# STATUS, ECOLOGY AND MANAGEMENT OF SCALED QUAIL IN WEST TEXAS

Dale Rollins
Texas Agricultural Extension Service, 7887 U.S. Highway 87 North, San Angelo, TX 76901

## ABSTRACT

Scaled quail (*Callipepla squamata*), more commonly referred to as "blue" quail, have always been viewed as a secondary species among Texas quail hunters and managers, who generally prefer to hunt northern bobwhites (*Colinus virginianus*). Scaled quail and bobwhites are sympatric over much of west Texas, and the 2 species share several habitat characteristics (e.g., similar loafing coverts). In areas where the 2 species are sympatric, they have essentially the same diets. However, scaled quail tend to prefer more open habitats, i.e., less and lower herbaceous cover, than bobwhites. Scaled quail populations have declined precipitously since 1988 across virtually all of their Texas range. Radio-marked scaled quail apparently had higher survival rates than sympatric bobwhites from February to July, 1995 at a study site in Irion County, Texas. Historically, scaled quail do not seem to decline as quickly as bobwhites in dry years, but neither do they increase quite as dramatically as bobwhites during wet years. The effects of common management practices like brush control, supplemental feeding, and predator control have not been investigated adequately for scaled quail. Additional studies conducted with radio telemetry will undoubtedly cause us to reconsider the current paradigms of scaled quail management, as it has recently done with bobwhites.

*Citation*: Rollins, D. 2000. Status, ecology and management of scaled quail in West Texas. Pages 165–172 *in* L.A. Brennan, W.E. Palmer, L.W. Burger, Jr., and T.L. Pruden (eds.). Quail IV: Proceedings of the Fourth National Quail Symposium. Tall Timbers Research Station, Tallahassee, FL.

## INTRODUCTION

Perhaps because of their affinity for seemingly inhospitable habitats, or their propensity to run, rather than freeze in front of bird dogs, quail hunters make various references to scaled, or blue quail in Texas; most of which contain "wild ol' blues" and selected expletives. Scaled quail have been the subject of significant biological investigations over the last 50 years, including Wallmo (1957), Schemnitz (1961), Campbell et al. (1973), and Rollins (1980).

Scaled quail are sympatric with northern bobwhites over much of west Texas, specifically that area between the 100$^{th}$ meridian and the Pecos River. In southwestern Oklahoma, scaled quail and bobwhites had essentially identical diets (Rollins 1981) and shared common endoparasites (Rollins 1980). There tends to be some habitat segregation, with scaled quail preferring the more shallow sites with less herbaceous cover while bobwhites typically prefer sites with more brush cover (Schemnitz 1964). However, coveys of scaled quail and bobwhites can be commonly found in the same microhabitats.

Scaled quail numbers in Texas have declined over the last 30 years and especially since the late-1980's (Sauer et al. 1997) (Figure 1). Evidence suggests that populations are also declining range-wide (Church et al. 1993, Schemnitz 1993). They have virtually disappeared from my home county (Harmon) in southwestern Oklahoma since 1988. During the 1970's and early 1980's, scaled quail often comprised 50% or more of the quail population in that area (Jackson 1947, Rollins 1980), and during very dry years (e.g., 1984) perhaps 90% of the quail population. However, scaled quail numbers waned in 1988–1989 and have failed to recover since that time in southwestern Oklahoma and over much of northwest Texas. Most of these areas have maintained only relict populations (if any) since 1992.

Many biologists dismiss this decrease to "normal fluctuations" characteristic of irruptive quail populations in semiarid regions. However, bobwhite populations in west Texas, which also crashed in 1988, rebounded in 1991–1992, and have exhibited their "typical" irruptive population growth since that time (Sauer et al. 1997). Biologists have evaluated several theories for irruptive quail populations, including weather patterns (Jackson 1962, Campbell et al. 1973, Giuliano and Lutz 1993), vitamin A (Lehmann 1953), phytoestrogens (Cain et al. 1987), water deprivation (Koerth and Guthery 1991) and habitat change (Schemnitz 1993).

I have been intrigued by scaled quail for the last 25 years as both a hunter and a quail manager. This paper reflects observations on scaled quail management based mostly on my experiences in the Rolling Plains, Edwards Plateau and Trans-Pecos ecoregions of Texas. My objective here is to offer alternative hypotheses to why scaled quail have decreased and remained at low levels over most of their range in Texas. I integrate survey information from Texas Parks and Wildlife Department (TPWD) personnel and Breeding Bird Survey (BBS) data with my personal observations and experience.

