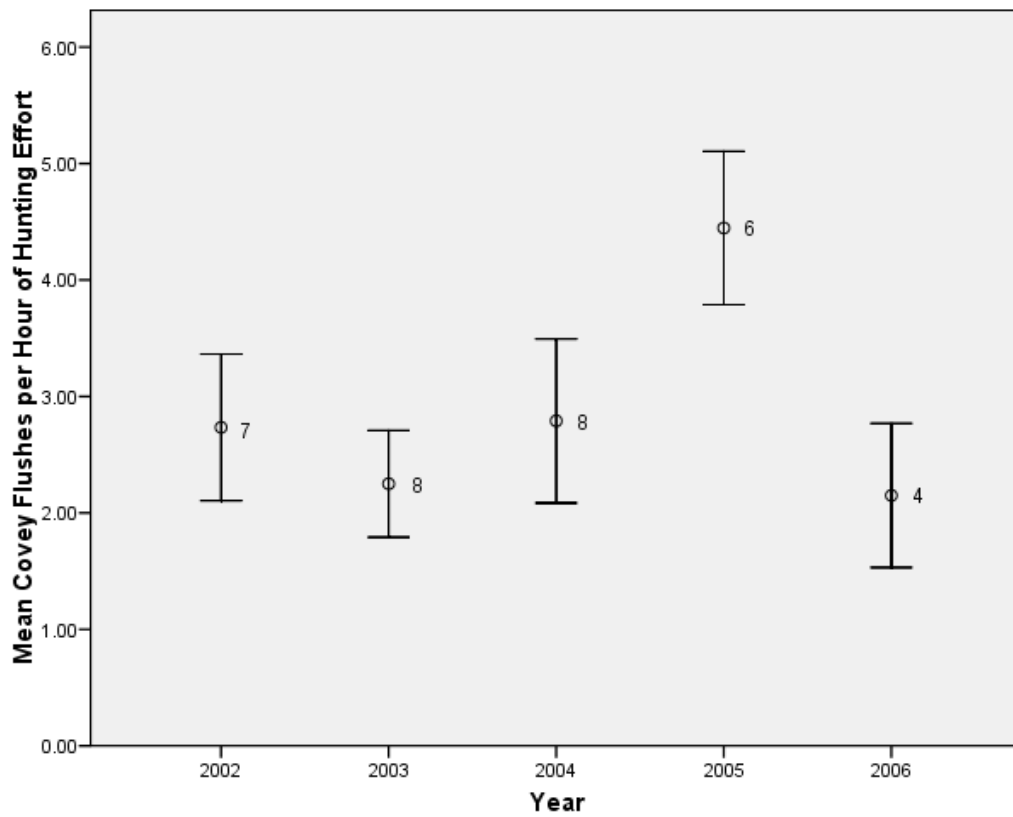


**Figure 2.21.** Distribution of percent juveniles in the hunter's bag of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Extreme outlier is indicated by an asterisk.

**Table 2.9.** Descriptive statistics of percent juveniles in the hunter's bag from 2002–2006, for 4 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward's Plateau, ER3=Cross Timbers and Prairies, and ER4=South Texas Plains).

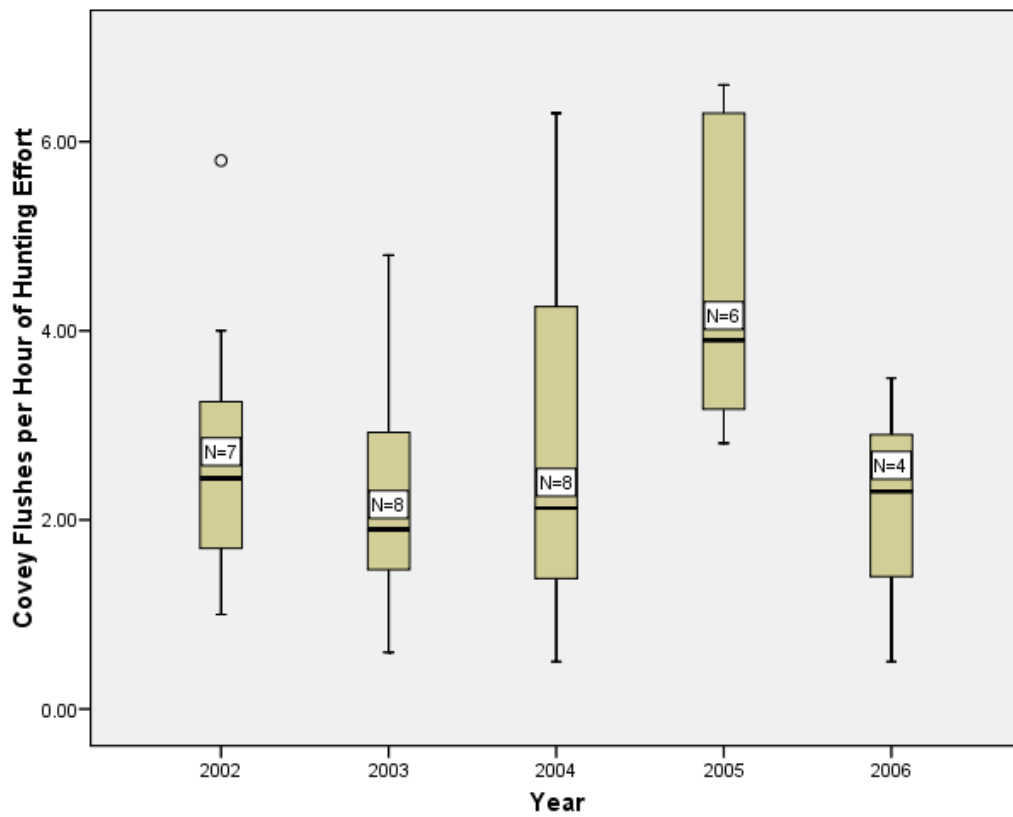
**Percent Juveniles in the Hunter's Bag**

Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	85.4000	5	3.29545	74.00	91.00
	4	21.0000	1	.	21.00	21.00
	Total	74.6667	6	11.06546	21.00	91.00
2003	1	66.1000	3	6.05062	54.00	72.30
	2	70.0000	2	23.00000	47.00	93.00
	Total	67.6600	5	8.04957	47.00	93.00
2004	1	68.3500	4	4.90807	59.00	81.40
	2	56.0000	1	.	56.00	56.00
	3	50.0000	1	.	50.00	50.00
	Total	63.2333	6	4.55058	50.00	81.40
2005	1	72.6000	5	5.47357	58.00	86.00
	2	64.2300	1	.	64.23	64.23
	3	65.0000	1	.	65.00	65.00
	Total	70.3186	7	4.05493	58.00	86.00
2006	1	17.3333	3	2.90593	12.00	22.00
	2	15.0000	1	.	15.00	15.00
	Total	16.7500	4	2.13600	12.00	22.00
Total	1	65.6850	20	5.28176	12.00	91.00
	2	55.0460	5	12.63761	15.00	93.00
	3	57.5000	2	7.50000	50.00	65.00
	4	21.0000	1	.	21.00	21.00
	Total	61.6046	28	4.62024	12.00	93.00



**Figure 2.22.** Mean ( $\pm$  standard error) covey flushes per hour of hunting effort of all Texas Quail Index sites from 2002–2006. Sample size is given alongside each group mean. Note low sample sizes reported for this variable.





