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Providing supplemental feed and water are sometimes used to manage scaled quail (*Callipepla squamata*) in the Chihuahuan Desert even though their biological and economical efficacies are questionable. Seasonal visitation rates of scaled quail and various nontarget species are important parameters affecting the efficacy of feeding and watering practices. However, empirical data on visitation by scaled quail at feeders and guzzlers are lacking. We used video surveillance to assess species visitation at free-choice quail feeders and guzzlers in south-central New Mexico during 2002. Scaled quail accounted for 19.4 and 21.5% of visitations at feeders and guzzlers, respectively. Mourning doves (*Zenaida macroura*), nongame birds, and desert cottontails (*Sylvilagus audubonni*) were the primary nontarget consumers at this site. Relative to similar studies of feeder visitation by northern bobwhite (*Colinus virginianus*) in west Texas, quail feeders tended to be more efficacious (i.e., a greater proportion of the feeder visitations were by quail) in this study. While the biological impacts of feeders and guzzlers remain poorly documented, their use by scaled quail suggests they are important foci within the birds' home ranges. Video surveillance technology permits managers to make data-based decisions on the biological and economic worth of such management efforts. We also describe novel uses for video surveillance relative to facilitating reconnaissance of radiotagged quail whose radios had malfunctioned. Future research should assess the potential for using video surveillance at guzzlers to estimate chick survival in scaled quail.

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Key words: *Callipepla squamata*, Chihuahuan desert, guzzlers, scaled quail, supplemental feeding, surveillance camera, water developments

Introduction

Few management practices have been evaluated to increase abundance of scaled quail (*Callipepla squamata*), whose biological basis for management has lagged notably behind most other North American quails (Rollins 2000). Supplemental feeding (usually with grain, e.g., milo) is a popular, but unproven, management practice for increasing quail (scaled quail, northern bobwhite [*Colinus virginianus*]) abundance on private lands in Texas (Rollins 2007). Most studies suggest that supplemental feeding is only beneficial when natural food sources have become limited (Campbell 1959, Doerr and Silvy 2002, Demaso et al. 2002) and such bottlenecks relative to food availability have not been documented (Guthery 2002, pg. 149). However, other studies have suggested benefits to quail survival and reproduction. Supplemental feeding of northern bobwhite with milo increased overwinter survival during times of severe winter stress in western Oklahoma (Townsend et al. 1999).

There is relatively little information on the efficacy of supplemental feeding for scaled quail. Campbell (1959) reported a modest increase in bird numbers in southeastern New Mexico, but dismissed the efficacy of supplementation as being cost-prohibitive. However, some private landowners may have the capital at their disposal to accommodate supplementation and can control some

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other factors (e.g., hunting pressure) that cannot be controlled on public land. Rollins (2000) reported frequent visitations of adults and young chicks (< 3 weeks old) to feeders in west Texas, and recommended that supplemental feeding be evaluated as a management tool in west Texas.

Water is another management practice often prescribed for quails in arid habitats. Glading (1947) was the first to describe the concept of "gallinaceous guzzlers" (hereafter guzzlers) that have been used commonly since the 1950s to provide drinking water for wildlife in remote arid landscapes. Water developments have benefited some wildlife populations in arid habitats of the western U.S. (Rosenstock et al. 2004) but also have been criticized as potentially rendering the target species more vulnerable to predators (Broyles 1995). Wallmo and Uzzell (1958) and Campbell (1960) summarized their efforts on enhancing scaled quail range with guzzlers and concluded there was no relationship between water availability and scaled quail abundance.

The advent of commercially-available photographic and video surveillance equipment in the past decade has provided a means for non-intrusive assessment of species visitation at quail feeders (Henson 2006) and guzzlers (Rosenstock et al. 2004). Henson (2006) reported that feeder use by bobwhite and scaled quail ranged from 6-16% seasonally at 4 sites in west Texas. Raccoons (*Procyon lotor*), mourning doves (*Zenaida macroura*), and nongame birds were the most frequent visitors in her study.