## BACKGROUND

Scaled quail occur over the western one-third of Texas, essentially west of the 100th meridian. Addi-

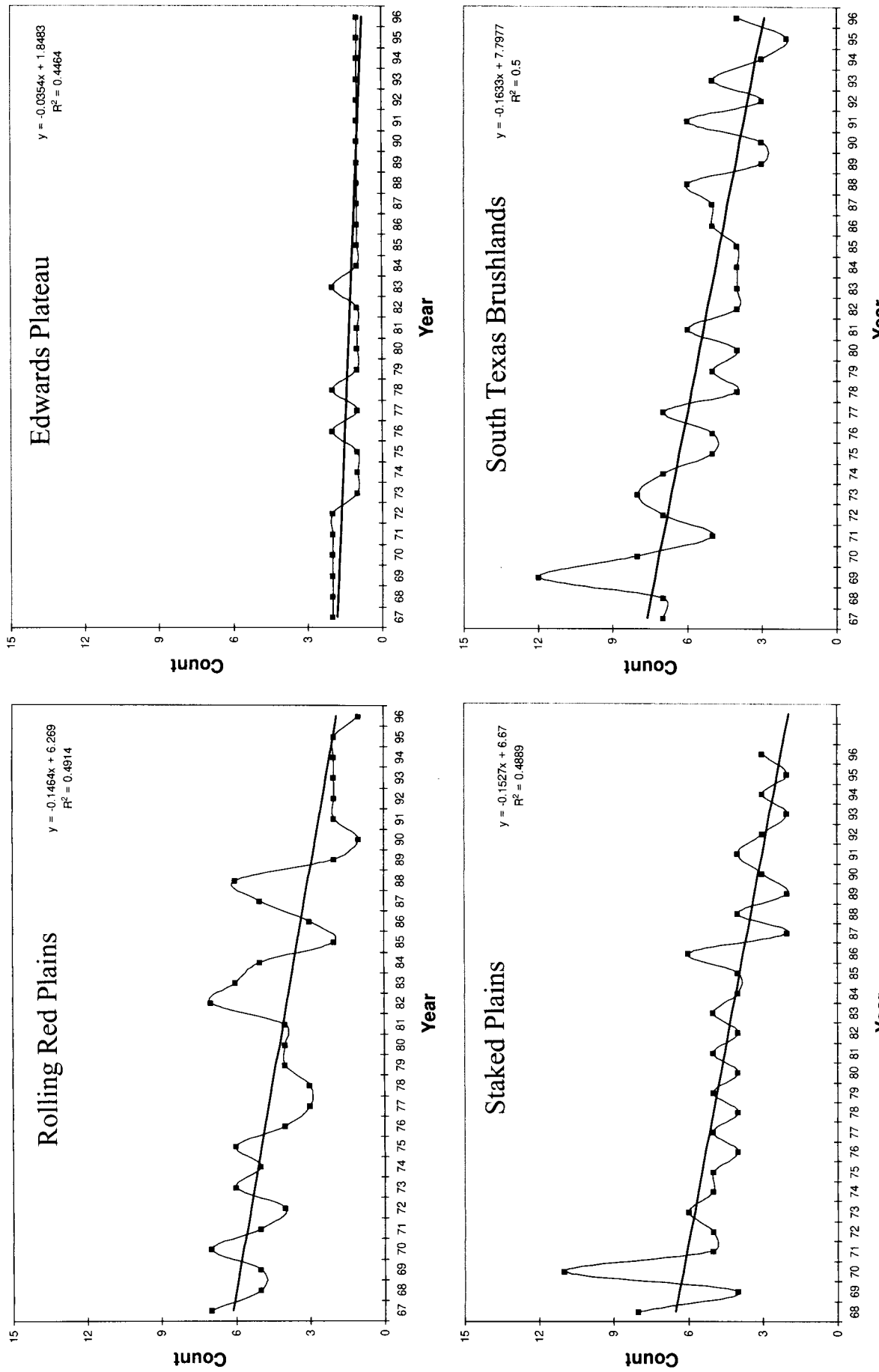


Fig. 1. Population trend of scaled quail in various regions of Texas as estimated by Breeding Bird Surveys, 1967–1996 (Sauer et al. 1997).

tionally, they occur in portions of western Oklahoma, southwestern Kansas, southeastern Colorado, most of New Mexico, southeastern Arizona and much of northeastern Mexico. In south Texas, scaled quail typically occur northwest of a line from Beeville to Hebronville to Zapata. These areas are within the Rolling Plains, Edwards Plateau, High Plains, Trans Pecos and Rio Grande Plains ecoregions. Annual precipitation ranges from about 600 mm along the eastern edge to about 250 mm in portions of the Trans Pecos. Vegetation varies from brush-infested prairie to hot desert scrub. Woody plants often associated with scaled quail range include honey mesquite (*Prosopis glandulosa*), lotebush (*Ziziphus obtusifolia*), and netleaf hackberry (*Celtis reticulata*). Dominant grasses in such areas include gramas (*Bouteloua* spp.), threeawns (*Aristida* spp.), and some bluestems (*Schizachyrium, Bothriochloa*) along the eastern periphery. Prickly pear (*Opuntia* spp.) and other cacti are common.