**Figure 2.23.** Distribution of covey flushes/hour of hunting effort of all Texas Quail Index sites from 2002–2006. Boxplot shows 25<sup>th</sup>, 50<sup>th</sup>, and 75<sup>th</sup> percentiles with whiskers showing minimum and maximum values. Outlier is indicated by a circle.

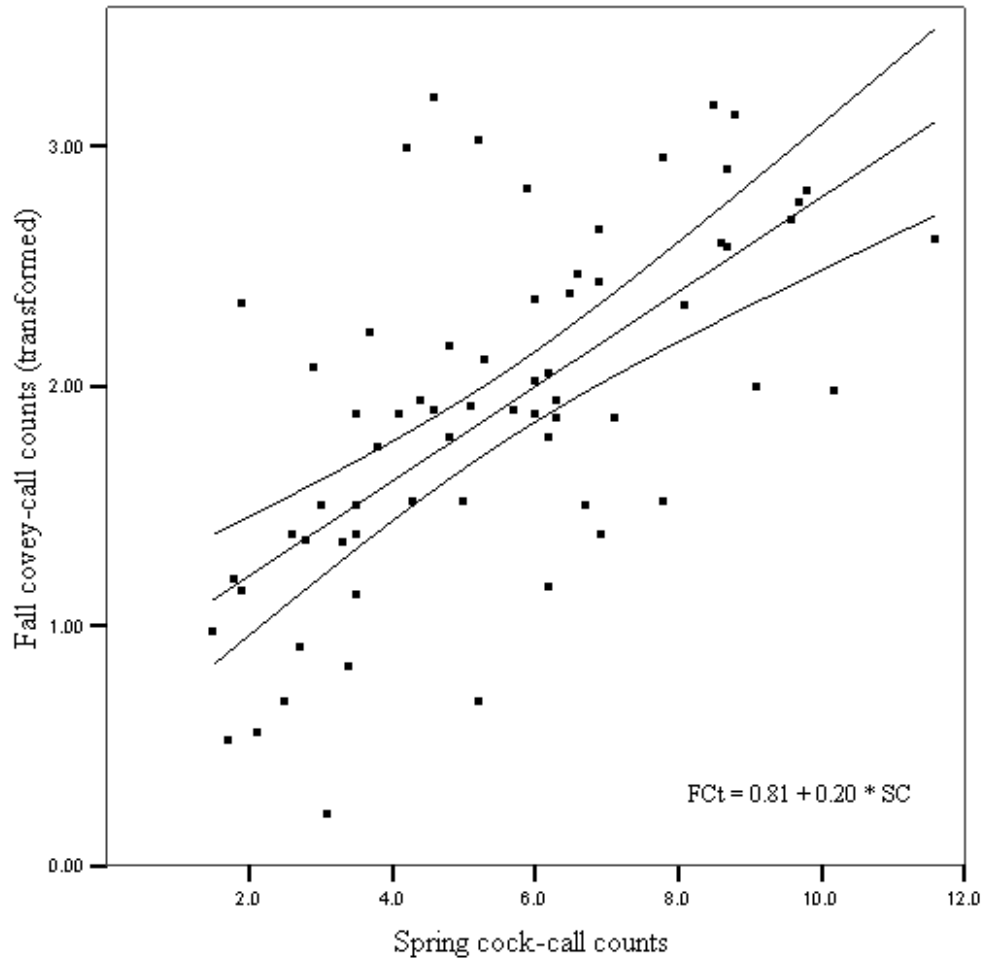
**Table 2.10.** Descriptive statistics of covey flushes/hour of hunting effort from 2002–2006, for 4 ecoregions (ER; ER1=Texas Rolling Plains, ER2=Edward’s Plateau, ER3= Cross Timbers and Prairies, and ER4=South Texas Plains).

**Covey Flushes per Hour of Hunting Effort**

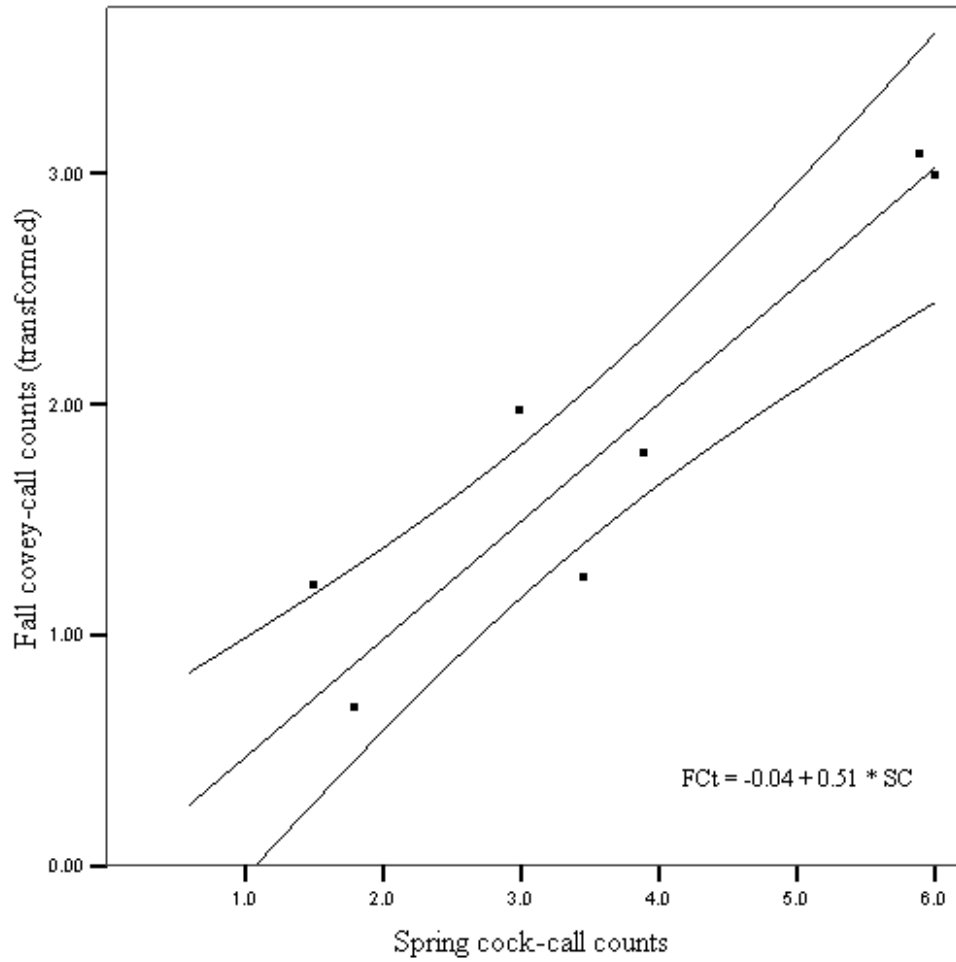
Year	ER	Mean	N	Std. Error of Mean	Minimum	Maximum
2002	1	3.0800	5	.83271	1.00	5.80
	2	1.3000	1	.	1.30	1.30
	4	2.4400	1	.	2.44	2.44
	Total	2.7343	7	.62886	1.00	5.80
2003	1	2.5833	3	1.11032	1.36	4.80
	2	2.6000	2	.50000	2.10	3.10
	3	1.1500	2	.55000	.60	1.70
	4	2.7500	1	.	2.75	2.75
	Total	2.2500	8	.45807	.60	4.80
2004	1	3.8120	5	.80666	2.00	6.30
	2	1.7600	1	.	1.76	1.76
	3	.7500	2	.25000	.50	1.00
	Total	2.7900	8	.70388	.50	6.30
2005	1	4.7020	5	.74304	2.81	6.60
	2	3.1700	1	.	3.17	3.17
	Total	4.4467	6	.65823	2.81	6.60
2006	1	2.1000	3	.87178	.50	3.50
	2	2.3000	1	.	2.30	2.30
	Total	2.1500	4	.61847	.50	3.50
Total	1	3.4295	21	.39872	.50	6.60
	2	2.2883	6	.30153	1.30	3.17
	3	.9500	4	.27234	.50	1.70
	4	2.5950	2	.15500	2.44	2.75
	Total	2.8709	33	.29825	.50	6.60