We initiated a project in 2002 to assess the value of supplemental feeding for increasing survival and recruitment in south-central New Mexico at a site near the northern edge of scaled quail range. A part of this project involved documenting seasonal use of feeders and guzzlers. We used video surveillance of feeders and guzzlers in order to assess their use by scaled quail and nontarget species.

Study Area

Our study area was the privately-owned Armendaris Ranch located 20 km east of Truth or Consequences, Sierra County, New Mexico (Latitude 33.18 N, Longitude 107.03 W). The ranch encompasses some 125,000 ha; our study was in the southeastern quadrant. Most of the ranch resides at elevations between 1375 and 1525 m, and the mean annual precipitation is 25 cm. The primary vegetation is semidesert grassland dominated by black grama (*Bouteloua eriopoda*) and palmilla (*Yucca elata*). Climate is warm-temperate with an average of 213 frost-free days per year (Truth or Consequences, NM). Bison (*Bison bison*) are the predominant grazing animals; other large herbivores include pronghorn (*Antelocaprus americana*), mule deer (*Odocoileus hemionus*), and free-roaming gemsbok (*Oryx gazella*).

Quail feeders and guzzlers were located across the southern half of the ranch. Feeders were constructed from plastic barrels with approximately 12 small (1.3 cm) holes placed at intervals ranging from 2-15 cm from the bottom of the barrel (Figure 1). These barrel feeders were 'free choice' as feed was available at any time throughout the day. Feeders were filled with milo and available year-round; they had been in use for at least 4 years prior to the onset of our study. Feed disappearance through these feeders during the course of this study was estimated at 68 kg/feeder/month (T. E. Wadell, personal communication).

Guzzlers were of several types but typically consisted of a sheet metal rainfall collector that stored water in a fiberglass reservoir directly beneath it (Figure 2). Entrance to a guzzler was restricted to birds and medium-sized mammals by the size of the entrance and the presence of rebar grill covering the entrance. The guzzler's roof was elevated about 50 cm above ground-level, and thus provided a source of shade as well as access to water. Feeder density in our study area was approximately 1 per 40 ha; density of guzzlers was approximately 1 per 300 ha.

Methods

We used motion-sensing video cameras (TrophyView, Inc., Kerens, TX) to assess visitation at feeders during winter (21 Dec - 20 Mar), spring (21 Mar - 20 Jun), and summer (21 Jun - 20 Sep) begin-