Scaled quail populations in the Rolling Plains and Edwards Plateau experienced a sudden, and inexplicable, decline during the winter of 1988–89. The weather during that time was not unusually cold or dry, and scaled quail experienced an above average production in 1987. During a hunt in Crockett County (Edwards Plateau) on 8 December 1988, I inspected 12 scaled quail, 4 of which had abnormal livers characterized by yellow nodules. After photographing the livers in the field, I dismissed the incident and discarded the affected birds. It was not until 3 weeks later during a hunt in southwestern Oklahoma (Harmon County) that I sensed that the quail populations (bobwhite and scaled quail) that were present in mid-November had virtually disappeared. Over the next several months, I queried other hunters and ranchers in the Rolling Plains and heard of similar experiences. One rancher who typically fed over 100 scaled quail in northern Harmon County, Oklahoma said the scaled quail numbers tapered off sometime during the winter. He found several dead birds and said they exhibited signs of diarrhea (e.g., stained vents), but did not submit any specimens for examination. Another rancher in Bailey County (about 300 km southwest of previous location) related to me that he had observed scaled quail that could be caught by hand in the spring of 1989. He also remarked about evidence of diarrhea, but he dismissed the incident at the time.

## DECLINE OF SCALED QUAIL

During 1993, I polled TPWD biologists, quail managers and selected ranchers to assess the extent of the demise of scaled quail across Texas. Additionally, I used Breeding Bird Survey (BBS) (Sauer et al. 1997) data to assess trends in Texas and throughout the scaled quail's range. According to survey respondents, the demise in scaled quail was most pronounced in the Rolling Plains, High Plains and Edwards Plateau ecoregions. Roadside quail counts conducted by TPWD and reported by Peterson and Perez (*this volume*) and BBS surveys confirmed these observations

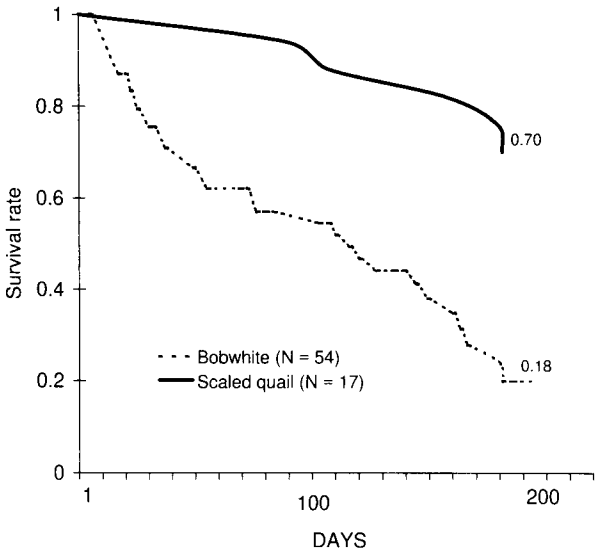


Fig. 2. Fate of radio-marked bobwhite ($N$ = 54) and scaled quail ($N$ = 17) on a sympatric site in Irion County, Texas, January–August, 1994–1995; bobwhite data include both years, but scaled quail monitored only during 1995 (Carter 1995 [bobwhite data]; P.S. Carter, Angelo State University, unpublished data [scaled quail]).

(Figure 1). The Rolling Plains (identified in BBS as Rolling Red Plains) population exhibited "typical" irruptive behavior until 1988, but has remained at a steady, low level since that time. Most respondents from the Trans Pecos or Rio Grande Plains reported that scaled quail had not declined any more than the annual population changes ("boom-bust") inherent in quail populations on semiarid ranges.

The decline of scaled quail relative to bobwhites is perplexing, as scaled quail are typically considered to be the better adapted of the 2 species to west Texas environs (Schemnitz 1964, Lehman 1984). This idea is supported by data from a pilot study on survival of sympatric bobwhite and a small sample ($N$ = 17) of scaled quail (Carter 1995; P.S. Carter, Angelo State University, unpublished data) (Figure 2). Speculation about the decline of scaled quail, their failure to repopulate former range since that time, and their apparent replacement by bobwhites in some areas (e.g., Staked Plains; Sauer et al. 1997) suggests that several factors may be involved. These may include improving range conditions (i.e., more grass cover), changing land use practices (e.g., Conservation Reserve Program) (Schemnitz 1993), differential response to precipitation patterns (Guiliano and Lutz 1993), brush encroachment (which would favor bobwhites), higher predator populations, and possibly disease.

