

Quail VII: Seventh National Quail Symposium

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ABSTRACTS



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Northern Bobwhite Nest Site Characteristics and Artificial Brush Structure Use in Weeping Lovegrass CRP

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Abstract

Populations of many grassland-nesting birds have declined during the last 30 years. Habitat loss and fragmentation have been considered the major cause of the decline for most species including the northern bobwhite. With over one million acres of weeping lovegrass established during the Conservation Reserve Program (CRP) on the Southern High Plains of Texas, thousands of acres could be modified to provide usable habitat to northern bobwhites (*Colinus virginianus*) in this region. We were unable to find any radiotelemetry studies concerning northern bobwhite nest success for this region of Texas. No data is available concerning the nest success of northern bobwhite in weeping lovegrass CRP. Consequently, we radiomarked and transplanted 94 wild northern bobwhite into weeping lovegrass CRP and monitored their nest success. We also monitored their use of artificial brush structures placed in weeping lovegrass CRP. The artificial brush structures were placed in the weeping lovegrass CRP to attempt to address the absence of woody cover in these areas. We recorded extremely high nest success of 70% in 2002, and 71% in 2003 for northern bobwhite nesting in weeping lovegrass CRP in the Southern High Plains of Texas. Northern bobwhites were often seen using artificial brush structures and this use appeared to peak during summer when high ambient temperatures may have forced them to seek shade. Weeping lovegrass CRP at the composition available in our study area appears to be suitable nesting cover for northern bobwhite.

Key words: artificial brush structures, *Colinus virginianus*, Conservation Reserve Program, nesting ecology, northern bobwhite, Southern High Plains, weeping lovegrass

Resident vs. Non-resident Northern Bobwhite Harvest: Do they Affect Additive/Compensatory Mortality?

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Abstract

A variety of factors are known to influence the importance of additive harvest mortality on northern bobwhite (*Colinus virginianus*) populations including covey dynamics, habitat fragmentation, and spatio-temporal harvest distribution. Bobwhite managers have long believed that hunters will self-regulate their effort when populations decrease making regulatory changes unnecessary. However, a confounding observation is that with lower population abundances, hunter skill and resulting harvest rate will actually increase because the remaining hunters are more avid. This also raises a hypothesis about whether non-resident hunters could have a larger impact at lower population levels because of their the higher skill and greater time commitment, compared to resident hunters. We examined long-term statewide bobwhite population and harvest data from Kansas (1962-2010) to determine if self-regulation differed between resident and nonresident hunters. The number of bobwhite hunters was correlated to harvest for both residents and non-residents. The estimated number of resident bobwhite hunters and their harvest did decrease correspondingly with the October population index. The existence of nonzero intercepts suggested that resident hunting pressure and harvest declined more slowly than quail abundance thereby indicating the ratio of hunters to quail increased as the quail population declined. Conversely, at lower October population index levels, increasing numbers of non-resident hunters participated in the hunting season and a larger number of birds were harvested. When state bobwhite populations are low or when surrounding state populations are relatively lower, managers may need to place greater restrictions on non-resident harvest to conserve local populations.

Key words: additive harvest, *Colinus virginianus*, compensatory harvest, non-resident hunter, northern bobwhite, resident hunter

Biotic Potential of Wild Northern Bobwhite Hens under Hatchery Conditions

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Abstract

Boom and bust cycles of northern bobwhites (*Colinus virginianus*) have long fascinated wildlife biologists. The annual productivity amplitude depends on reproductive performance of hens buffered by environmental pressures. Under optimum environmental conditions, females maximized reproductive rates and individuals fulfill their biotic potential until constrained by their physiology. We tested the biotic potential of 90 pairs of randomly selected, mature, wild-caught northern bobwhites housed under optimum conditions of food, water, climate and a 17-h photoperiod at the Game Bird Alliance hatchery. We collected eggs daily and differentiated clutches by 18-day periods. We evaluated eggs laid by hens including total number, number/clutch, number laid/day, and egg weight. Overall, 88 hens produced 5,895 eggs, and eggs laid by a hen ranged from 0 to 171 over about 200 days. Mean eggs laid/day was 0.86. Mean clutch size was 8.57 with most hens (83.3%) producing three or more clutches (range = 0-12). However, some hens (54.7%) demonstrated continuous production of several clutches (10-11). Clutch size and number of clutches had a strong correlation ($r^2 = 0.978$). Weight of eggs did not vary by clutch number or hatching success ($P > 0.05$). Our study indicates the population recovery phase in boom and bust cycles may depend on the number of highly productive hens and managing for an optimum-breeding habitat may partially control the intensity of the bust phase.

Key words: biotic potential, boom and bust cycle, clutch, *Colinus virginianus*, fecundity, northern bobwhite

A Biogeographic Analysis of Masked Bobwhite (*Colinus virginianus ridgwayi*) Collections in an Attempt to Better Understand its Habitat Requirements

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Abstract

We located some 300 masked bobwhite (*Colinus virginianus ridgwayi*) specimens in scientific collections. Only three of the collection locales originate from Arizona, and all of these specimens were obtained by Herbert Brown. The remaining majority (96%) of specimens come from the Mexican state of Sonora. All specimens from both states were collected near major drainages in grass-weed habitats within or at the edge of the Sonoran Desert. Descriptions by collectors are nearly unanimous in describing the bird's escape cover as tall grass-weed associations with the term, *savanna* prominently mentioned. These descriptions fit in well with the observed associations for other Pacific coast races of bobwhite. The habitats favored by all of these forms can be characterized as a diverse tropic/sub-tropic grass-weed community within a thornscrub or tropical dry forest environment. Because of grazing and encroachment of invasive species (buffle grass), such habitats may not longer exist. In Arizona, masked bobwhite restoration has been thwarted by releasing mostly captive-raised birds in a warm temperate semi-desert grassland poor in bobwhite food resources. Additionally, recovery attempts in the only area in Sonora known to have these birds have been handicapped by attempting to reconcile bobwhite restoration with livestock management practices— land uses discordant with the requirements of this subspecies. This bird may now be extinct in the wild.