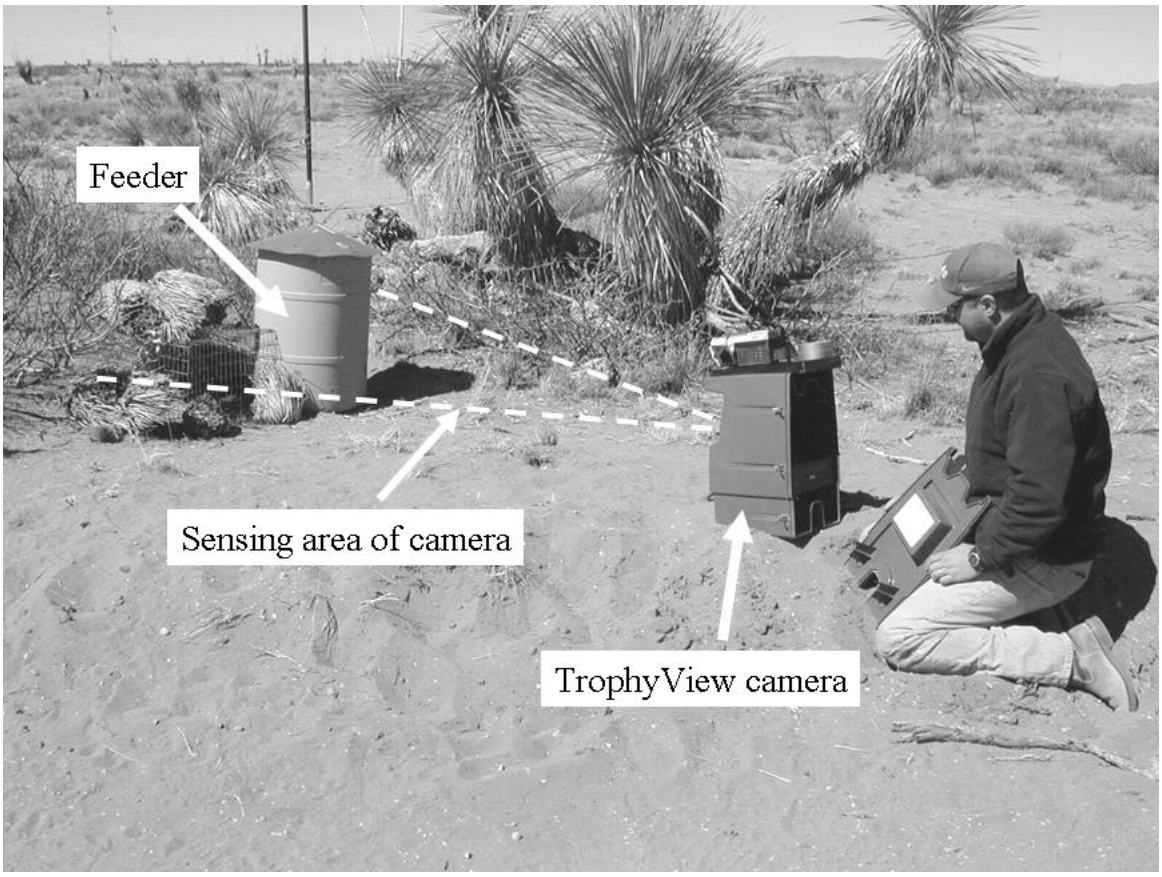

Figure 1: Example of barrel quail feeder used at Armendaris Ranch, Sierra County, New Mexico. TrophyView^{TM}video system is seen in foreground.

ning with winter 2001 and extending through summer 2002, and at guzzlers during spring, and summer seasons in 2002. Two cameras were used and rotated among 4 feeders and 4 guzzlers. These cameras feature a passive-infrared triggering system and provide 24-hour surveillance. Camera systems were placed about 3 m from the feeder or guzzler which provided a horizontal field of view for the camera of approximately 3 m. When triggered, the unit records activity on a VHS videotape. Individual recording events are tagged with date, time, and lunar phase. Recorded tapes were recovered approximately every week and new tapes were inserted. We reviewed videotapes and recorded species, number of individuals, duration at feeder or guzzler (amount of time an individual species spends at feeder or guzzler), time spent actually feeding or watering (as opposed to investigating or shading). A feeding event was recorded if the animal was observed consuming milo. A drinking event was recorded if the animal either walked into the guzzler (and out of site of the camera), or placed its head in the opening of the guzzler. Successive events were not counted as a new event if the same animals returned to the feeder within 30 minutes as a means of ensuring independence among successive observations. Visitation by species was recored by treatment (feeder vs. guzzler) and calculated as a percent of the total number of visitations. We present only descriptive statistics (means and standard errors [SE]) in order to determine 95% confidence intervals. Significant differences were inferred if confidence intervals were non-