The importance of disease is usually dismissed as a concern in wild quail management. However, I speculate the decline of scaled quail in northwest Texas may have been related to epizootic disease in or about November 1988. My theory is based upon the anecdotal observations and circumstantial evidence mentioned earlier. Unfortunately, sick, dying or dead quail are rarely witnessed or reported. The symptoms observed (spotted livers, diarrhea) are consistent with

"quail disease" (ulcerative enteritis) which is caused by a *Clostridium* bacterium (Davidson and Nettles 1988) or "quail bronchitis" (an avian adenovirus; Davidson et al. (1982). While ulcerative enteritis is a serious concern for pen-raised quail breeders, it has never been reported among wild quail (Davidson et al. 1982). Neither ulcerative enteritis nor quail bronchitis have been reported for scaled quail. Wallmo (1957) reported that 17 of 61 (28%) scaled quail collected from Brewster County in 1953 had enlarged livers with nodules; these birds were diagnosed with tuberculosis. Avian malaria (Hungerford 1955) and avian pox (Wilson and Crawford 1988) have been reported for scaled quail in Arizona and south Texas, respectively, but neither disease is considered an important mortality factor for scaled quail.

The decline of scaled quail and my theory of an undocumented disease are confounded with the inception of the Conservation Reserve Program, an apparently burgeoning predator population, brush encroachment and perhaps other unknown factors. My contention is that disease may have decimated the population in or about 1988, and high levels of nest predation (Slater 1996, Tolleson et al. *this volume*) have kept the population depressed since then. Krebs (1996) described the "predator-pit" hypothesis that suggests predators were capable of suppressing fecund prey species when prey populations were at low densities. I speculate that scaled quail may be mired in a similar predator-pit. Under such conditions, a quail population can decline quite rapidly (Jackson 1947) and undergo numerous local extinctions.

## SCALED QUAIL VERSUS BOBWHITE MANAGEMENT

Attributes of scaled quail and bobwhite life history are summarized in Table 1. The sympatric range of bobwhites and scaled quail tends to change over time along an east-west gradient. Generally, it is believed that scaled quail tend to expand eastward during prolonged droughts, and that bobwhites move westward in a series of wetter years. BBS data suggest that bobwhites are indeed spreading westward and the western periphery of the bobwhite's range is one of the few populations showing an increase in recent years (e.g., Staked Plains; Sauer et al. 1997). In September 1995, I observed 3 coveys of bobwhites about 50 km south of Ft. Sumner, New Mexico. This area is some 150 km west of where I expected to find them. All coveys were flushed in the floodplain of the Pecos River in habitat similar to that found along the Canadian River in the Texas panhandle. In January 1989, I flushed a covey of bobwhites north of Ft. Stockton, Pecos County, Texas, an area where locals indicated that they had never seen bobwhites prior to that time.

Scaled quail tend to maintain their populations in prolonged drought better than the more mesic bobwhites (Schemnitz 1964). Conversely, scaled quail typically are not as productive as bobwhites under more "normal" precipitation conditions. As a result, scaled quail populations tend not to decline as quickly as bobwhites do during dry years, but neither do they increase as quickly as bobwhites during wet years. Bobwhite hens have been documented to produce multiple broods (Burger et al. 1995, Peoples et al. 1996). Double-brooding was documented in the small sample of scaled quail radio-marked in Irion County during 1995 (P.S. Carter, Angelo State University, unpublished data). Two instances of a female laying a clutch of eggs then leaving the male to incubate the eggs were recorded.

Mixed coveys of bobwhites and scaled quail are uncommon, but they do occur (Schemnitz 1961, Rollins 1980). Hybridization between the 2 species occurs occasionally (McCabe 1954, Sutton 1963, Webb and Tyler 1988), and the resulting offspring are true (i.e., sterile) hybrids (Shupe 1990).

During Carter's (1995) study on bobwhite survival in Irion County, Texas, 17 scaled quail were radio-marked with neck-loop transmitters (Wildlife Materials Inc., Carbondale, IL). Seventeen of these birds were monitored concurrently with a larger sample of northern bobwhites ($N$ = 54) at a sympatric site in Irion County, TX. Because of the small sample size of scaled quail, no statistical analyses of survival data were calculated, but scaled quail survival during the 1995 breeding season appeared higher than bobwhites on the same site (Figure 2).

## MANAGEMENT STRATEGIES

### Brush management

The proper distribution and density of woody plants is just as critical to scaled quail as it is to bobwhites, albeit scaled quail may need less brush overall than do bobwhites. The availability of suitable loafing coverts is one of the first things I look for in evaluating habitat conditions for quail in west Texas. Suitable loafing sites are provided by some mesquites, larger lotebushes, sandplum (*Prunus angustifolia*), agarito (*Mahonia trifoliolata*) and other similarly shaped shrubs. On the High Plains, scaled quail use cholla (*Opuntia imbricata*) as loafing cover (Stormer 1981). Scaled quail readily use artificial coverts like half-cut mesquite trees (Rollins 1997), "teepee" brush shelters, and even abandoned farm machinery for loafing sites (Schemnitz 1961).