Key words: masked bobwhite, *Colinus virginianus ridgwayi*, extinction, Sonoran Desert, grazing, Arizona, Mexico, biogeography, buffle grass, captive, restoration.

Summary of Mountain Quail Translocation in Oregon, 2001-2010

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Abstract

We trapped mountain quail (*Oreortyx pictus*) from relatively abundant populations in southwest Oregon for re-introduction or augmentation in areas where they were rare or extirpated. From 2001-2010, a total of 2,596 mountain quail were captured using treddle-style traps, of which 1,430 were released in Oregon, the remainder of the birds were transferred to Idaho, Nevada, and Washington. Using primary wing coverts as an indicator, 70% of the captured birds were juvenile. Of the quail released in Oregon, 800 were radio-marked. DNA from blood samples was used to determine gender of 850 captured mountain quail of which 52% were male. A total 150 Oregon nests were located of which 110 (73%) hatched \geq one egg. Average clutch size was 10.2 ± 0.2 and average hatch size of successful nests was 8.3 ± 0.3 . Sixty-eight of the nests (45%) were incubated by males, 78 (52%) by females, and 4 (3%) of unknown gender. The reproductive effort and nest success of translocated mountain quail was comparable to native populations in Oregon, however the long-term persistence of these translocated populations remains unknown.

Key words: mountain quail, *Oreortyx pictus*, clutch size, nest success, translocation, Oregon

Effects of Varying Levels of Disturbance on the Behavior and Reproduction of California Quail

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Abstract

While populations of California quail (*Callipepla californica*) persist on relatively small habitat patches in southern California, they are vulnerable to localized extinction on small and/or highly disturbed patches. One possible cause of this extinction is the impact of habitat disturbance on the social and reproductive behavior of individuals. I conducted a preliminary investigation of the effects of differing levels of disturbance upon a population; from road construction to vegetation loss and nest damage due to re-vegetation attempts. I used trapping and observation data to compare the dispersal of individuals before and after disturbances, the resultant changes in social group composition, and the changes in per capita reproductive rates. Dispersal rates significantly increased following the disturbance, leading to changes in group size and sex ratio. The increased movement appeared to affect family group stability, thereby disrupting relatedness within social groups. Furthermore, reproductive rates were lower in the year following the disturbance. These results indicate the need for further study on the impacts of localized disturbance events on behavior and reproduction in California, and other new world, quail.

Key Words: California quail, *Callipepla californica*, dispersal, disturbance, habitat fragmentation, mating behavior, new world quail

Northern Bobwhite and Scaled Quail Response to Two Large-scale Wildfires in the Texas Panhandle

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Abstract

Rangeland wildfires burned more than 293,000 ha in two large blocks in the Texas Panhandle in March of 2006. To assess the impact on bobwhite (*Colinus virginianus*) and scaled quail (*Callipepla squamata*) populations, spring call counts were undertaken at 6 study sites in Gray, Carson, and Roberts counties during the summers of 2006-2008. Eleven sampling points were established along 16-km transects, extending from unburned areas into burned areas. Distance from sampling points to the burn perimeter was determined using GIS. Presence was documented and relative abundance measured at these various distances inside and outside of the burns. Soils within the 600-m listening radius around each point were characterized using USDA's Web Soil Survey. Recovery rate and abundance of quails were affected more by: soil particle size; topography; and rainfall than spatial relation to the burned areas. Sites comprised of coarse-textured soils responded more quickly and likely supported higher densities pre-burn than sites with more finely textured soils. Shortgrass sites without a significant woody component probably had lower populations pre-burn, and recovered more slowly than midgrass communities possessing more of a woody component. Rough topography appeared to mitigate the immediate impact of the burn, thereby speeding recovery by providing refugia (unburned patches) within the burn.

Key words: wildfire, fire, *Colinus virginianus*, *Callipepla squamata*, Texas Panhandle, northern bobwhite, scaled quail, interaction

Impact of Inclement Weather on Overwinter Mortality of Montezuma Quail in Southeast Arizona

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Abstract

The impact of variation in winter and summer precipitation on the population dynamics of quail has been studied extensively in a few North American quail species. Such studies have served as models for evaluating impacts on other species for which direct data is poor or lacking, including the Montezuma quail (*Cyrtonix montezumae*). Inclement weather such as droughts or hard freezes are known to negatively impact quail species and population viability models exist which have evaluated northern bobwhite (*Colinus virginianus*) response to summer and winter catastrophes. Previous research suggests inclement weather may be an important factor that contributes to mortality of Montezuma quail, but few data has been collected to evaluate actual rates of overwinter mortality. We evaluate the overwinter mortality of Montezuma quail in southeast Arizona following an episode of severe winter weather, consisting of 18.34 cm of precipitation, which occurred from January–March 2010. A combination of flush counts from dog surveys and telemetry of radio-tagged birds was used to track populations of Montezuma quail before, during, and after the period of inclement weather. Overwinter mortality for radio tagged birds (n=23) was 95.6%. Total abundance using flush counts at a control site estimated an 88% reduction in the population following the episode of above-average precipitation. Post-hunting season flush counts across multiple study sites throughout the Coronado National Forest also support this trend. The three-year (2007-2009) average of birds flushed (41.67±4.73) was about 80% higher than number of birds (n=8) flushed in the post-hunting season in 2010.