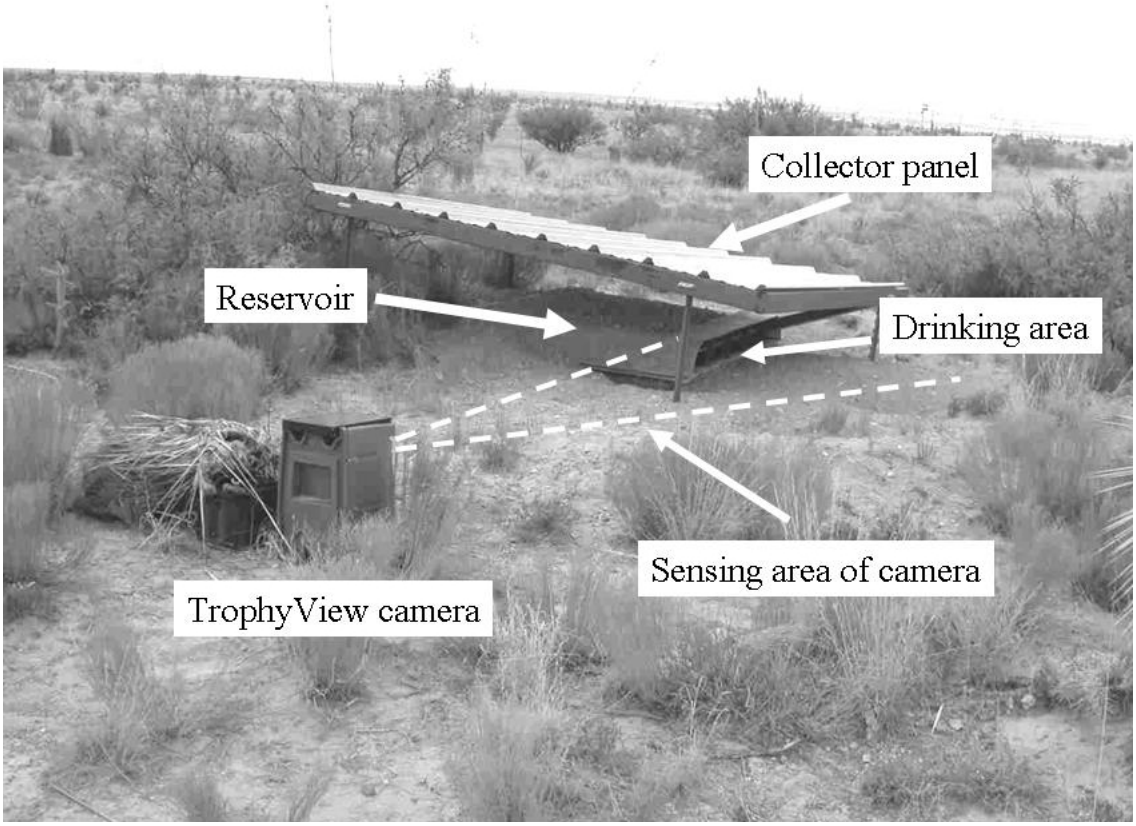

Figure 2: Example of guzzler monitored and placement of TrophyView^{TM}video system, Armendaris Ranch, Sierra County, New Mexico.

overlapping.

Results

We recorded a total of 682 events from a total of 4 feeders and 4 guzzlers that occurred over 150 hours of video surveillance from December 2001-August 2002. We monitored a total of 422 events at feeders and 260 events at guzzlers. Our sample size at guzzlers for winter was only 18 events; these data were not included for subsequent analyses.

Overall, scaled quail represented 19.4% of visitations at feeders and 21.5% of visitations at guzzlers across all seasons (Table 1). Scaled quail comprised a greater proportion of visitations at feeders during winter (43.7%), with less frequent use (i.e., <9%) during spring or summer. The most common species observed at feeders and guzzlers was mourning dove, which accounted for 34.1 and 23.5% of the total visitations, respectively. No mourning doves were recorded in the winter, but they accounted for over half of visitations during spring and summer. Nongame birds accounted for 24.9% and 28.5% of the visitations to feeders and guzzlers, respectively. Feeder visitation by nongame birds was highest during winter. Ravens (*Corvus corax*) were included within nongame birds, and typically accounted for 2-4% of visitations at both feeders and guzzlers. No raptors were videotaped at either feeders or guzzlers. Miscellaneous mammals, which included desert cottontails (*Sylvilagus audubonni*), badger (*Taxidea taxus*), kit fox (*Vulpes macrotis*), bobcat (*Felis rufus*), feral cats, and rodents accounted for 21.6% and 26.5% of visitations at feeders and guzzlers, respectively.