When contemplating brush management, managers should learn to recognize the structure of places that support high densities of quail and seek to maintain the integrity of such sites. Maintain at least 1 loafing covert per 20 ha, and preferably up to 3 per ha. Exactly how much brush to leave untreated has not been determined, but leaving at least 10 percent of the brush intact should be a minimum goal. Whether such brush strips cause nesting habitat to be more or less fragmented and vulnerable to nest predators needs to be determined. Mechanical control methods are generally preferred over chemical methods because of the forbs stimulated by soil disturbance. Mechanical con-

Table 1. A comparison of selected characteristics for blue and bobwhite quail in Texas.

| Characteristic | Bobwhite | Scaled quail | References |
|---|---|---|---|
| Mass | 160–170 g | 175–190 g | Rollins (1980) |
| Diet | Seeds of forbs, grasses and woody plants; insects and greens seasonally important. | Diets essentially the same as bobwhites when the 2 species occupy same habitats. | Schemnitz (1964) Rollins (1981) |
| Home range (ha) | 8–20 | 10–30 (Oklahoma) 40–180 (West Texas) | Schemnitz (1961) Wallmo (1957) |
| Foraging behavior | Usually limited to within 20–50 m of woody cover. | More likely to feed further from woody cover. | Rollins (1980) |
| Topography | Most dense along drainages. | Prefer more open hillsides or shallow sites on lowlands. | Schemnitz (1964) |
| Habitat preferences | Open to moderately dense stands of grasses with interspersed woody | Similar woody overstories, but usually occur in less dense understories. | Rollins (1980) Campbell-Kissock et al. (1984) |
| Fecundity | Multiple-brooding documented; perhaps up to 3 broods by some hens. | Multiple-brooding documented but frequency unknown. | Peoples et al. 1996, P.S. Carter (unpublished data) |
| Nest sites | Bunchgrasses usually, but will use woody cover or cactus if grass is limited. | More variable, including abandoned farm machinery, prickly pear. | Schemnitz (1964) Lehmann (1984:78), Carter 1995 |
| Vulnerability to hunting | "more vulnerable" | "less vulnerable" | Ask any hunter! |
| Vulnerability to predators | "more vulnerable" | "less vulnerable" | Jackson (1947), P.S. Carter (unpublished data) |
| Endoparasite loads | higher cecal worm densities | lower cecal worm densities | Rollins (1980), Gruver (1984) |
| Reproductive strategies | "boom and bust" relative to environmental stimuli (rain) | neither bust as badly nor boom as wildly as bobwhites | Jackson (1947) Campbell et al. (1973) |

trol also offers greater selectivity about which individual plants are killed. However, new technology incorporating "Individual Plant Treatments" (McGinty and Ueckert 1995) with herbicides also afford high selectivity.

Recent studies west of San Angelo (Carter 1995) suggest that prickly pear may provide important nesting habitat for scaled quail, especially during drought conditions where suitable herbaceous nesting cover is limited. Twelve of 21 bobwhite nests and 8 of 12 scaled quail nests were located in prickly pear clumps. Carter (1995) hypothesized that prickly pear provided some mechanical protection against nest predation. Subsequent studies conducted during 1995–96 confirmed that nests situated in prickly pear exhibited higher survival rates than nests placed in bunchgrasses on sites with <760 potential grass nest sites per ha (Slater 1996). Prickly pear is often targeted for control with a combination of fire and picloram (Ueckert et al. 1988), a treatment which provides > 95% control. Additional research is needed to further clarify the relationship between prickly pear and quail nest success.

## Grazing Management

An observant quail hunter can look at the condition of a pasture (i.e., grass height and structure) and predict whether the pasture harbors scaled quail, bobwhites or both. This relationship suggests that grazing pressure and sward height/structure affect the relative habitat suitability for scaled quail versus bobwhites. Scaled quail tend to avoid areas that inhibit their ability to run from danger or perceived threats (Wallmo 1957, Lehman 1984, Schemnitz 1994).

Given that scaled quail tend to prefer more open (i.e., more heavily grazed) sites than bobwhites, it would seem that heavy continuous stocking would provide better scaled quail habitat. However, there is little consensus in the literature about which grazing methods are best for scaled quail management (Ligon 1937, Wallmo 1957, Campbell et al. 1973, Brown 1978, Campbell-Kissock et al. 1984). Campbell-Kissock et al. (1984) found higher densities of scaled quail on areas under a short duration grazing system than on a continuously grazed site in the western Rio Grande Plains. As one goes from east to west, range condition should be higher for the best scaled quail habitat just as Rice et al. (1993) suggested for bobwhites in the Rio Grande Plains. I suggest moderate (15 ha animal-unit$^{-1}$) to light (>30 ha animal-unit$^{-1}$) stocking rates as one goes from east to west, respectively.

The abundance of scaled quail relative to bobwhites shifted dramatically from 1969–1973 at the Chaparral Wildlife Management Area near Cotulla, purportedly due to improved range conditions brought about by implementing a rotational grazing scheme (D. Synatzke, Texas Parks and Wildlife Department, personal communication). The ratio of scaled quail to bobwhites shifted from roughly 60:40 in 1969 to 5:95 in 1980, and has remained similar since then. Several other biologists from the Rio Grande Plain of Texas suggested that improved range conditions (i.e., more grass) provide some adaptive advantage to bobwhites. Bare ground, which is sometimes cited as a management concern for bobwhites in the southeastern half of Texas (Guthery 1986), is rarely a management concern for scaled quail in west Texas.