**Table 2.11.** Stepwise multiple regression table for the Texas Quail Index. Fall covey-call counts (transformed) were used as the dependent variable.

Independent Variable	Standardized Coefficient	Significance
Spring cock-call counts	0.675	< 0.001
Habitat photo points	0.157	0.301
Forb species richness	-0.200	0.187
Simulated-nest fate	0.147	0.338
Predator scent-stations	0.085	0.586
Potential nest sites	-0.004	0.981



**Figure 2.24.** Fall covey-call counts (transformed) plotted versus spring cock-call counts for years 1–4 of the Texas Quail Index (2002–2005). Predicted line and 95% confidence belts around the line are given ( $P < 0.0001$ ,  $R^2 = 0.41$ ).



**Figure 2.25.** Fall covey-call counts (transformed) plotted versus spring cock-call counts for year 5 of the Texas Quail Index (2006). Predicted line and 95% confidence belts around the line are given ( $P < 0.0001$ ,  $R^2 = 0.89$ ).

## **DISCUSSION**

### **Data collection**

The low rate of return of complete data sets proved problematic and noteworthy. Most cooperators did not return data after September of each year and indicated that the project took too much of their time (Chapter III). Such a low rate of return for dependent variables drastically reduced the sample size and affected potential results.

The large range and standard deviation of fall indices might be attributed to: (a) inherent variability in discerning unique coveys calling (Irwin 1995: 81–92); and (b) inconsistent data collection within a site across years. On many study sites, different people collected data each year, potentially increasing observer error. In a note intended to summarize the year's data collection, a cooperator wrote, "...since I was sick for [spring cock-call] counts, I had my [untrained] wife collect the data...we both like to conduct the counts because I can see better than her and she can hear better than me." This excerpt indicates a probable variation in data collection and observer bias. In other instances cooperators changed the protocol, usually for convenience or because they thought it would improve the study. One letter accompanying a data summary sheet said, "Sorry for the delay in getting you the numbers, we were about 4 weeks late collecting [spring cock-call counts]. We didn't have many birds this year, not really sure why..." This is a good example of the cooperator not realizing the effects of changing the protocol, and not knowing the importance of sampling during peak calling periods (Wellendorf et al. 2004).

In addition, the dearth of data collected in the fall may be attributed to a lack of understanding the purpose of the study (Trumbull et al. 2000). Several personal e-mails from cooperators led me to believe they may have different expectations from the study, for example, many indicated they thought the study was to determine the extent of the quail decline in Texas, some thought they were observing the effects of land management on quail populations, and a few indicated that they were hoping to contribute to TPW annual quail trends. While these serendipitous results may seem minor, a lack of understanding the goal of the project can lead citizen-scientists to inflate results, hesitate to report negative results, or exhibit bias during data collection (i.e., they tend to make their results or study site more attractive; Trumbull et al. 2000, McCaffrey 2005).

### **Data evaluation**

The function of the spring cock-call (actually a song) remains debatable. Stoddard (Stoddard 1931: 126–161) believed the song was made only by unmated cocks attempting to lure a mate. However, Rosene (1957), Stokes (1967), and Ellis (1972) contended that both unmated males and mated males separated from their mate, elicit the song. Kozicky et al. (1956) indicated that spring cock-call counts can only be used as an index of potential quail production, thus, I used spring cock-call counts as an index of the potential breeding population in the spring.

My 5-year regression model was significant, but the  $R^2$  value indicates that only 41% of the variation in  $FC_t$  is explained by spring cock-call counts (not a reliable

predictor). Such low prediction power is not unheard of for 1 index (Bennitt 1951), but I anticipated capturing the remaining variation with other indices. Since I did not, I performed an ANCOVA to look for a year or ecoregion effect.

An ANCOVA suggested a year effect in the relationship between spring cock-call counts and  $FC_t$ . Equations for years 1–4 did not differ significantly, but year 5 yielded an entirely different equation. The high  $R^2$  value (0.89) is similar to that of Brown et al.'s (1978,  $R^2 = 0.94$ ) prediction equations for scaled quail in the desert (Scaled quail bagged per hunter day =  $3.5 + 0.97 \times$  Spring cock-call counts). Even though my equation was quite different from Brown et al.'s, I was curious if weather variables (i.e., desert-like conditions) explained any variation in  $FC_t$  since other studies have quantified correlations between quail abundance and weather (Bridges et al. 2001, Guthery et al. 2001). Bridges et al. (2001) reported that the Palmer Drought Severity Index (PDSI) accounted for more variability in bobwhite abundance than raw precipitation. Accordingly, I looked at the PDSI for 2002–2006 and found 2006 (year 5) to be a drought year for the TQI ecoregions (Figure 2.26). These data suggest that during drought years, hunting-season quail abundance is more predictable than non-drought years. Low breeding success may be the reason that spring cock-call counts explain about 90% of  $FC_t$  in the drought year which had a significantly lower percentage of juveniles than in other years (Figure 2.6). Conversely, precipitation, temperature, and soil moisture (3 factors of the PDSI) may explain variation in breeding success, especially in drought years.



**Figure 2.26.** Long-term Palmer Drought Severity Index for January–August of each year of the Texas Quail Index. Year 5 (2006) is denoted as a drought year for all Texas Quail Index study sites.