Key words: Appleton-Whittell Research Ranch, Coronado National Forest, covey size, *Cyrtonix montezumae*, dog surveys, flush counts, freezing, Mearn's quail, Montezuma quail, National Audubon Society, overwinter mortality, precipitation, radio telemetry

Post-fire Succession of Montezuma Quail in a Semi-desert Grassland of Southeast Arizona

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Abstract

The immediate impact of wildfires on quail is generally associated with negative consequences due to a corresponding reduction in available cover. There are a limited number of studies that evaluate the impact of wildfire and post-fire succession on quail, and fewer still through the use of marked animals using radio telemetry. This is especially true for the Montezuma quail (*Cyrtonix montezumae*), where field studies on their populations have been extremely limited. A 1,011.7-hectare wildfire that occurred in southeast Arizona in May 2009 provided an opportunity to evaluate pre- and post-fire abundances and habitat use of Montezuma quail through the use of flush surveys and radio telemetry. Movements of radio-tagged quail were evaluated from 2 months prior to the burn to 12 months post-burn. Strong site fidelity was observed, with coveys persisting in small patches of unburned areas and microtopography, despite an intensive reduction in cover in the surrounding landscape. Flush counts documented at least a 50% reduction in abundance within the first 2 weeks post-fire, and a 75% reduction in abundance within 3 weeks post-fire. Our study also documents some of the first observations of roosting within a fire-affected area as well as successful nesting attempts of Montezuma quail a few months following a wildfire.

Key words: Appleton-Whittell Research Ranch, *Cyrtonix montezumae*, dog survey, flush count, Mearns quail, Montezuma quail, National Audubon Society, nesting, post-fire succession, radio telemetry, roosting, wildfire

Use of Portable Infrared Cameras to Facilitate Detection and Capture Success of Montezuma Quail

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Abstract

Survey and trapping methods for the Montezuma quail (*Cyrtonix montezumae*) require means other than those traditionally used on other quail species (e.g. northern bobwhite [*Colinus virginianus*]). Trapping of Montezuma quail is most effective by using pointing dogs at night when coveys can be located and captured with a net while on their roost. However, reduced visibility at night, cryptic coloration of plumage, as well as the quail's behavioral adaptive stillness reduce the chances of detection and increase the probability of accidentally flushing birds while searching for a roost location. Forward-looking infrared (FLIR) cameras have been used to aid in detection of cryptic wildlife, including avifauna roosting sites. We conducted over 25 survey and night-trapping sessions for Montezuma quail in southeast Arizona using a combination of trained pointing dogs and a portable FLIR camera. Detection of coveys on a roost was mostly dependent upon ambient climate conditions, density of grass cover, and distance to covey. Successful detection of coveys with FLIR before trapping was less than 10%. The small thermal signatures of quail were often obstructed by vegetative cover or confused with residual thermal signatures reflected by inanimate objects (e.g. rocks, bare ground). Proper tuning of FLIR camera sensitivity to a limited thermal bandwidth, or isotherm range, may effectively narrow down the location of a covey approximated by a pointing dog. The FLIR camera was of limited benefit when actively trapping a covey, but is beneficial for non-invasive monitoring and determination of covey size of marked birds on a roost.

Key words: Appleton-Whittell Research Ranch, Coronado National Forest, *Cyrtonix montezumae*, FLIR, forward-looking infrared, Mearn's quail, Montezuma quail, National Audubon Society, roost, survey, trapping

Distribution of Raccoons and Coyotes during Quail Nesting Season

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Abstract

Coyotes and raccoons are common predators of quail and their eggs. Detailed knowledge of the habitat preferences of these predators may help managers reduce predation of quail through habitat alteration. At Rolling Plains Quail Research Ranch, Fisher County, Texas, during the nesting season of northern bobwhites (*Colinus virginianus*), we placed GPS collars on 5 coyotes (*Canis latrans*) and 11 raccoons (*Procyon lotor*). The location of each animal was recorded at 5 min intervals for 35-42 consecutive nights. Habitat use and selectivity was calculated by chi-squared test of proportional use and availability of ecological sites both within the minimum convex polygon area used by each animal and throughout the ranch and adjacent 3 km buffer zone. Coyotes preferentially hunted in grassland which is prime quail nesting habitat. Coyotes were not deterred from using grassland heavily infested with low growing plains prickly pear (*Opuntia polyacantha*). Female raccoons were restricted to areas of heavy cover such as wooded creek sides and boulder strewn hillsides. They rarely entered the more open habitats where quail nest. Male raccoons also favored wooded areas and hillsides but did venture into more open habitats. Within the grasslands, male raccoons avoided cactus infested areas. The presence of coyotes and the occurrence of dense stands of cactus probably offer some protection for quail nests against depredation by raccoons. Managers should be aware of potential trade-offs between reducing cactus, which is problematic for livestock and for hunter access, reducing coyote numbers, and increasing the vulnerability of quail nests to raccoon depredation.

Key words: *Canis latrans*, *Colinus virginianus*, coyote, habitat management, habitat selection, nest predation, northern bobwhite, *Opuntia spp.*, *Procyon lotor*, quail, raccoon

An Occupancy-based Population Model for Northern Bobwhite in Oklahoma: New Directions for Long-term Monitoring and Habitat Management Programs

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Abstract

One of the biggest challenges in management for Northern Bobwhite (*Colinus virginianus*) has been the collection of reliable, long-term data on populations throughout their range. Occupancy-based models allow us to make inferences about populations based on presence/absence data rather than counts. However, the failure to account for false absences (a lack of detection even though the species is present) can negatively bias results of these surveys. New methods for modeling occupancy across a given area allow us to explicitly account for the probability of a false absence in the model while also incorporating site- and survey-specific variables, resulting in more accurate estimates of species occurrence. The purpose of this study was to develop and test the accuracy of an occupancy model for Northern Bobwhite occurrence in Oklahoma. We used the results of surveys done at non-randomly selected sites from 2009-2011 to create the model. Specifically, we sought to determine how time of year and weather conditions effect detection probability, as well as find the local- and landscape-level variables that best predict bobwhite occupancy at a given site. We validated the model by randomly separating the sites into test sites and validation sites. Preliminary analysis suggests that detection probabilities tend to be low in the eastern part of the state, even in areas where good habitat exists. Full results will be presented from the completed analysis. This information will be useful to wildlife professionals and land managers for the purpose of conducting long-term monitoring and habitat management programs.