### Food Management

Historically, quail managers spend much of their efforts trying to increase food availability. Scaled quail diets are dominated by seeds of forbs and woody plants, with mast and fruits (e.g., tasajillo [*Opuntia leptocaulis*]), greens and insects seasonally important (Wallmo 1957, Rollins 1980, Burd 1989, Ault and Stormer 1983).

Soil disturbance caused by mechanical brush control, winter disking, and livestock grazing stimulates most of the early successional species that provide the bulk of the diet for scaled quail and bobwhites. Strip disking should be conducted during Dec–Feb in proximity to suitable woody cover for foods to be available to quail. Seeds of woody plants like mesquite, catclaw (*Acacia* spp.), hackberry (*Celtis* spp.) and chittam (*Bumelia lanuginosa*) are seasonally important foods, as are seeds of various cacti, including prickly pear and tasajillo. Larger trees of these species should be maintained during brush control operations.

Food plots are one of the most popular options for active habitat management with bobwhites. However, west of the 98th meridian, arid conditions usually limit the dependability and production of food plots. I have come to the conclusion that "*when you need food plots, you can't grow them, and when you can grow them, you probably don't need them.*" However, scaled quail readily use various sorghums, wheat and other agricultural crops where they occur. I have observed scaled quail feeding over 75 m from brush cover in wheat fields during the early fall (Rollins 1980). The greatest value of food plots in semiarid regions may be the (a) weeds associated with soil disturbance or (b) insects attracted to the food plots.

Supplemental feeding is another popular practice, but one that rarely results in production of any more quail than areas without feeders. No research has been conducted to evaluate the effects of supplemental feeding on scaled quail in Texas. Campbell (1959) speculated that supplemental feeding was ineffective, but his study was confounded with availability of water. Scaled quail readily use quail feeders, and hence become more available to hunters. I have photographed scaled quail with chicks <3 weeks old at feeders in Irion County. They also frequent deer feeders ("sling feeders" that broadcast corn) during the fall months. I have documented scaled quail during winter months feeding at free-choice deer feeders stocked with protein pellets. Quail management dogma maintains that supplemental feeding should be discouraged, as it may increase the incidence of predation, parasitism or disease. However such ideas have not been thoroughly tested on bobwhites or scaled quail in semiarid regions.

### Water Development

While scaled quail will drink if surface water is available, there is no evidence that providing supplemental water benefits scaled quail populations (Wallmo 1957). Wallmo and Uzell (1958) summarized their efforts at enhancing scaled quail range with guzzlers and concluded "there in no correlation between water availability and population size." It appears that scaled quail are capable of meeting their water requirement from preformed water (e.g., dew) or metabolizable water contained in their foods (insects, greens, etc.).

### Predator Control

Like livestock grazing recommendations, opinions often differ about the efficacy of predator control for enhancing quail populations (Hurst et al. 1996). Jackson (1947) suggested that scaled quail were less vulnerable to raptor predation than bobwhites in the Rolling Plains. Scaled quail appeared to be less vulnerable to predation (mostly mammal-related) in a study near San Angelo (P.S. Carter, Angelo State University, unpublished data).

If predator control is to be effective, it will most likely be related to a decreased incidence of nest predation. Beasom (1974) found that an intensive predator control program resulted in a moderate increase of bobwhites in the eastern Rio Grande Plains. However, Guthery and Beasom (1977) conducted a similar study in the western Rio Grande Plains and observed no difference in scaled quail population trends and abundance. Hernandez (1995) conducted a preliminary test on the use of lithium chloride for providing a conditioned taste aversion (CTA) of eggs to nest predators in west Texas. His results were equivocal; 1 site exhibited a higher nest survival following CTA trials, but the other did not.

During May–July 1996, I used cage traps to remove potential nest predators (e.g., raccoons [*Procyon lotor*]) for a 28-day period just prior to nest initiation (i.e., May) in Sterling County, Texas. Following the trapping regime, a total of 96 simulated quail nests (48 each in a trapped vs. untrapped site) were monitored weekly for 28 days. Nest success was 277% higher in the trapped site ($\bar{x}$ = 36%) than untrapped sites ($\bar{x}$ = 13%). This pilot study suggests that "prescribed" trapping of mesomammals should be evaluated further as a management practice. While not normally considered effective, today's more fragmented landscape and other factors may affect the viability of predator control for increasing quail populations (Guthery 1995).