## **CHAPTER III**

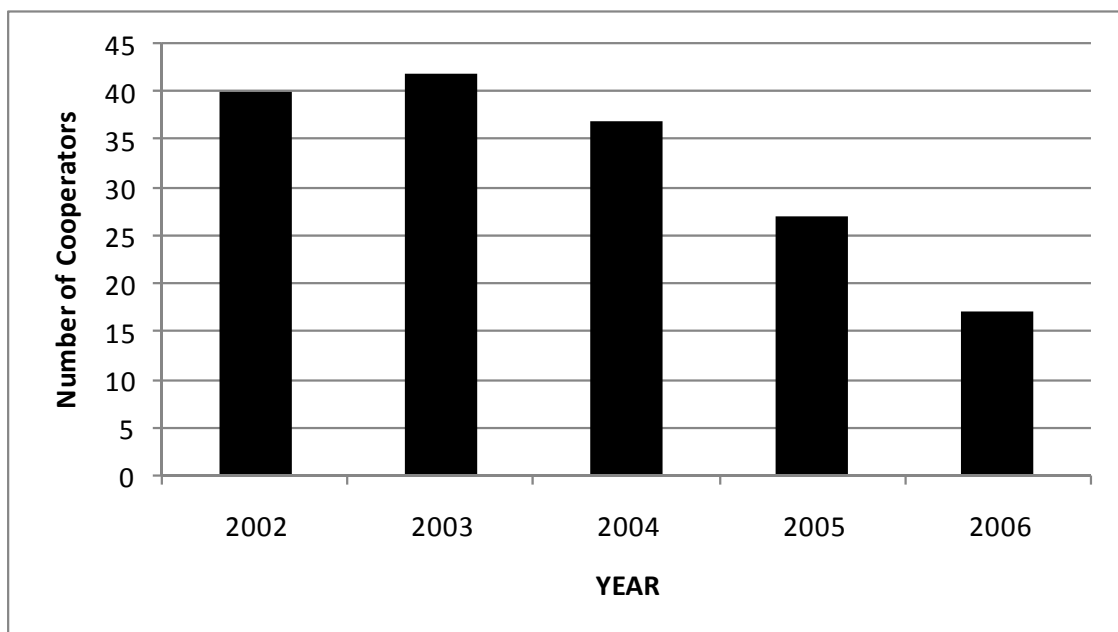
### **CITIZEN-SCIENCE**

#### **INTRODUCTION**

Citizen-science involves volunteers from the general public gathering data for use by scientists to investigate questions of research importance (Trumbull et al. 2000). Citizen-science programs were established initially as a tool to educate the public about the scientific process (Brossard et al. 2005), but are used increasingly for surveying and monitoring animal populations (e.g., Christmas Bird Count; Lepczyk 2005). This trend is likely due to their practicality and affordability in projects where the collection of data is large-scale, time-sensitive, and funding is limited (Altizer et al. 2004). Although practical and affordable, debate continues on whether citizen scientists collect reliable data (Irwin 1995, Fore et al. 2001, McCaffrey 2005).

Citizen-science project coordinators seek to recruit volunteers who will provide useful data throughout the study; however, the volunteer aspect of citizen-science often results in participants who are initially excited about participating but later drop out (McCaffrey 2005). I observed this pattern of retention in my analysis of the TQI cooperators. Cooperator participation peaked in year 2 and later declined (Figure 3.1). Accordingly, I sought to identify characteristics of a reliable cooperator so future citizen-science coordinators of bird-monitoring programs can identify reliable participants. Several studies characterized various user groups (e.g., landowners, hunters) based on

their willingness to cooperate in land and wildlife management programs (Raedeke 2001, Sanders 2005, and Wagner et al. 2007). Others examined motivations and values of volunteers in general (Hayghe 1991, Clary et al. 1996). In this chapter I test the hypothesis that cooperator retention is a function of motives for participation, demographics, program satisfaction, and landownership goals. I also quantify the rate of participation for all TQI cooperators over the duration of the study.



**Figure 3.1.** Number of Texas Quail Index cooperators per year, 2002–2006.

## **OBJECTIVES**

My objectives were to: (1) identify characteristics of a reliable cooperator; (2) compute a participation rate for TQI cooperators over the duration of the study; and (3) determine the cause(s) of declining rates of cooperator participation in the TQI.

## **METHODS**

### **Cooperator characteristics**

I administered a mail survey (Appendix B) to all TQI cooperators ( $n = 76$ ) in May 2007 to acquire information regarding their (a) motives for participation, (b) demographics, (c) participant satisfaction, and (d) landownership goals. The questionnaire was approved by the Texas A&M Institutional Review Board (Protocol number: 2007-0214) and followed Dillman's (2007) Total Design Method (TDM) which uses a personalized multiple mailing approach to achieve an ample response rate. Dillman (1991) found that multiple contacts were more effective than any other technique for increasing response to mail surveys.

Initially, I mailed pre-survey letters (day 1) to all cooperators informing them of the forthcoming questionnaire. On day 5, I mailed 70 questionnaires (after finding I had 6 invalid addresses) in color print with self-addressed stamped envelopes, followed by 70 post cards (serving as a thank you or reminder) on day 12. I sent another black and white questionnaire with self-addressed stamped envelopes to non-respondents only on day 19; subsequently sending a final postcard (serving as a thank you or reminder) on

day 26. I personalized all correspondence by addressing each cooperator by name and by signing all documents.

### **Cooperator participation rate**

Project participation rate is typically shown as a bar graph (Figure 3.1) but such graphs only illustrate the number of total participants each year and lack important information such as the actual time (e.g. month or quarter) when participants immigrated to, or emigrated from, the program. Therefore, I used the Kaplan-Meier procedure (Kaplan and Meier 1958) with modifications from Pollock et al. (1989) to more accurately display the timing of cooperator decline. I divided each year into quarters for my time scale since harvest-data collection ended in the first quarter and new cooperators began work in the second quarter of each year. In addition, I did not censor any cooperators; I only recorded their status as “out of TQI” or “new to TQI”. I recorded the number “at risk” as the number of cooperators available for data collection at the beginning of the quarter.

### **Statistical analysis**

I used Statistical Package for the Social Sciences (SPSS; Chicago, Illinois, USA) version 15.0 to analyze data from the mail survey. I used t-tests (Ott and Longnecker 2001: 275–285) to compute mean differences in motivations, demographics, satisfaction, and landownership goals between those that dropped out of the program (Leavers), and those that did not (Non-leavers).

## RESULTS

### Cooperator characteristics

Total response rate was 84.3% ( $n = 59$ ); 61.4% for the initial questionnaire, 1.4% for the initial post card, 20.0% for the second questionnaire, and 1.4% for the final reminder. Dillman (1978: 188) found an average response rate to mail surveys of 74% using the TDM.

The TQI experienced high turnover rate where 66.1% ( $n = 50$ ) of all participants left the program. Of those, 39 responded to the questionnaire. Most Leavers (61.5%) reported that they left the program because it took too much of their time; 20.5% said they changed jobs and left the area (mainly County Extension Agents, CEAs); 12.8% said it required too much work, and 5.1% believed the data they collected did not matter. Demographic variables did not differ between Leavers, and Non-leavers (Table 3.1). Average age for all cooperators was 49 ( $\pm 13.8$ ; standard deviation) years of age. Males comprised 93% of respondents, 85% had a college degree, 40% were landowners, 45% CEAs, 10% TPWD biologists, and 5% interested volunteers. Relative to motivation for participating in the TQI, 49% of respondents joined to learn more about quail management, 33% to contribute to scientific data, 9% to learn more about their land, 5% because they thought it would be fun, and 4% said it was recommended as part of their job. Only 15% of respondents reported previous citizen-science experience, and most (92%) completed at least 1 wildlife course (college or workshop) prior to participating in the TQI.

