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# Behavioral Responses at Distribution Extremes: How Artificial Surface Water Can Affect Quail Movement Patterns☆

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ABSTRACT

Supplementing wildlife populations with resources during times of limitation has been suggested for many species. The focus of our study was to determine responses of northern bobwhite (*Colinus virginianus;* Linnaeus) and scaled quail (*Callipepla squamata;* Vigors) to artificial surface-water sources in semiarid rangelands. From 2012–2014, we monitored quail populations via radio telemetry at Beaver River Wildlife Management Area, Beaver County, Oklahoma. We used cumulative distribution functions and resource utilization functions (RUFs) to determine behavioral responses of quail to water sources. We also used Program MARK to determine if water sources had any effect on quail vital rates. Our results indicated that both northern bobwhite and scaled quail exhibited behavioral responses to the presence of surface-water sources. Northern bobwhite selected for areas < 700 m and < 650 m from water sources during the breeding and nonbreeding season, respectively. However, the nonbreeding season response was weak ($\overline{\beta} = -0.06$, SE = < 0.01), and the breeding season ($\overline{\beta} = 0.01$, SE = 0.02) response was nonsignificant on the basis of RUFs. Scaled quail selected for areas < 650 m and < 250 m from water sources during the breeding and nonbreeding season, respectively. The breeding season RUF ($\overline{\beta} = -0.31$, SE = 0.07) indicated a stronger response for scaled quail than bobwhite. Conversely, there was no direct effect of surface water on quail vital rates or nest success during the course of our study. Although water may affect behavioral patterns of quail, we found no evidence that it affects quail survival or nest success for these two species.



## Introduction

Understanding the ecology of species at their distribution limits has important implications to conservation (Grinnell, 1917; MacArthur, 1972). Limits in a species' distribution can provide insight into examining potential constraints on populations, or how populations may adapt to unique conditions that infrequently occur within the core of a species' distribution (Sexton et al., 2009). The availability of resources for wildlife, such as food, water, and cover (Leopold, 1933), on distribution extremes may influence a species in ways that may not occur away from the periphery of its distribution. Furthermore, population responses and/or persistence can vary along gradients of resource and environmental variables, leading to the formation of distribution limits (Birch, 1953).

Sympatric populations of northern bobwhite (*Colinus virginianus;* hereafter "bobwhite") and scaled quail *(Callipepla squamata)* offer a unique opportunity to study the influence of limiting resources on space use and vital rates, as these populations typically occur on the western and eastern extremes of the species' distributions, respectively (Schemnitz, 1964). Within this region and other semiarid and arid rangelands, the importance of water as a potentially limiting resource has been emphasized and the supplementation of water to enhance wildlife habitat continues to be a subject of debate among biologists (Rosenstock et al., 1999). Recommendations for provision of artificial surface water may be a result of actual observable depletions of available surface water in ecosystems or from analogies of human situations in which water supplementation is necessary (Campbell, 1960).

Particular attention has been paid to providing surface-water sources to various species of quail in semiarid and arid rangelands (Glading, 1943), as the potential for population responses and economic payoffs is more likely in dry environments (Campbell, 1960). However, ambiguity in tangible benefits of surface water to quail has existed since early results from studies by Grinnell (1927) and Vorhies (1928),

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though many of these studies relied purely on observational data to support or refute any benefits of surface-water sources. Because of limited data and ambiguous results, researchers and managers continue to try to assess if and when quail respond and/or benefit from the presence of artificial surface-water sources.

Generally speaking, scaled quail tend to be more drought tolerant than bobwhite (Schemnitz, 1964) as they have better osmoregulation during times of extreme water deprivation (Giuliano et al., 1998). Because of this difference in physiology, a greater response of bobwhite to the provision of artificial surface-water sources in semiarid regions would be predicted. Although direct individual use of surface water has been documented in bobwhite populations (Lehman, 1984; Prasad and Guthery, 1986), results on population responses to artificial surface-water sources have been mixed. For instance, Guthery and Koerth (1992) determined that water supplementation did not benefit bobwhite, particularly when water was not a limiting factor. Conversely, Hiller et al. (2009) determined that both nonnesting bobwhite and bobwhite nest locations were located significantly closer to surface-water sources compared with random locations, whereas Dunkin et al. (2009) provided evidence of bobwhite breeding and nonbreeding selection to areas > 250 m and < 600 m from surface-water sources. Such studies suggest that bobwhite may be responding behaviorally to the presence of surface-water sources but do not indicate if such behavioral responses result in increased vital rates.

Similarly, there have been contrasting results when studying the response of scaled quail to surface-water sources. Direct use of surface-water sources have been documented for scaled quail, though at relatively low rates that may not be biologically meaningful (Campbell, 1960). Additionally, scaled quail in Oklahoma were observed at locations closer to water than would be expected at random, though it was not determined whether this behavior was from direct use of water or from responding to other elements of habitat such as vegetation (Schemnitz, 1961). Ultimately, it has been suggested that scaled quail may satisfy their water requirements from food sources and that providing surface-water sources is not necessary (Campbell et al., 1973).