## RESEARCH NEEDS

What is known of reproductive ecology for scaled quail should be labeled with the footnote "B.T.," i.e., "before telemetry." When one looks at many of the recent discoveries into bobwhite behavior and reproductive ecology (e.g., multiple brooding) that were considered heretical not too many years ago, one should be cautious when interpreting existing information about scaled quail reproductive ecology. Future studies are needed to identify, and hopefully rectify, the agents responsible for the decline of scaled quail over the last 15 years. The relationships between sympatric bobwhite and scaled quail, especially along the western periphery of sympatry, need further investigation. The potential interactions of disease and nest

predation as a suppressing agent for scaled quail populations warrant additional study. The role of predation in avian recruitment has received renewed interest in recent years (e.g., Hurst et al. 1996) and studies to evaluate the efficacy of "prescribed" mesomammal control to enhance nesting success are warranted. Finally, the assumption that diseases are unimportant in free-ranging quail may need to be revisited.

## ACKNOWLEDGMENTS

I thank P.S. Carter for his assistance with the telemetry field work and to J. Funk for access to the Irion County study site. J. Trail conducted the intensive trapping pilot effort in Sterling County. F. Hernandez, G.T. Miller, S.C. Slater and M. Peterson provided timely review comments during preparation of the manuscript. The late S.L. Beasom reinforced my appreciation of scaled quail on numerous occasions.

## LITERATURE CITED

Ault, S.C., and F.A. Stormer. 1983. Seasonal food selection by scaled quail in northwest Texas. Journal of Wildlife Management 47:222–228.

Beasom, S.L. 1974. Intensive short-term predator removal as a game management tool. Transactions of the North American Wildlife and Natural Resources Conference 29:230–240.

Burger, L.W., Jr., M.R. Ryan, T.V. Dailey, and E.W. Kurzejeski. 1995. Reproductive strategies, success, and mating systems of northern bobwhite in Missouri. Journal of Wildlife Management 59:417–426.

Brown, D.E. 1978. Grazing, grassland cover, and game birds. Transactions of the North American Wildlife and Natural Resources Conference 43:477–485.

Burd, J. 1989. Foods of scaled quail during prebreeding and breeding in northwest Texas. Thesis. Texas Tech University, Lubbock.

Cain, J.R., R.J. Lien, and S.L. Beasom. 1987. Phytoestrogen effects on reproductive performance of scaled quail. Journal of Wildlife Management 51:198–201.

Campbell, H. 1959. Experimental feeding of wild quail in New Mexico. Southwestern Naturalist 4:169–175.

Campbell, H., D.K. Martin, P.E. Ferkovich, and B.K. Harris. 1973. Effects of hunting and some other environmental factors on scaled quail in New Mexico. Wildlife Monograph 34.

Campbell-Kissock, L., L.H. Blankenship, and L.D. White. 1984. Grazing management impacts on quail during drought in the northern Rio Grande Plain, Texas. Journal of Range Management 37:442–446.

Carter, P.S. 1995. Post-burn ecology of northern bobwhites in west Texas. Thesis. Angelo State University, San Angelo, Texas.

Church, K.E., J.R. Sauer, and S. Droege. 1993. Population trends of quails in North America. National Quail Symposium Proceedings 3:44–54.

Davidson, W.R., F.E. Kellogg, and G.L. Doster. 1982. An overview of disease and parasitism in southeastern bobwhite quail. National Bobwhite Quail Symposium Proceedings 2: 57–63.

Davidson, W.R., and V.F. Nettles. 1988. Field manual of wildlife diseases in the southeastern United States. Southeastern Cooperative Wildlife Disease Study, University of Georgia, Athens.

Giuliano, W.M., and R.S. Lutz. 1993. Quail and rain: what's the relationship? National Quail Symposium Proceedings 3:64–68.

Gruver, B.J. 1984. Management and live-brush density effects on avifauna in northwest Texas. Dissertation. Texas Tech University, Lubbock.

Guthery, F.S. 1986. Beef, brush and bobwhites: quail management in cattle country. Caesar Kleberg Wildlife Research Institute. Texas A&I University, Kingsville.

Guthery, F.S. 1995. Coyotes and upland gamebirds. Pages 104–107 *in* D. Rollins et al. (eds.). Coyotes in the Southwest. Texas Parks & Wildlife Department, Austin.

Guthery, F.S., and S.L. Beasom. 1977. Responses of game and nongame wildlife to predator control in south Texas. Journal of Range Management 30:404–409.

Hernandez, F. 1995. Characterizing the modus operandi of various nest predators with an evaluation of conditioned taste aversion to deter nest predators. Thesis. Angelo State University, San Angelo, Texas.

Hungerford, C.R. 1955. A preliminary evaluation of quail malaria in southern Arizona in relation to habitat and quail mortality. Transactions of the North American Wildlife and Natural Resources Conference 20:209–219.

Hurst, G.A., L.W. Burger, and B.D. Leopold. 1996. Predation and galliforme recruitment: an old issue revisited. Transactions of the North American Wildlife and Natural Resources Conference 61:62–76.

Jackson, A.S. 1947. A bobwhite quail irruption in northwest Texas lower plains terminated by predation. Transactions of the North American Wildlife and Natural Resources Conference 12:511–519.