Table 1: Visitations to quail feeders and guzzlers by species as recorded by video surveillance in south-central New Mexico, October-December 2001 and January-August 2002.

Device	Season	Events (*n*)	Scaled quail	Mourning dove	Nongame birds	Misc. mammals
Feeder	Winter	142	62 43.70%	0	53 37.30%	27 19.00%
	Spring	191	17 8.90%	101 52.90%	32 16.80%	41 21.50%
	Summer	89	3 3.40%	43 48.30%	20 22.50%	23 25.80%
	Total	422	82 19.40%	144 34.10%	105 24.90%	91 21.60%
Guzzler	Spring	166	31 18.70%	52 31.30%	44 26.50%	39 23.50%
	Summer	94	25 26.60%	9 9.60%	30 31.90%	30 31.90%
	Total	260	56 21.50%	61 23.50%	74 28.50%	69 26.50%

Scaled quail visitations at feeders and guzzlers averaged 11.2 ± 1.20 min ($x \pm SE$) and 7.6 ± 2.31 min, respectively (Figure 3). Proportion of time spent feeding versus loafing was similar for scaled quail at feeders and guzzlers (34% of time feeding, 65% loafing at feeders; 43% watering, 56% loafing at guzzlers). Scaled quail spent an average of 3.8 ± 0.68 min feeding and 3.3 ± 1.10 min drinking (Figure 3). Mourning dove spent an average of 25.7 ± 4.10 min feeding and 3.8 ± 1.1 min watering. Nongame birds were recorded feeding for an average of 11.1 ± 2.8 min and 1.0 min $\pm$ 0.38 min watering.

Discussion

Supplemental Feeding

Proportion of visitations comprised by scaled quail at feeders and guzzlers suggested that both can be viable tools in scaled quail management in this area. Scaled quail were observed at a greater incidence at feeders in southeastern New Mexico than at feeders in west Texas by northern bobwhite (Henson 2006, <10% of visitations across all seasons were by quail [bobwhite and scaled quail] in this study). Accordingly, we suggest that supplemental feeding programs may reap greater benefits to quail in more arid environments. Female scaled quail at this study site with access to free-choice quail feeders survived at greater rates during the breeding season (Mar-Aug) than where feeders were absent (Rollins et al. 2006); access to guzzlers was available at both sites.

Quail visitation at feeders was greatest during the winter in this study similar to the pattern reported by Henson (2006) for bobwhite in west Texas. If feeder visitation by quail is influenced by seasonal energy needs, then this pattern seems logical and