In North America, an understanding of rangeland faunal responses to the provisioning of surface water will become increasingly important in future decades, as many of these rangelands are predicted to experience unprecedented droughts as a result of climate change (Cook et al., 2015). Furthermore, ground water withdrawal by humans often exceeds water recharge in aquifers within these rangeland systems (Dennehy et al., 2002; Moore et al., 2012), and recharge of these aquifers is predicted to be further reduced under future climate scenarios (Rosenberg et al., 1999). As such, the efficacy of providing artificial water sources for rangeland wildlife may be confounded by increased water demand and decreased water availability.

In this paper, we present results of the most comprehensive study to date examining bobwhite and scaled quail population responses to surface-water sources. By addressing multiple facets of potential population responses, we hope to provide greater insight as to whether surface water confers any benefit to these two quail species. We assessed the direct benefit of water provision through increased quail vital rates, changes in resource selection of quail from provision of surface water, and the confounding effects related to artificial surface water and vegetation cover. Our objectives were to determine if sympatric populations of bobwhite and scaled quail respond behaviorally to artificial surface-water sources in a semiarid region at the species' distribution extremes. More specifically, we wanted to determine at what spatial scale birds may be behaviorally responding to water, whether or not the probability of space use by quail increased as distance from water decreased, and quantify any differences in vegetation cover between used and unused water sources. We also sought to estimate any relation between quail vital rates (nest success and adult survival) and presence of surface-water sources that may ultimately influence overall population levels.

## Methods

### *Study Area*

Beaver River Wildlife Management Area (WMA), located in Beaver County, Oklahoma (lat 36°50'21.62"N, long 100°42'15.93"W), consists of approximately 11 315 ha managed by the Oklahoma Department of Wildlife Conservation (ODWC). Most of the WMA consists of upland rangelands and the floodplain of the Beaver River. Much of the upland areas are dominated by tivilo fine sand soils, whereas the floodplain is dominated by lesho silty clay loam. Dominant grasses on upland sites consist of buffalograss *(Buchloe dactyloides),* little bluestem *(Schizachyrium scopariu),* and bromes (*Bromus* spp.; non-native). Dominant forbs on upland sites include western ragweed *(Ambrosia psilostachya),* queen's delight *(Stillingia sylvatica),* and Texas croton *(Croton texensis).* Dominant shrubs on upland sites include yucca *(Yucca glauca),* sand sagebrush *(Artemisia filifolia),* sand plum *(Prunus angustifolia),* and fragrant sumac *(Rhus aromatica).* Dominant grasses in the floodplain areas include weeping lovegrass (*Eragrostis curvala;* non-native), little bluestem, and switchgrass *(Panicum virgatum).*

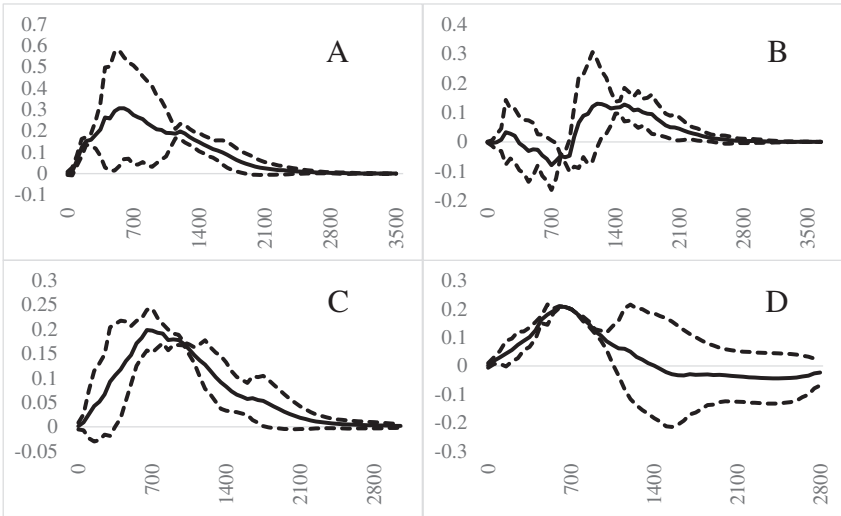


**Fig. 1.** Average selection-avoidance-neutral trends (solid lines) with 95% confidence limits (dashed lines) of scaled quail and northern bobwhite based on distance from artificial surface-water sources (m) from 1 April 2012–31 March 2014, Beaver River Wildlife Management Area, Beaver County, Oklahoma, USA. **A,** Scaled quail breeding season. **B,** Scaled quail nonbreeding season. **C,** Northern bobwhite breeding season. **D,** Northern bobwhite nonbreeding season.