Satisfaction level did not differ significantly between Leavers and Non-leavers (Table 3.1). Most respondents (75%) were satisfied with communication with coordinators, 85% with quality of training and personal benefits, and 90% said they were satisfied with the overall experience.

Landownership goals were also not significantly different between Leavers and Non-leavers (Table 3.1). Half of sites were used for ranching (50%), 28% hunting, 14% research, and 8% pleasure. Of all sites, 33% reported participating in a landowner incentive program (i.e., an incentive program usually funded by a governmental agency designed to assist landowners in protecting or managing rare species).

**Table 3.1.** Characteristics of Texas Quail Index cooperators who left the program ( $n = 39$ ) compared to those who did not leave ( $n = 20$ ).

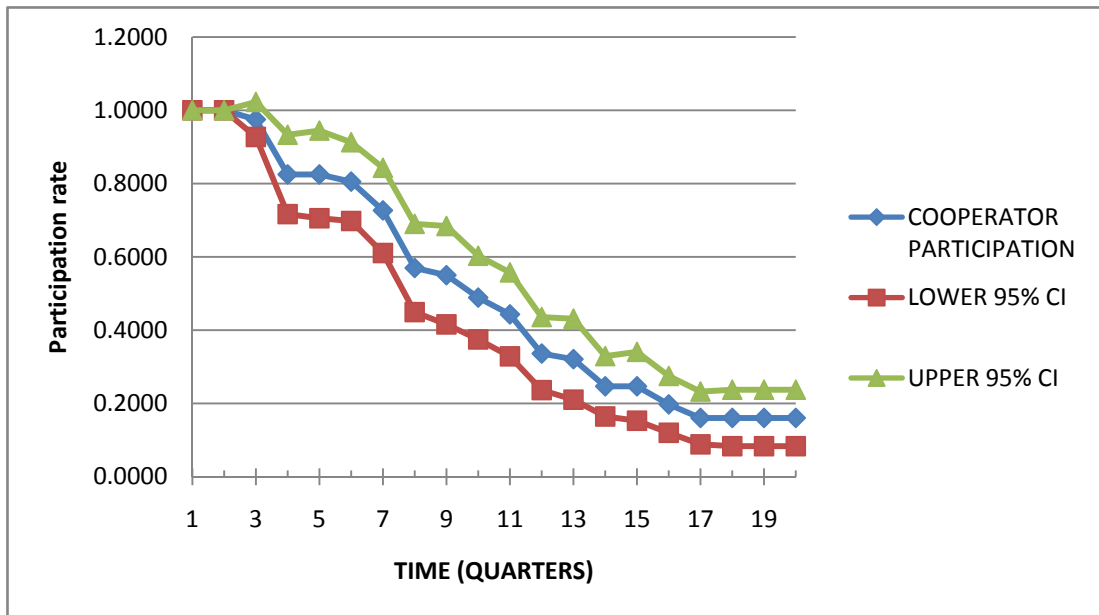
Test Variable	t	p
Demographic		
Age	-0.533	0.601
Education	-0.616	0.545
Role	0.000	1.000
Gender	0.000	1.000
Motive for joining	-0.680	0.502
Previous citizen-science experience	1.371	0.186
Number of wildlife classes taken	0.675	0.509
Satisfaction		
Communication by coordinators	-1.831	0.083
Quality of training	-0.567	0.577
Personal gain	-1.552	0.137
Overall experience	-1.453	0.163
Study Site		
Site purpose	0.399	0.695
LIP participation	1.719	0.104

### Cooperator participation rate

Participation rate for year 1 was steady in the first 2 quarters, but declined in the 3<sup>rd</sup> and 4<sup>th</sup> quarters (Table 3.2). Year 2 began without a decline in the 1<sup>st</sup> quarter but the participation rate decline began and continued from the 2<sup>nd</sup> quarter of year 2, until the 2<sup>nd</sup> quarter of year 4. The 3<sup>rd</sup> quarter of year 4 was steady, but participation later declined in the 4<sup>th</sup> quarter. Recruitment and retention of cooperators declined over the first 4 years as well. Year 5 demonstrated a steady trend, but with the least amount of cooperators (Figure 3.2).

**Table 3.2.** Kaplan-Meir participation rate data for all volunteers of the Texas Quail Index. The volunteers who left the program were recorded as “out of TQI”, new recruits were recorded as “new to TQI”, and those who remained in the program were recorded as the number “at risk.” No volunteers were censored.

Year	Quarters	No. at risk	No. out of TQI	No. new to TQI	Participation rate	Lower 95% CI	Upper 95% CI
1 (2002)	1	40	0	0	1.0000	1.0000	1.0000
	2	40	0	0	1.0000	1.0000	1.0000
	3	40	1	0	0.9750	0.9272	1.0228
	4	39	6	0	0.8250	0.7167	0.9333
2 (2003)	5	32	0	10	0.8250	0.7054	0.9446
	6	42	1	0	0.8054	0.6979	0.9128
	7	41	4	0	0.7268	0.6105	0.8431
	8	37	8	0	0.5696	0.4492	0.6901
3 (2004)	9	29	1	8	0.5500	0.4157	0.6843
	10	36	4	0	0.4889	0.3747	0.6031
	11	32	3	0	0.4431	0.3285	0.5576
4 (2005)	12	29	7	0	0.3361	0.2364	0.4358
	13	22	1	5	0.3208	0.2103	0.4313
	14	26	6	0	0.2468	0.1645	0.3291
	15	20	0	0	0.2468	0.1529	0.3407
5 (2006)	16	20	4	0	0.1974	0.1199	0.2750
	17	16	3	1	0.1604	0.0884	0.2324
	18	14	0	0	0.1604	0.0834	0.2374
	19	14	0	0	0.1604	0.0834	0.2374
	20	14	0	0	0.1604	0.0834	0.2374



**Figure 3.2.** Kaplan-Meier survival curve illustrating the participation rate of all Texas Quail Index cooperators, 2002–2006.

## DISCUSSION

The response rate I observed (84.3%) was high; therefore, I considered non-response bias to be insignificant. Dillman (2007) stated that a response rate of >74% is unrealistic without an incentive (e.g., money). I believe the high response rate to the TQI questionnaire (without incentive) was realized because of several factors. First, most of the landowners involved were either personally interested in the project (i.e., local status-trends of quail abundance) or had worked previously as a cooperator with their local CEA. Second, the professional style of the document (i.e., personalized greetings, color print, and personally signed) may have made a better visual impact on cooperators than a standard form letter. In addition, my initial letter to the cooperators



was on Texas AgriLife Extension letterhead since most of the TQI participants were previously in close contact with Texas AgriLife Extension programs and their respective CEA. I believe the respondents trusted the source of the survey and deemed the project's results to be useful for future Texas AgriLife Extension programs, thus increasing the response rate.