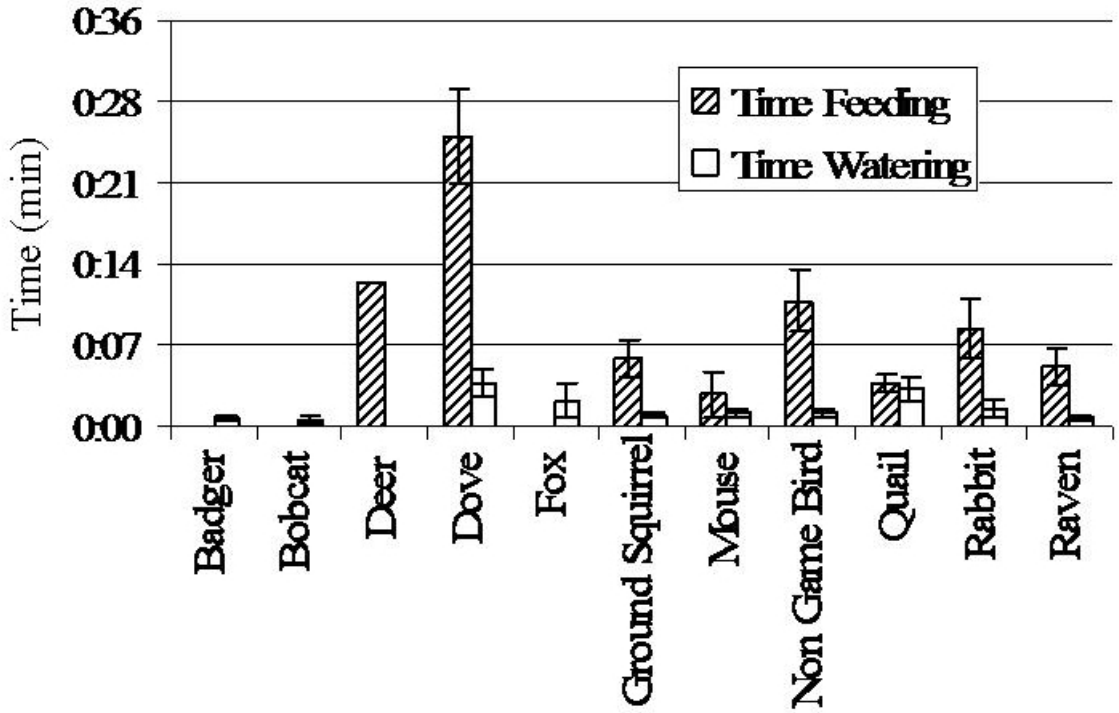

Figure 3: Time spent (minutes) by species at feeders and guzzlers actually feeding or watering in south-central New Mexico.

adaptive. Additional surveillance that includes the fall season, the only season not monitored in our study, is warranted.

The cost of supplemental feeding can be substantial. A conundrum over the efficacy of supplemental feeding of quail remains the issue of what portion of the feed provided is actually consumed by quail as opposed to nontarget species. At the feed disappearance rates estimated on this study site (68 kg/feeder/month), feed costs alone (milo valued at \$0.16/kg) would account for \$10.58/feeder/month. Expenses for labor and travel are not included in these estimates, but would increase feeding costs substantially. Henson (2006) estimated feeding costs at 4 sites in west Texas at approximately \$15/feeder/month for feed costs alone. Raccoons and nongame were responsible for most of the feed lost to nontarget species in her study, and ultimately responsible for inflating the cost of a feeding program at her sites (\$15/feeder/month) relative to this study (\$10.58/feeder/month). Boyer (1989) reported that an additional quail in the bag could cost from \$24 to \$60 in successful feeding programs.

Due to the costs associated with a supplemental feeding program, managers should be concerned with the loss of feed to nontarget species at quail feeders. Mourning doves and nongame birds accounted for the majority (59.0%) of visitations at feeders across all seasons. Nontarget species comprised 98% of visitations at quail feeders at 1 site in the Texas panhandle (Guthery et al. 2004). However, as Henson (2006) noted, feeder visitation rates do not necessarily equal feed consumption. Presumably, a small passerine does not consume as much milo per feeding event as does a scaled quail.

Quail biologists have historically dismissed, or demeaned, feeding programs as ineffective, expensive, and even counterproductive. Feeders do concentrate quail and make their locations on the landscape more predictable for hunting purposes

(Rollins 2000, Guthery et al. 2004). Concerns have been expressed that feeders may render quail more vulnerable to various predators, but recent studies (Guthery et al. 2004, Henson 2006) have failed to document such conjecture. Other management concerns regarding supplemental feeding for quail include direct, e.g., potential exposure to aflatoxins (Oberheu and Dabbert 2001), and indirect impacts (attraction of nest-depredating mesomammals [e.g., raccoons] to feeders; Cooper and Ginnett 2000).

The proportion of feeder visitations comprised by scaled quail at this site was 4-10x greater than Guthery et al. (2004) and Henson (2006) recorded for bobwhites in Texas presumably due to more complex assemblages of nontarget species. Raccoons were the predominate species at quail feeders in the Henson (2006) study, accounting for 30-45% of feeder visitations. Raccoons were not present at our study site, and their absence makes feeders more efficacious for scaled quail, and for quail managers in more arid habitats. Henson (2006) concluded that, while feed loss to some nontarget species (e.g., raccoons) may be ameliorated through technology (e.g., electric fencing) or ingenuity, feed loss to other nontarget species (e.g., mourning doves and nongame birds in this study) should be considered an overhead cost of feeding.