Key words: *Colinus virginianus*, detection probability, northern bobwhite, occupancy modeling, Oklahoma

Rowing Against the Tide: Getting Landowners to Manage Habitat for Their Favorite Wildlife Species, Bobwhites

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Abstract

A primary cause of the decline of northern bobwhite (*Colinus virginianus*) is that landowners often lack adequate motivation to take on the arduous task of creating and managing habitat. In Missouri we gained insight into some of these motivations through survey questionnaires and focus groups, and here we report findings from 3 studies containing 3,057 survey responses during 2004-2007. One of the surveys targeted Conservation Reserve Program (CRP) lands (hereafter “CRP survey”), another lands with potential for bobwhite restoration (hereafter “bobwhite survey”) and the third focused on grassland bird restoration. Landowners in each survey identified bobwhites as the most popular (>80% of respondents chose ‘somewhat’ or ‘very’ ‘important’ to have bobwhites ‘on my land’) natural resource among a list that included deer, turkeys, prairie-chickens, native plants, grassland birds, rabbits, hawks/owls, etc. Although bobwhites were highly valued by landowners, other answers in these surveys revealed many obstacles to habitat management including economics, time, knowledge, skill and equipment. For example, only 39% of respondents in the bobwhite survey were interested in joining a habitat restoration cooperative, and in all surveys <50% of respondents were willing to adopt quail-friendly habitat management (prescribed fire, disking, herbicides, moderate grazing, native vegetation, presence of weeds, etc.). Because of the gap between landowners’ fondness for quail, but being less willing to take action, bobwhite restoration programs must include a comprehensive approach, ranging from local community involvement by agency biologists and non-government organizations to resource-use policy in Washington, D.C.

Key Words: landowner attitudes, motivation, economics, Missouri, *Colinus virginianus*, financial incentives, cooperative, non-government organizations, private lands, values

Density Dependence in Northern Bobwhite Populations: What Do We Know?

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Abstract

Density dependence is considered a crucial part of northern bobwhite (*Colinus virginianus*) population dynamics. Bobwhite population models indicate that density-dependence affects reproduction and overwinter mortality in bobwhites and models without these parameters do not perform well. However, the relationships among population density, reproduction, and overwinter mortality are elusive, and the causal factors that drive these relationships are largely unknown. Causal factors that drive density-dependent mechanisms in bobwhite populations are thought to be based on resources, the most common of which is considered to be food. The interplay between density-dependent and density-independent factors further complicates the issue, because density-independent factors may dampen the effects of density dependence. For example, during the breeding season, usable space available for nesting can be strongly limited by drought, and thus could dampen a potentially positive density-dependent response of a low-density breeding population. We review the literature on density dependence as it relates to bobwhites and other *r*-selected species. Based on our literature review, we hypothesize explanations for the extent and influence of density dependence in bobwhite populations.

Key words: density dependence, *Colinus virginianus*, mortality, northern bobwhite, population, reproduction

Genetic Structure and Diversity in South Texas Bobwhites: Implications for Conservation

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Abstract

Changes in land-use patterns have coincided with the range-wide decline in northern bobwhites (*Colinus virginianus*). However, the specific manner in which land-use changes have affected bobwhite populations is unknown. We initiated a large-scale genetic study to investigate the population structure of bobwhites at the landscape scale and determine if bobwhites function as metapopulations. In a metapopulation system, dispersal and exchange are critical to the long-term maintenance of populations; if interrupted, the entire network of populations might collapse. We sampled hunter-harvested bobwhites from 21 areas in south Texas, a region containing large areas of contiguous habitat where bobwhite populations have been relatively stable. We used bi-parentally and maternally inherited genetic markers to compare genetic structure and diversity among populations. We found high levels of genetic variation throughout the region and maternal lineages were broadly distributed. Overall, south Texas bobwhites displayed high levels of genetic variation and were genetically similar across a broad region. Population genetic theory predicts that genetic diversity and genetic similarity among local populations in a metapopulation are influenced by the rate of dispersal (gene flow). The region-wide genetic similarity among bobwhites implies that dispersal may be more important in bobwhite population dynamics than previous studies have indicated. We hypothesize that disruption of dispersal by habitat fragmentation may explain the overall decline of bobwhite populations in some regions. In fragmented landscapes, this may explain why patches of suitable habitat go unoccupied by bobwhites. Our results lend additional support to recent calls for regional-scale management of this declining species.

Key words: *Colinus virginianus*, conservation, dispersal, fragmentation, genetic diversity, metapopulation, northern bobwhite, population structure

Linking Long-term Habitat Changes to Northern Bobwhite Populations: Assessing the Predictive Power of a Static Multi-scale Occupancy Model

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Abstract

Broad-scale habitat loss is believed to be the primary cause of declining northern bobwhite (*Colinus virginianus*) populations. However, past research and management have primarily focused on site scale relationships. We tested if a static multi-scale habitat-based occupancy model for bobwhite could predict the change in occupancy of Breeding Bird Survey (BBS) routes over time in the Delmarva Peninsula, USA. We used 50-stop BBS route data to calculate the percentage of stops occupied by bobwhite during 1992, 1996, 2001 and 2005. We then calculated the probability of breeding-season bobwhite occupancy at each BBS stop for each time period using a previously established occupancy model applied to National Oceanic and Atmospheric Organization Coastal Change and Analysis Program (NOAA CCAP) land cover data. The average change in observed occupancy per year was -8.7% (\pm SE 1.3%) while the average predicted change in occupancy was 1.0% (\pm SE 0.8%). Predicted route occupancy was not related to observed route occupancy across sampling periods. Change in predicted occupancy and observed occupancy were also not related across sampling periods. We consider two broad reasons why observed results did not correlate to our predictive model including methodological (e.g., error from applying model from one year to other years, imperfect detection of bobwhite during BBS surveys, and coarse land cover data resolution) and biological (e.g., slack in habitat configurations, differential habitat use between breeding and nonbreeding season, impact of predation and agricultural chemicals). Biologists should use caution when applying a static multi-scale occupancy model to large-scale temporal habitat-population processes.