### **Cooperator characteristics**

I detected no significant differences between Leaver and Non-leaver demographics, satisfaction with program, or landownership goals. However, more Leavers (38%) were not completely satisfied with communication from TQI coordinators compared to only 15% of Non-leavers ( $P < 1.0$ ), indicating that communication, or perhaps overall volunteer management might have been improved during the study. When asked, "If you had been in charge of the TQI, what would you have done differently?" >30% of all respondents commented on the lack of feedback and communication during the project.

A personal conversation with 2 of the TQI coordinators revealed that communication involved: (1) training the cooperators at the beginning of each year; and (2) a 1-way communication path where cooperators could call or write coordinators, but were rarely contacted by coordinators. In fact, the TQI records were missing >50% of the cooperator's current contact information. Few follow-ups regarding missing or untimely data were made by coordinators and only the raw data were made publicly available at year's end via the TQI website (i.e., no interpretations for better

understanding). Nelson and Damberg (1995), and McCaffery (2005) experienced similar results of missing data and inconsistent data collection and stressed the importance of increased communication to minimize such errors.

In addition to communication problems, the TQI was time-consuming and labor-intensive compared to an average citizen-science project such as Project Feeder Watch (Cornell Lab of Ornithology 2007), the Christmas Bird Count (National Audubon Society 2007), or the North American Breeding Bird Survey (United States Geological Survey 2007). Most Leavers (61.5%) listed their reason for leaving as the TQI took too much time and another 12.8% reported it required too much work. Total time required annually totaled approximately 60 hours, not including travel to and from the study site. Call counts took about 2–4 hours per outing and varied according to weather conditions and transect smoothness (i.e., for rougher transects, the cooperators had to drive slower). Simulated-nest surveys took  $\geq 6$  hours to establish, and approximately 4 hours to check although the amount of time required checking the nests varied according to ease of finding them, which was often difficult. Simulated-nest surveys required significant amounts of walking in various habitat types, and was thought to be labor-intensive and time-consuming. Predator scent-stations, forb species-richness, and habitat photos all took about 4 hours to conduct and required moderate amounts of labor. Scent-stations were often rendered unusable because of precipitation and animal disturbance which some respondents considered frustrating.

Finally, the TQI lacked stipends and enticement was minimal. The program did not reimburse volunteers for most project-related costs, including fuel for vehicles, photograph development, and supplies, so it is possible that the net benefit to some cooperators was perceived to be negligible. Most citizen-science projects lacking stipends are small-scale from the perspective of the volunteer and require very little labor and out-of-pocket expense. Most large-scale projects compensate volunteers for expenses and sometimes offer a stipend, resulting in increased productivity and likelihood of future service (Tschirhart et al. 2001). During training, cooperators were informed they would learn more about quail population dynamics on their respective study site and develop a better understanding of how their management schemes affect local quail abundance. This ulterior motive of the TQI may have been viewed as only a minimal enticement since nearly all citizen-science programs are designed to increase the scientific knowledge of the volunteer (McCaffery 2005).

### **Cooperator participation rate**

Participation rate mimicked McCaffery's (2005) observation of participants being initially excited about collecting data and being involved in the scientific process, but later leaving the program. For the TQI, cooperator participation declined earlier each of the first 4 years and then leveled out in year 5 when a steady corps of volunteers emerged. The TQI also suffered from inconsistencies as many cooperators left the program in the middle of the year resulting in incomplete data sets. Many of the CEAs involved transferred to other counties over the course of the study and their successor

may have lacked interest in following through with the TQI. Irwin (1995), McLaughlin and Hilts (1999), and McCaffery (2005) all discuss the possibility of inconsistent data collection when using citizen-science.

## **CHAPTER IV**

### **CONCLUSIONS**

#### **TEXAS QUAIL INDEX**

My main objective was to determine the best predictor(s) of fall quail abundance. Across the 5-year study, no single measure, nor group of measures, proved to be a reliable indicator of fall quail abundance. The best predictor was spring cock-call counts which accounted for 44% of the variability in the data across the duration of the study. I observed that spring cock-call counts are better indicators of  $FC_t$  in drought years possibly because of significantly lower percent juveniles in the fall population. If these data are correct, quail managers should have a better ability to predict the declines of their fall quail abundance in the dry years. Arguably, it is the “bust” seasons that are the most critical to sustaining a hunting operation, so by providing a 4-month forewarning of a poor upcoming season, these results may be economically and ecologically expedient.

The TQI also experienced a high turnover rate among cooperators resulting in inconsistent or missing data. Future studies should require annual training of all volunteers (TQI only required new cooperators to attend training) which emphasizes the importance of strict adherence to project protocols (e.g., one should not conduct roadside counts while feeding cattle), the significance of the scientific method (e.g., how to minimize bias), and highlight the project’s purpose. Quarterly follow-ups, via newsletter or list-serves, should re-emphasize these points throughout the year. Researchers using

citizen-science should be aware of the potential for a high volunteer turnover rate, and work to minimize missing data.

### **CITIZEN SCIENCE**

Lack of management, and communication between project coordinators and cooperators was identified as a weak link in my study. Future studies should include more communication with volunteers (i.e., annual meetings and quarterly newsletters), less work and labor, reimburse participants for expenses, and include an incentive for retention. A person whose primary purpose is to manage the project and volunteers would serve as a good citizen-science coordinator significantly improving communications. Immediate follow-ups regarding missing data or delayed sampling should be made, as well as frequent reminders of the programs purpose, upcoming events, and preliminary results.

To provide less work, most citizen-science projects revolve around 1 task per volunteer (e.g., recording a single species' call,). For multi-tasked projects like the TQI, tasks might be divided among cooperators instead of having all cooperators perform all tasks. For example, 1 study site could record SC and FC, while another records SN and PJ. Dividing tasks among study sites would decrease the time and labor required, while reducing error.

Finally, a successful project should reimburse volunteers for costs incurred and provide an enticement for retention. A meeting at the year's end could provide refreshments, question and answer sessions, and preliminary results to provide a forum

for volunteers to discuss concerns, improvements, and results amongst each other for better understanding of the project.

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## APPENDIX A

The Palmer Drought Severity Index (PDSI) is the monthly value (meteorological drought index) that is generated to indicate the severity of a wet or dry spell. This index is based on the principles of a balance between moisture supply and demand. The index generally ranges from -6 to +6; with negative values denoting dry spells and positive values indicating wet spells. There are a few values in the magnitude of +7 or -7. PDSI values 0 to -0.5 = normal; -0.5 to -1.0 = incipient drought; -1.0 to -2.0 = mild drought; -2.0 to -3.0 = moderate drought; -3.0 to -4.0 = severe drought; and greater than -4.0 = extreme drought. Similar adjectives are attached to positive values of wet spells (NOAA 2008).

The parameters in the following table are the monthly averaged Palmer Drought Severity Indices from NOAA climatic divisions of Texas, and are time biased corrected (Karl et al. 1986). The element is the division of Texas and the year the data were collected (e.g., division 1, 2002 = D1-2002).