Guzzlers

Scaled quail can meet most of their water needs by consuming succulent foods (Hungerford 1960, Schemnitz 1994, Guthery 1999). However, desert quail require drinking water to survive periods of sustained heat and drought (Leopold 1977, pg. 183). Desert quail (*Callipepla* spp., *Oreortyx picta*) frequently drink from catchments, particularly during hot and dry periods (Elder 1956) and show strong fidelity to guzzlers within their home range (Delehanty et al. 2004).

We monitored use of guzzlers during the spring and summer seasons which Rosenstock et al. (2004) identified as the period of peak use of water developments by Gambel's quail and mourning doves in Arizona. Campbell (1960) suggested that water developments were most beneficial for scaled quail in areas characterized by drought during the spring-summer breeding season. Our study area was mired in drought for the duration of the study–annual precipitation in 2001 and 2002 was only 53% and 44% of the long-term means, respectively (Western Regional Climate Center 2003). Above normal temperatures prevailed during this time (e.g., June 2002 had the highest mean monthly temperature on record). Accordingly, our estimates of guzzler use may represent maximum levels. Additional surveillance is warranted to determine guzzler use in cooler, wetter summers and during fall and winter seasons.

Four potentially adverse impacts of water developments in arid habitats are commonly cited: predation, competition, direct mortality, and health problems resulting from poor water quality or disease transmission (Rosenstock et al. 1999). We gathered data during this study that addressed 2 of these concerns (predation and direct mortality).

There is evidence that water developments attract avian and mammalian predators (Cutler 1996, Rosenstock et al. 1999, 2004); however, the effects of these facilities on predator populations and subsequently on scaled quail are unknown. Rosenstock et al. (2004) recorded 4 species of raptors at water developments in Arizona that have been identified as predators of quail (Cooper's hawk [*Accipiter cooperii*], sharp-shinned hawk [*A. striatus*], red-tailed hawk [*Buteo jamaicensis*], and great-horned owl [*Bubo virginianus*]; Rollins and Carroll 2001). However, aside from ravens (a potential egg predator of scaled quail) we did not detect raptors using guzzlers at our site.

The guzzlers used in our study were (by design) fairly specific as to which species could access them, which was documented with low visitations by many nontarget species. The size of the opening on the guzzlers (about 20 cm in height) in our study, and the rebar grill along the opening, precluded larger species of nontarget animals (e.g., mule deer). Guzzlers that feature open drinkers (e.g., like those monitored by Rosenstock et al. 2004), make drinking water available to a wide range of animals-mule

deer, turkey vulture (*Cathartes aura*), and coyote constituted the majority of visits to guzzlers. Thus, guzzlers can be successfully designed to limit nontarget use if such is desired (as it was at this study site). Water facilities that facilitate exotic species (in our case free-ranging oryx) should be discouraged (Burkett and Thompson 1994).

We did not detect any direct mortalities (i.e., drowning) in the guzzlers we monitored. Mortalities of birds and small mammals in livestock troughs and other water facilities have been reported (Schemnitz et al. 1998). Rollins et al. (2006) reported that 3 radiotagged scaled quail drowned in the same water trough at the Elephant Mountain Wildlife Management Area in west Texas. The design of the guzzlers used at our site precluded animals from falling into a trough and subsequently drowning, i.e., access to water is on a sloping gradient.

Providing supplemental watering points has been a popular management technique over the past 40 years on many public lands in the American Southwest. Rosenstock et al. (1999) recommended that future wildlife water development projects should: (1) have a solid biological basis, (2) reflect clearly articulated management objectives, and (3) include a formal economic benefit:cost analysis. While we concur with their first and second conclusions, we submit that private land managers are not always constrained by cost:benefit considerations to the same extent expected of public agencies.