Key words: breeding bird survey, *Colinus virginianus*, northern bobwhite, landscape change, occupancy change, Delmarva Peninsula

Dietary Considerations in Increasing Production of Mearn's Quail in Captivity

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Abstract

Captive propagation is a frequently encountered element of quail management strategies. A survey of private breeders of Mearn's quail (*Cyrtonyx montezumae*) indicated that quail production was low (8-10 eggs/pair, n=50 pair). We proposed that the low production was due to diet especially Omega-3 fat acids. In 2007-2008 three age groups (1 yr., 2 yr., 3yr) were placed on a diet including standard game bird breeder crumble (*Super breeder, Cooperative Milling, Gettysburg, Pa), grit and water. Pairs were maintained in 1m x 1m x 2 m. cages with a 61 cm x 41cm x 41 cm wooden box at one end. Eggs were gathered daily with an artificial egg placed in the nest box after the first egg was removed. Total number of eggs produced by each pair/group was recorded. In 2009 and 2010 diet was changed with the standard game bird crumble being replaced by Resolution Kibble (Resolve Sustainable Solutions, St Cloud, MN). The 2007-2008 diet contained no significant amounts of omega-3 fatty acids. The 2009-2010 diet contained catfish and crab meal to meet protein requirements therefore contained Omega 3 fatty acids. Total number of eggs produced increased from 30/pair in 2008-09 to 80/pair in 2009-10. These results, while sample size was small, indicate that Mearn's quail production may benefit from Omega 3 fatty acids similar to the Patuxent "pre-war diet" fed northern bobwhite quail (*Colinus virginianus*) prior to the substitution of fishmeal by soybean oil meal. Since numerous factors influence egg production, additional larger scale diet trails are needed to test the dietary value of Omega 3 fatty acids.

Key words: diet, Mearn's quail, *Cyrtonyx montezumae*, Omega 3 Fatty Acids, egg production, captivity, protein

Quail Focus Area Monitoring: A Case Study in Knox and Saline Counties

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Abstract

The Missouri Department of Conservation established Quail Focus Areas (QFAs) on private lands in 2004. The goal of QFAs is to increase and expand quail habitat management efforts at a larger scale. Since the majority of Missouri's landscape is in private ownership (93%), habitat improvement programs on private lands have greater potential to impact statewide quail populations than on public lands alone. In order to determine if focus areas are affecting quail numbers, we proposed a pilot project to monitor fall coveys on 2 QFAs. We chose the Knox County Focus Area (11,400 ac) and the Sweet Springs Focus Area (located in Saline County) (39,122 ac) based on the habitat work already in place, and the willingness of the Private Lands Conservationists and local landowners to cooperate with us in our monitoring efforts. We randomly selected an equal number of listening points inside and outside of each focus area. We sampled 20 points both inside and outside the Knox County Focus Area and heard an average of 3.4 coveys per point in 2008 and 3.4 in 2009 inside the focus area. We heard an average of 2.5 coveys in 2008, and 2.2 coveys in 2009 outside the focus area. We sampled 33 points inside and outside the Sweet Springs Focus Area and heard an average of 1.8 coveys per point in 2008 and 2.1 in 2009 inside the focus area. We heard an average of 0.9 coveys per point in 2008 and 2.4 in 2009 outside the focus area. Additional results from the 2010 monitoring season will be presented.

Key words: Northern bobwhite, quail focus area, population monitoring, case study, Missouri.

Effectiveness of Training on Reducing Distance Measurement Error for Bobwhite Quail Surveys

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Abstract

Distance sampling is a valuable tool used to estimate the abundance or density of populations. One of the assumptions of distance sampling is that distances are measured accurately. One way to reduce variability is by using well-trained observers. We conducted field tests, using electronic speakers to train observers before spring bobwhite and grassland songbird sampling for the Conservation Reserve Program Practice 33 (Habitat Buffers for Upland Birds). Training exercises were conducted 2 times before the field season (May) again at the end of the field season (July) to determine if the observer's ability to accurately measure distances improved. We conducted 3 rounds of field tests (2 pre-season and 1 post-season) in 2007, 2008, and 2009. There was a marginally significant effect of round ($p=0.057$), but a Tukey test revealed that differences were between rounds 2 and 3, whereas there were no significant differences between rounds 1 and 2 or 1 and 3. These results do not seem to indicate that ability to accurately measure distances improved with added training efforts. Density estimates based on inaccurate distance measurements may lead to biased results.

Key words: Northern bobwhite, distance sampling, measurement error, point count surveys

Genetic Structure of Northern Bobwhite in Northeast Mississippi and Southwest Tennessee

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Abstract

There have been numerous studies on the population biology of northern bobwhite (*Colinus virginianus*), yet there is a conspicuous gap regarding our knowledge of how genetic variability is partitioned and maintained within and between populations of this species. To address this need, we characterized the level of microsatellite variation among 4 subpopulations of wild bobwhite in north and east Mississippi and southwest Tennessee from feather samples collected in 2002. The results from analyses of population substructure indicate that genetic differentiation of subpopulations was negligible. In addition, we failed to find evidence of reduced genetic variability. We suggest that despite what we perceive to be increasing isolation associated with habitat loss gene flow continues to be maintained between populations. Bobwhite may therefore be better equipped genetically than previously thought to respond to habitat improvements in this region. Nevertheless, we see a need for a greater understanding of the genetic structure of bobwhite populations on larger geographic scales across the species' range. Such information would be a valuable addition that would enhance current management strategies for this species.