Element	January	February	March	April	May	June	July	August
D1-2002	-1.28	-1.24	-0.56	-0.61	-1.51	-2.2	-2.41	-2.2
D2-2002	0.57	0.5	1.21	1.22	-0.64	-0.67	1.23	-0.3
D3-2002	1.04	0.8	1.49	1.08	0.89	0.79	1.65	1.49
D4-2002	3.35	2.77	3.09	2.3	1.68	1.41	1.57	1.3
D5-2002	-3.83	-3.16	-2.98	-3.14	-3.71	-4.09	-3.13	-3.47
D6-2002	-0.52	-0.68	-0.61	-1.11	-1.92	-2.22	1.6	-0.67
D7-2002	-0.34	-0.67	-0.88	-1.17	-1.75	-1.72	1.2	0.93
D8-2002	-0.49	-1.02	-1.2	-1.08	-1.46	0.15	0.41	1.07
D9-2002	-0.51	-0.84	-1.13	-1.57	-2.15	-2.52	3.51	3.18
D10-2002	-2.85	-2.87	-3.13	-3.6	-3.99	-4.02	-3.9	-4.23
D1-2003	-0.28	-0.36	-0.41	-0.75	-1.39	1.22	-0.99	-1.62
D2-2003	-0.17	-0.16	-0.31	-0.43	-1.05	1.54	-0.32	-0.44
D3-2003	1.99	2.35	-0.43	-1.07	-1.68	-0.94	-1.26	-1.13
D4-2003	1.96	2.99	-0.51	-1.25	-2.06	-1.42	-1.33	-1.25
D5-2003	-2.32	-1.72	-1.61	-2.07	-2.61	-2.16	-1.88	-2.11
D6-2003	-0.26	0.29	-0.03	-0.69	-1.31	0.3	0.53	0.55
D7-2003	4.14	4.3	0.02	-0.64	-1.64	-1.7	-1.01	-1.31
D8-2003	-0.18	-0.03	-0.31	-0.91	-2.05	0	0.24	0.05
D9-2003	4.78	5.01	5.17	4.63	3.37	3.26	4.6	3.7
D10-2003	3.12	2.88	3.16	3.3	2.35	1.87	1.73	1.56
D1-2004	0.2	0.9	1.32	2.39	1	1.77	1.99	2.54
D2-2004	0.19	0.9	1.22	1.68	-1.09	1.14	1.92	2.73
D3-2004	-1.9	0.65	0.16	0.59	-0.62	1.69	2.55	3.53
D4-2004	-1.54	1.19	0.75	0.72	0.68	2.15	1.86	2.06
D5-2004	0.2	0.32	1.35	2.29	1.3	1.38	1.99	2.69
D6-2004	0.11	0.31	0.81	1.79	1.18	2.3	2.36	3.04
D7-2004	0.1	0.35	0.22	1.29	1.4	2.96	3.11	3.05
D8-2004	1.47	2.02	1.45	1.69	2.51	4	3.43	2.67
D9-2004	4.4	4.28	4.87	6.03	5.75	6.81	6.93	6.84
D10-2004	2.91	2.53	3.16	3.96	3.71	4.36	-0.21	-0.36
D1-2005	6.43	6.25	6.1	5.5	5.1	4.72	4.52	5.22
D2-2005	4.63	4.71	4.54	3.65	3.24	2.8	2.84	4.49
D3-2005	4.14	3.89	-0.1	-0.84	-1.13	-1.65	-1.7	-0.8
D4-2005	-0.32	0.29	-0.36	-0.8	-1.41	-2.21	-2.27	-2.08
D5-2005	4.03	4.64	4.64	4.09	4.33	3.6	3.52	4
D6-2005	3.93	4	4	3.09	3.22	2.5	2.34	2.9
D7-2005	3.19	3.34	3.55	-0.48	-0.49	-1.05	-0.93	-1.34
D8-2005	2.22	2.52	2.62	-0.47	-0.5	-1.25	-0.9	-1.4
D9-2005	4.42	4.51	4.71	-0.39	-0.58	-1.26	-0.71	-1.45
D10-2005	-1.35	-1.35	-1.63	-2.2	-2.65	-3.33	-1.89	-2.28
D1-2006	-2.02	-2.3	-2.09	-2.71	-3.37	-4.06	-4.38	1.15
D2-2006	-2.28	-2.54	-2.26	-2.69	-3.17	-4.08	-4.78	-4.37
D3-2006	-3.67	-3.62	-2.83	-3.03	-3.53	-3.85	-4.36	-4.47
D4-2006	-4.11	-3.83	-3.19	-3.47	-3.93	-4.02	-3.87	-4.09
D5-2006	-1.3	-1.64	-1.87	-2.34	-3.24	-3.77	-3.68	1.87
D6-2006	-1.81	-2.12	-2.13	-2.55	-3.22	-3.72	-4.04	-3.87
D7-2006	-3.41	-3.91	-4.09	-4.81	-4.95	-4.95	-4.39	-4.89
D8-2006	-2.87	-3.33	-3.63	-3.88	-3.54	0.51	1.88	1.66
D9-2006	-2.65	-2.92	-3.44	-4.06	-4.23	-4.42	-3.24	-3.83
D10-2006	-2.89	-3.14	-3.53	-4.2	-4.41	-4.42	-3.55	-3.81

## APPENDIX B

	<h1 style="text-align: center;">Texas Quail Index Cooperator Survey</h1> <p style="text-align: center;">Kelly Reyna • 111 Nagle Hall • Texas A&amp;M University • College Station, TX 77843-2258 • 979-450-8680</p>
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Your views on the quality and effectiveness of Extension research programs are extremely important. Please take a few minutes to tell us about your experience with the Texas Quail Index (TQI), and return the survey in the accompanying envelope. Your answers will help us better meet your needs in the future. We appreciate your participation!

**We assure you that your participation and responses to all questions will be kept strictly confidential.**

If you encounter a question that does NOT APPLY to you, please indicate this by writing "NA" in the margin next to the question. If you encounter a question for which you DON'T KNOW the answer, please indicate this by writing "DK" in the margin next to the question.