Novel Uses For Video Surveillance

We documented novel uses for video surveillance during our study. In December 2002, we experienced massive telemeter failure because of premature battery failure (Rollins et al. 2006). When radiotagged birds disappear, the cause might be emigration or telemeter malfunction. In such cases, considerable time, effort, and expense can be incurred to conduct searches outside the study area (e.g., via aircraft). We employed a TrophyView camera on a feeder in early January, and to our surprise, recorded 3 radiotagged scaled quail on the first day of video surveillance. Subsequent surveillance at other feeders revealed other radiotagged quail (albeit with non-functioning telemeters). Knowledge that "missing" birds were indeed still present in their former locales allowed us to re-initiate trapping, and subsequently recapture and replace radio on a number of sample birds.

We documented several cases of broods accompanying 1 or both parent quail to guzzlers during the summer. Brood survival is perhaps the most poorly understood aspect of recruitment in quail. We suggest that if parent birds could be marked (perhaps with various combinations of leg bands) and subsequently identified from video surveillance, nonintrusive estimates of chick survival might be obtained. Given that scaled quail used guzzlers much greater than feeders in summer, surveillance of guzzlers would provide the greater probability of repeat videocaptures. Broods of mountain quail exhibited strong fidelity to individual guzzlers in the Mojave Desert (Delehanty et al. 2004), thus surveillance of a particular guzzler could potentially provide numerous videocaptures over time.

Management Implications

Opportunities for active management, e.g., food plots, prescribed burning, are limited for quails in arid and semiarid climates (Rollins 2000). Providing supplemental feed and water for scaled quail has typically been dismissed by quail biologists as either ineffective or too inexpensive. Regardless, feeding is a popular management practice by landowners and hunters, even though it is typically considered a biologically-neutral management practice (Guthery 2002, pg. 149). However, the relatively high level of quail visitations we observed at feeders and guzzlers, and higher survival rates during the breeding season on fed areas (Rollins et al. 2006), indicate that both technologies may have implications for scaled quail management which inhabit more arid habitats than bobwhites. Benefits from providing supplemental feed and water are likely more important for scaled quail under weather conditions similar to

those we encountered during our study (below normal precipitation and above normal temperatures).

Providing scaled quail access to feeders and guzzlers likely cannot overcome deficiencies of habitat structure, excessive harvest or other limiting environmental factors, a caveat recognized in bobwhite management (Doerr and Silvy 2002). If habitat structure is inappropriate, then habitat improvement, rather than supplemental feeding-watering, should be the priority of management plans. That said, stationary feeders for scaled quail in the Chihuauhan desert appear to be relatively efficient way to distribute feed.

We acknowledge that the Armendaris Ranch was in better range condition (good to excellent condition) than the adjacent public lands (poor condition) during the drought-characterized period of our study. Thus our ability to assess the absolute impacts of feeding and watering are confounded with range condition.

Costs of constructing guzzlers like those we monitored were estimated at $600 per unit in 2002 (including labor). Given the cost of supplementation efforts, we recommend that managers use some type of surveillance (video or digital photography) in order to make intelligent decisions as to the efficacy of their supplementation efforts. The cost of TrophyView video cameras was $1,100 in 2002; deep cycle marine 12-volt batteries cost about $70, and we suggest at least 2 batteries for each camera system, so that 1 may be recharged and alternated regularly (e.g., every 2 weeks). Less expensive remote cameras (35 mm or digital formats) provide similar estimates of species visitation as video surveillance (Henson 2006) and are considerably less expensive ($200-600/unit) than video surveillance technologies. However we recommend a video system if behaviors of interest (i.e., drinking vs. loafing) need to be quantified.

Access to feeders provided a biological benefit to scaled quail (e.g., increased survival during the breeding season; Rollins et al. 2006) on the Armendaris Ranch, and the concurrent use of guzzlers suggested they can be beneficial to scaled quail. Such benefits likely accrue most during dry years, which are the bane of quail managers. Feeders (especially) and guzzlers are also effective in making quail hunting more predictable and productive. We recognize however that such intensive management practices may not be politically- or cost-feasible on surrounding public lands.

Acknowledgments

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