Keywords: *Colinus virginianus*, gene flow, genetic structure, genetic variability, microsatellites, Mississippi, northern bobwhite, Tennessee

The Sexual Proclivities of Northern Bobwhites

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Abstract

The mating system of northern bobwhites (*Colinus virginianus*) has been described as monogamous, polygamous, multi-clutch polygamous, ambisexually polygamous, and polyandrous. However, prior studies of bobwhite breeding behavior were based on observations of social interactions and did not incorporate genetic outcomes. We used three years of field observations and variation at 14 microsatellite loci of 601 adult and 841 neonatal bobwhites to estimate the rates of extra-pair paternity in bobwhite broods, evaluate the utility of social behavior as an indicator of genetic outcomes, and evaluate the fit of bobwhite social and genetic behavior to classic mating system theories. We found that extra-pair paternity occurred in >50% of bobwhite broods, while extra-pair matings resulted in few ($\bar{x} = 1.1$) extra-pair offspring per nest. Social interactions between female and male bobwhites generally predicted the father of most offspring in a brood, but social interactions did not predict extra-pair matings better than chance. Furthermore, we found that the mating behavior of individual females changed within and between breeding seasons, suggesting that individual reproductive decisions of females were flexible. Taken as a whole, the mating “system” of bobwhites meets neither the predictions nor the assumptions of classic mating theories, suggesting that these theories inadequately address biological systems in which male and female reproductive roles approach equivalence.

Key words: *Colinus virginianus*, mating systems, reproductive behavior, microsatellite, radio-telemetry

Distance-based Habitat Associations of Northern Bobwhite in Kansas

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Abstract

The northern bobwhite (*Colinus virginianus*) has been studied extensively over the last 75+ years. During this time bobwhite carrying capacity has been reduced or eliminated throughout much of the species range. We used Euclidean distance to characterize land cover associations of bobwhite at a general and a specific land cover classifications during reproductive period (15 April to 14 October) and covey period (15 October to 14 April) in southeastern Kansas. Habitat selection occurred during reproductive period (Wilkes $\lambda = 0.04$, $F_{6,36} = 143.682$, $P < 0.001$) and covey period (Wilkes $\lambda = 0.056$, $F_{6,29} = 81.99$, $P < 0.001$). Ranking of the reproductive period habitats indicated that bobwhite preferred locations in close proximity to fescue grasses over all other habitats. Based on habitat rankings for covey period, coveys preferred locations in close proximity to woody cover. Bobwhites were also found to select habitat when a more detailed land cover classification was used for reproductive period (Wilkes $\lambda = 0.006$, $F_{16,26} = 284.483$, $P < 0.001$) and covey period (Wilkes $\lambda = 0.004$, $F_{16,19} = 276.037$, $P < 0.001$). During the reproductive period, bobwhites preferred locations in close proximity to fescue pastures and roads equally over all other habitats. During the covey period coveys preferred locations in close proximity to roads and CRP lands. Our findings suggest that fescue may be avoided by bobwhites during the covey period when short vegetation results in increased fragmentation of the landscape forcing birds into small patches.

Keywords: *Colinus virginianus*, Conservation Reserve Program, Euclidean distance, habitat associations, Kansas, northern bobwhite

Population Ecology and Habitat Relationships of Northern Bobwhites in Southwestern Ohio

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Abstract

Ohio's northern bobwhite (*Colinus virginianus*) population declined 76% since 1984. The species is hunted (28 days, 4 bird bag) in 16 counties, although factors affecting survival and reproduction are unknown. We investigated abundance, survival, nesting, movements, and habitat use on 7 private land sites in southwestern Ohio during 2008-11. Bobwhites were patchily distributed across the landscape with 0.8-4.8 coveys/km² on three of the most densely populated sites, and few or no coveys on 4 sites. Non-breeding season survival was 8.8% (95% CI= 5.1-14.6) in 2009-10. Survival was highest through mid-December and harvest accounted for 5.3% of mortalities. Mortality was highest during January-February when prolonged (> 3days) snow cover restricted access to food, forcing birds to forage where they were vulnerable to predation. Adult survival was 40.9% (95% CI: 30.5-52.2) in summers 2009-2010. Call-counts and covey densities declined between 2008 and 2010 indicating that recruitment did not offset winter losses. Age-ratios of captured birds (3.2 juv/ad), suggested low post-hatch survival. Coveys used wooded and herbaceous edges during autumn and winter then shifted to grass and cropland during spring and summer. Bobwhites dispersed 0-19 km in spring, varying with juxtaposition of non-breeding and breeding habitats. We contend that growth of this population is limited by weather-mediated predation in winter. Recruitment appears inadequate to sustain the population after severe winters or produce surplus individuals to colonize vacant habitats. Managing edges to provide protective cover near winter food is essential for the Ohio bobwhite population to grow and reoccupy areas of its historic range.

Key words: *Colinus virginianus*, habitat use, harvest, movements, nesting, Northern bobwhite, southwestern Ohio, survival

Mixed Species Coveys of California and Gambel's Quail (*Callipepla californica* and *C. gambelii*) and their Hybrids: Effects on Pairing and Reproductive Success

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Abstract

As is the case for many North American New World Quail, California and Gambel's Quail (*Callipepla californica* and *C. gambelii*) hybridize where their distribution overlaps. Outside of the area of overlap, individuals group together in coveys that disband during the breeding season, and most pairs form within the covey. I observed two coveys within the hybrid zone and asked whether pairing occurred within the covey. I compared the hatching success and survival of chicks compared between mixed-class pairs and pure parental pairs. Isolated coveys may be inbred, and choice of conspecific mate constrained by small population size. For each individual that paired within the covey, I measured relatedness between a quail and tested whether it was more or less related to its mate than to other individuals in the covey of the same and opposite sex. The study revealed that mixed-species coveys were formed in the area of species overlap, pairing was random with respect to species class within the covey but pairs were less closely related to the mate than other birds in the covey. Mixed pairs did not have significantly different reproductive success than pure parental species pairs. Quail in the same covey that paired together bred earlier than other quail. Pairs that bred earlier had bigger clutches. Thus there is no intrinsic genetic barrier to hybridization between California and Gambel's Quail and the hybrid zone is propagated through mixed species covey formation and pairing within the covey.