Jackson, A.S. 1962. A pattern to population oscillations of the bobwhite quail in the lower plains grazing ranges of northwest Texas. Proceedings Southeastern Association Game and Fish Commissioners 16:120–126.

Koerth, N.E., and F.S. Guthery. 1991. Water restriction effects on northern bobwhite reproduction. Journal of Wildlife Management 55:132–137.

Krebs, C.J. 1996. Population cycles revisited. Journal of Mammalogy 77:8–24.

Lehman, V.W. 1953. Bobwhite population fluctuations and vitamin A. Transactions of the North American Wildlife and Natural Resources Conference 18:199–246.

Lehman, V.W. 1984. Bobwhites in the Rio Grande Plains of Texas. Texas A&M University Press, College Station.

Ligon, J.S. 1937. Tragedy of upland game birds throughout the west and southwest. Transactions of the North American Wildlife and Natural Resources Conference 2:476–480.

McCabe, R.A. 1954. Hybridization between the bobwhite and scaled quail. Auk 71:294–297.

McGinty, A., and D.N. Ueckert. 1995. Brush busters: how to beat mesquite. Texas Agricultural Extension Service and Texas Agricultural Experiment Station Leaflet L-5144. College Station.

Peoples, A.D., S.T. Demaso, S.A. Cox, and E.S. Parry. 1996. Bobwhite reproductive strategies in western Oklahoma. Pages 1–6 *in* W.E. Cohen (ed.). Proceedings Texas Quail Shortcourse II. Texas Agricultural Extension Service, Corpus Christi.

Rice, S.M., F.S. Guthery, G.S. Spears, S.J. Demaso, and B.H. Koerth. 1993. A precipitation-based model for northern bobwhites on semiarid rangelands. Journal of Wildlife Management 57:92–102.

Rollins, D. 1980. Comparative ecology of bobwhite and scaled quail in mesquite grassland habitats. Thesis. Oklahoma State University, Stillwater.

Rollins, D. 1981. Diets of sympatric bobwhite and scaled quail in southwestern Oklahoma. Proceedings Southeastern Association Fish and Wildlife Agencies 35:239–249.

Rollins, D. 1997. Half-cutting mesquite trees to enhance loafing cover for quail. Page 149 *in* D. Rollins, D.N. Ueckert, and C.G. Brown (eds.). Brush Sculptors symposium. Texas Agricultural Extension Service, San Angelo.

Sauer, J.R., J.E. Hines, G. Gough, I. Thomas, and B.G. Peterjohn. 1997. The North American Breeding Bird Survey Re-

sults and Analysis. Version 96.2. Patuxent Wildlife Research Center, Laurel, MD.

Schemnitz, S.D. 1961. Ecology of the scaled quail in the Oklahoma Panhandle. Wildlife Monograph 8.

Schemnitz, S.D. 1964. Comparative ecology of bobwhite and scaled quail in the Oklahoma Panhandle. American Midland Naturalist 71:429–433.

Schemnitz, S.D. 1993. Scaled quail habitats revisited—Oklahoma panhandle. National Quail Symposium Proceedings 3:143–147.

Schemnitz, S.D. 1994. Scaled quail (*Callipepla squamata*). *In* The Birds of North America, No. 106 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Shupe, T.E. 1990. Frequency of northern bobwhite x scaled quail hybridization. Wilson Bulletin 102:352–353.

Slater, S.C. 1996. An evaluation of pricklypear (*Opuntia* spp.) as a predator deterrent in nest site selection by northern bobwhite (*Colinus virginianus*). Thesis. Angelo State University, San Angelo, Texas.

Stormer, F.A. 1981. Characteristics of scaled quail loafing coverts in northwest Texas. Research Note RM-395, U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Sutton, G.M. 1963. Interbreeding in the wild of the bobwhite and scaled quail in Stonewall County, northwestern Texas. Southwestern Naturalist 8:108–11.

Ueckert, D.N., J.L. Peterson, R.L. Potter, J.D. Whipple, and M.W. Wagner. 1988. Managing prickly pear with herbicides and fire. Pages 10–15 *in* Research Reports, sheep and goat, wool and mohair, 1988. Texas Agricultural Experiment Station Consolidated Progress Report 4565–4591.

Wallmo, O.C. 1957. Ecology of scaled quail in west Texas. PhD Dissertation, Texas A&M University, College Station.

Wallmo, O.C., and P.B. Uzell. 1958. Ecological and social problems in quail management in west Texas. Transactions of the North American Wildlife and Natural Resources Conference 23:320–327.

Webb, W.D., and J.D. Tyler. 1988. Hybridization of northern bobwhites and scaled quail in Oklahoma and Texas. Bulletin Oklahoma Ornithological Society 21:3–5.

Wilson, M.H., and J.A. Crawford. 1988. Poxvirus in scaled quail and poxvirus-like lesions in northern bobwhites and scaled quail from Texas. Journal of Wildlife Diseases 24:360–363.