Effectiveness of the Texas Quail Index	Place an X in the appropriate box				
1. My knowledge of the following increased as a result of participating in the TQI:	Strongly Agree 1	Agree 2	Neutral 3	Disagree 4	Strongly Disagree 5
Quail abundance estimation					
Predator abundance estimation					
Plant identification					
Habitat evaluation					
Quail response to management actions					
Valuable food sources for quail					
Quail nesting success					
Quail biology					
Identification of quail calls					
Identification of bird calls (non-quail)					
Location of quail on my property					

*Thank you for your participation!*

Adoption of Practices		Place an X in the appropriate box					
2. Indicate your intentions to adopt the following practices as a result of the TQI	Definitely will not 1	Probably will not 2	Unsure 3	Probably will 4	Definitely will 5	Already Adopted 6	
Spring call counts							
Road-side counts							
Fall covey-call counts							
Habitat photo points							
Forb species richness							
Dummy-nest fate							
Scent-station surveys							
Potential nest site estimation							
Harvest data							
Improvement of nesting cover							
Predator management							
Brush management							
Harvest management							
Other:							
Other:							
Customer Satisfaction:		Place an X in the appropriate box					
3. How satisfied are you with the following?	Completely Satisfied 1	Mostly Satisfied 2	Neutral 3	Slightly Satisfied 4	Not At All Satisfied 5		
Communication from TQI coordinators							
The quality of training you received for the TQI							
What you have gained personally from the TQI							
Your overall TQI experience							

<b>Customer Satisfaction: (Continued)</b>		<b>Check ONE box per question</b>	
4. Which <b>ONE</b> TQI practice did you learn the <b>most</b> from?	<input type="checkbox"/> Spring call counts <input type="checkbox"/> Road-side counts <input type="checkbox"/> Fall covey-call counts <input type="checkbox"/> Habitat photos <input type="checkbox"/> Forb species richness	<input type="checkbox"/> Dummy nest fate <input type="checkbox"/> Scent-station surveys <input type="checkbox"/> Potential nest site estimation <input type="checkbox"/> Harvest data	
5. Which <b>ONE</b> TQI practice did you learn the <b>least</b> from?	<input type="checkbox"/> Spring call counts <input type="checkbox"/> Road-side counts <input type="checkbox"/> Fall covey-call counts <input type="checkbox"/> Habitat photos <input type="checkbox"/> Forb species richness	<input type="checkbox"/> Dummy nest fate <input type="checkbox"/> Scent-station surveys <input type="checkbox"/> Potential nest site estimation <input type="checkbox"/> Harvest data	
6. If you <b>dropped out</b> of the TQI, what was your <b>main reason</b> ?	<input type="checkbox"/> It took too much of my time <input type="checkbox"/> It interfered with my family <input type="checkbox"/> It interfered with my job <input type="checkbox"/> It required too much work <input type="checkbox"/> My interest declined <input type="checkbox"/> I did not think my data mattered <input type="checkbox"/> Other (please specify): _____		
<b>About your TQI Site:</b>		<b>Check ONE box per question</b>	
7. Is your TQI site enrolled in a government incentive program (e.g., EQUIP, CP-33, WHIP)?	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, which one(s): _____		
8. What is the <b>PRIMARY</b> purpose of your TQI site?	<input type="checkbox"/> Ranching <input type="checkbox"/> Farming <input type="checkbox"/> Hunting <input type="checkbox"/> Pleasure <input type="checkbox"/> Other (please specify): _____		
9. How many years have you owned the land associated with the TQI?	_____ years <input type="checkbox"/> I do not own the TQI site		
10. Do you believe your participation in the TQI affected your ability to market quail hunting?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Not Applicable If Yes, how? _____		
11. Based on what you learned during the TQI, what do you believe is the most <b>LIMITING FACTOR</b> affecting quail abundance on your TQI site?			
_____			
_____			

About You:	Check ONE box per question
12. How many years did you participate in the TQI?	_____ years
13. How were you associated with the TQI site?	<input type="checkbox"/> Land owner <input type="checkbox"/> Extension employee <input type="checkbox"/> TPWD employee <input type="checkbox"/> Volunteer
14. Have you collected data for other natural resource citizen-science projects?	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, which one(s): _____
15. How many wildlife seminars/classes did you attend prior to your involvement with the TQI?	_____ wildlife seminars/classes
16. Why did you participate in the TQI? (check all that apply)	<input type="checkbox"/> To learn more about quail management <input type="checkbox"/> To contribute scientific data <input type="checkbox"/> To become more familiar with my land <input type="checkbox"/> I thought it would be fun <input type="checkbox"/> Other (please specify): _____
17. Do you belong to a conservation organization? (example: Quail Unlimited)	<input type="checkbox"/> Yes <input type="checkbox"/> No If yes, which one(s): _____
18. How do you rate your hearing ability?	<input type="checkbox"/> 100% accurate <input type="checkbox"/> 75-99% <input type="checkbox"/> 50-74% <input type="checkbox"/> 25-49% <input type="checkbox"/> 0-24%
19. How do you rate the accuracy of your data collection?	<input type="checkbox"/> 100% accurate <input type="checkbox"/> 75-99% <input type="checkbox"/> 50-74% <input type="checkbox"/> 25-49% <input type="checkbox"/> 0-24%
20. What is your gender?	<input type="checkbox"/> Male <input type="checkbox"/> Female
21. In which year were you born?	_____ (example: 1954 )
22. What is your education level?	<input type="checkbox"/> Did not complete high school <input type="checkbox"/> High school diploma <input type="checkbox"/> Some college <input type="checkbox"/> College degree <input type="checkbox"/> Graduate degree

About You: (Continued)	
23. If you had been in charge of the TQI, what would you have done differently? (Please be specific).	
_____	
_____	
_____	
_____	
_____	
_____	
_____	
_____	

- > If you are NOT a County Extension Agent (CEA), you have completed the questionnaire.

Thank you for taking the time to fill out this questionnaire.  
Your response is greatly appreciated!  
Please return the questionnaire in the accompanying envelope.

- > CEAs continue to question 24.

For CEAs only:	Check ONE box per question
24. Did you use these data for annual reports (Goldmine, Result-Demonstration handbook)?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> If yes, which one(s): _____
25. Did you use these data in any news release, field day, educational program, etc?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> If yes, which one(s): _____
26. Was the TQI a component of an outcome program?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> If yes, which one(s): _____

Thank you for taking the time to fill out this questionnaire.  
Your response is greatly appreciated!  
Please return the questionnaire in the accompanying envelope



## VITA

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Research and Teaching Assistant (Physiology and Biology) University of North Texas, Denton, Texas	2007–2008
Research Assistant (Quail population dynamics) Texas AgriLife Extension, College Station, TX	2006–2007
Learning Center Associate (Biology, Chemistry, Writing) Blinn College Learning Center, Bryan, TX	2006–2007
Wildlife Technician (Quail and mammal population dynamics) Texas AgriLife Extension, Barnhart, TX	2006
Wildlife Technician (Wild turkey population dynamics) Texas Tech University, Paducah, TX	2004
Research Volunteer (White-tailed deer nutrition) Kerr Wildlife Management Area, TX	2004

### Publications:

Butcher, J. A., J. E. Groce, C. M. Lituma, M. C. Cocimano, Y. Sanchez-Johnson, A. J. Camponizzi, T. L. Pope, K. S. Reyna, and A. C. Knipps. 2007. Persistent controversy in statistical approaches in wildlife sciences: a perspective of students. *Journal of Wildlife Management* 70: 2142–2144.

Reyna, K. S., D. Rollins, B. D. Taylor, and D. Ransom. 2006. The Texas Quail Index: A citizen science effort to monitor ranch-level quail dynamics. Pages 4–11 *in* D. Ransom, J. Sanders, and S. Lyda, editors. *Proceeding of the Red River Quail Symposium*, 11–13 October 2006, Wichita Falls, Texas, USA