Key words: *Callipepla californica*, *Callipepla gambelii*, hybridization, covey, reproductive success, hybrid zone, inbreeding, relatedness, pairing

Construction of Species-specific PCR Primers for Detection of *Eimeria* spp. coccidia in Captive-reared Northern Bobwhites

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Abstract

Captive rearing and subsequent release of game birds, including Northern bobwhites (*Colinus virginianus*), has become commonplace in certain areas; however, there is little research on the potential disease issues associated with captive bobwhites. Coccidiosis has been previously identified as an important disease in captive bobwhites. *Eimeria lettyae*, *Eimeria colini*, and *Eimeria dispersa* are the three described coccidia species from bobwhites. To aid in parasite detection and distinction, we collected litter or intestinal samples from 31 captive bobwhite facilities originating from 13 states. Species-specific PCR primers were constructed against the internal transcribed spacer region 1 (ITS-1) of the ribosomal RNA gene of the various *Eimeria* spp. The primers were used to detect the *Eimeria* spp. in the collected 31 samples. All 31 samples were positive for coccidia. The primers survey results disclosed *E. lettyae*, *E. dispersa*, and the undetermined *Eimeria* sp. in 20 (64.5%), 22 (72%), and 29 (93.5%) of the samples, respectively. Thirteen (41.9%) samples had 3 *Eimeria* spp. detected, 14 (45.2%) samples had 2 spp. detected, and 4 (12.9%) samples had 1 sp. detected. Flock age or geographical location was not associated with the presence of any particular *Eimeria* spp.

Key words: Captive facilities, coccidia, *Colinus virginianus*, diseases, *Eimeria*, northern bobwhites, PCR primers

NBCI Gives Us Power

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Abstract

The National Bobwhite Conservation Initiative (NBCI) will be 10 years old in March 2012. Launched by the states, the Initiative is a means for all quail conservationists to unite behind a common vision and strategy toward the end of restoring huntable bobwhite populations across their range. Given the array of fundamental positive and empowering changes catalyzed for quail conservation since 2002, the original NBCI is one of the most influential and effective conservation initiatives in history. One year ago, a complete overhaul of the plan was completed by the states and their partners, coordinated by Tall Timbers Research Station. Continuing our track record of progress, the NBCI 2.0 provides more and better technical and policy guidance, engages more states and people, and ultimately carries more clout. Combined with the other basic organizational, infrastructural and leadership improvements in the quail management arena—such as the NBCI Management Board, the National Bobwhite Technical Committee, the permanent NBCI operational center at the University of Tennessee, and the NBCI staff—we all are poised to make bigger and better progress. Even though so much heavy lifting has been completed, we cannot afford to pause, to savor our many successes. We have too much to do, and bobwhite population trends are not affording us the luxury of time. Now is the time to hit the gas. Now is the time for states, NGOs, private and federal partners, landowners, and all our other potential allies to stand up with renewed resolve, to take advantage of this new quail power. We must make the NBCI's second ten years as remarkable as the first ten.

Key Words: National Bobwhite Conservation Initiative, NBCI, Tall Timbers Research Station, NBCI Management Board, National Bobwhite Technical Committee, University of Tennessee.

Effects of Patch Burning and Grazing Exotic-Grass Monocultures on Northern Bobwhite Habitat and Productivity

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Abstract

Buffelgrass (*Pennisetum ciliare*) is an invasive, exotic grass that threatens biodiversity and wildlife habitat throughout the southwest. This is especially true for northern bobwhites (*Colinus virginianus*). Bobwhite populations have decreased over the past century because of a loss in habitat and usable space. Use of exotic grass monocultures by quail tends to be limited to edges adjacent to woody plant communities. We initiated this study to evaluate if creating a mosaic of small, prescribed burns followed by intense cattle grazing in exotic grass monocultures will increase usable space for bobwhites and increase bobwhite abundance. Our research is being conducted in La Salle County, Texas. We randomly assigned a patch burn-graze treatment to two 200-ha pastures dominated by buffelgrass and randomly selected 2 experimental controls (grazing only) to two 200-ha pastures. We burned patches totaling 25% of each pasture in January 2010 and allowed grazing after burned grass reached 15 cm in height. Grazing intensity (standing crop removal) was sampled in June and August 2010. Patch burning and grazing resulted in more heterogeneity in standing crop of buffelgrass ($P < 0.001$). Bobwhites appeared to use these exotic grass monocultures in burned patches with a greater abundance of native forbs and woody plants during the first year of study. Bobwhites avoided areas where there was no native vegetation, and their abundance was closely associated with brushy riparian areas ($P = 0.09$). There were no differences ($P > 0.05$) in abundance between treatment and control pastures. Severe drought during the first year of study may have affected results.

Key words: Northern Bobwhite, *Colinus virginianus*, Patch Burning, Grazing, Exotic Grasses, Buffelgrass, *Pennisetum ciliare*, Habitat Management, South Texas

Spatial Ecology and Habitat Selection of Montezuma Quail in Texas

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Abstract

Montezuma quail (*Cyrtonyx montezumae*) are located throughout desert mountain ranges in the southwestern deserts of the United States and northern Mexico. Considered a popular game bird in Arizona and New Mexico, they are not hunted in Texas. In 1997 a hunting season was proposed for the species but met with strong objections- most citing the dearth of information about the species. Most of the literature on Montezuma quail ecology is anecdotal or outdated. Previous researchers experienced problems of capturing birds for marking, and once captured keeping radio-marked birds alive. With improvements in transmitters and the use of trained pointing dogs we conducted a radiotelemetry study in the Davis Mountains of Texas from January 2009 through September 2010. We captured a total of 72 birds and recorded 966 locations. Home range was performed on 13 individuals, which had at least 25 locations. A 95% fixed kernel was calculated on each individual giving a mean of 2,149.4 ha (SD = 4,736.8 ha). Movements varied widely by individuals—greatest straight-line movement was 12.7 km. We also performed habitat selection analysis. Mountain savannah ecological sites were preferred across all 3 spatial scales. Our results confirm that home range size and movements by Montezuma quail occur at a much larger scale than previously reported. From a management standpoint, managing lands on a larger scale and targeting mountain savannah ecological sites should be considered.

Key words: *Cyrtonyx montezumae*, habitat selection, home range, Montezuma quail, radiotelemetry, Texas

Northern Bobwhite Habitat Modeling on a Military Installation in Relation to Red-cockaded Woodpecker Management

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Abstract

The Department of Defense (DoD) manages natural resources on about 8 million ha of land. A top priority for much of this land is to restore and maintain native ecosystems and associated wildlife species. However, given the typical location (i.e. threatened ecosystems) and size of DoD lands management conflicts usually occur among endangered/threatened species and game species. Specifically, military installations in the Southeastern U.S. are commonly managed to protect red-cockaded woodpecker (*Picoides borealis*; hereafter RCW) populations and longleaf wiregrass ecosystems. But, mandated RCW management is not entirely compatible with other declining species such as Northern bobwhite (*Colinus virginianus*; hereafter bobwhite). Land managers need to be equipped with spatially-explicit habitat models that can be used to make informed decisions on how to manage lands. Data collected on Fort Gordon Military Installation from male whistle counts during the summer of 2010 and 2011 will be used to construct competing models on the relationship between RCW management and other habitat structure metrics as it relates to bobwhite habitat suitability. These data were collected using a robust occupancy sampling design to allow open and closed population assumptions. Preliminary data suggests that the RCW habitat ranking matrix is a poor predictor of bobwhite habitat suitability and more alarmingly RCW population performance. These models will assist natural resources managers on DoD land in making efficient decisions in the face of uncertainty.

Keywords: Department of Defense, endangered species, northern bobwhite, red-cockaded woodpecker, robust occupancy sampling, spatial habitat models, threatened species

The Forgotten Quail Decline: The Plight of Scaled Quail in Texas

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Abstract

Several quail species are experiencing range-wide declines in the United States. Of these declining species, northern bobwhite (*Colinus virginianus*) has garnered the most attention, both from a research and conservation perspective. In Texas, the bobwhite decline has resulted in considerable time and effort being devoted to its research and management due to its status as a highly popular and economically important game bird. Although such attention has been beneficial to bobwhite conservation and management, an unfortunate consequence of such intense focus has been the neglect of another quail species that has been declining at even a more alarming rate, the scaled quail (*Callipepla squamata*). According to Breeding Bird Survey (BBS) data, scaled quail have declined at a rate of 5.1% per year in the Tamaulipan Biotic Province (southern Texas), the greatest of any region surveyed in its geographic range.

Anecdotal reports of landowners have long noted the gradual disappearance of scaled quail and concomitant replacement with northern bobwhite throughout southern Texas, beginning since about the 1990s. Analysis of BBS data provides evidence for such species replacement. Percent of quail detections in the core of the scaled quail range in the Tamaulipan Biotic Province were 80:20 (scaled quail:bobwhite) during the 1960s but currently represent about 5:95. In addition, the range of scaled quail has been contracting, moving progressively west with time. The species is no longer detected in the easternmost BBS routes in southern Texas. Here we discuss possible reasons for the population decline, range contraction, and species replacement.

Key words: Breeding Bird Survey, *Callipepla squamata*, quail decline, scaled quail, Tamaulipan Biotic Province, Texas

Annual Variation in Northern Bobwhite Survival and Cause-specific Mortality in Relation to Ground Cover and Phenology of Raptor Migration

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Abstract

We estimated survival of radio-marked northern bobwhite (*Colinus virginianus*) on a managed prairie site in northeast Mississippi during 2 disparate winters (15 Sep-14 Apr 2000-2002). We retrospectively examined factors that may influence bobwhite survival. Pooled survival rates (\pm SE) differed substantially between years ($S = 2.67 \pm 0.01\%$ in 2000-2001 and $S = 36.15 \pm 0.08\%$ in 2001-2002). The 2000 growing season was characterized by drier conditions and vegetation was sparser and shorter compare to the 2001 growing season. Winter 2000-2001 temperatures were generally colder that winter 2001-2002. Cause-specific mortality rates due to avian predation were greater in 2000-2001 ($49.6 \pm 0.04\%$) compared to 2001-2002 ($28.0 \pm 0.07\%$). Regional relative abundance of 3 species of raptors thought to be important predators of bobwhite was greater during 2000 compared to 2001 as determined by kriging of Christmas Bird Count data. Annual variation in winter survival rates observed during our study may be explained by a combination of factors including differing weather regimes during the growing season and winter and a change in the local abundance of migratory avian predators on our study site. We demonstrate an approach for characterizing annual variation in spatial distribution of migratory raptors and suggest that annual variation in local winter predator context may be useful for explaining annual variation in winter survival of local bobwhite populations.

Key words: *Colinus virginianus*, northern bobwhite, predation, raptors, survival

Review of the Masked Bobwhite Quail Recovery Effort at Buenos Aires National Wildlife Refuge

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Abstract

The masked bobwhite (*Colinus virginianus ridgwayi*) has been the focus of Buenos Aires National Wildlife Refuge since its establishment in 1985. There have been three components to the masked bobwhite program: captive rearing, release of birds into suitable habitat, and habitat manipulation. We will discuss the status of the bird in both the United States and in Mexico. We will discuss the successes and failures of the reintroduction program and the difficulties in working with this highly endangered bird. We will provide updates on new strategies for saving this sub-species.

Key words: Buenos Aires National Wildlife Refuge masked bobwhite, captive rearing, *Colinus virginianus ridgwayi*, reintroduction

Nutritional Facts of Quail's Meat: A Comparison Between Four Wild Species in Central Mexico

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Abstract

Humans' diet is composed by a wide array of food, in which the common source of protein is the animal, having its basis mainly on livestock animals. Due to intensive breeding the meat is obtained in less time, but with effects on health within a medium or long term because of the high quantity of fat and the relatively low percentage of protein. In this investigation, a nutritional study was made on breasts from four species of wild quails: the common (*Colinus virginianus*), banded (*Philortyx fasciatus*), scaled (*Callipepla squamata*) and Montezuma (*Cyrtonyx montezumae*) collected from Mexico's center, from January to March of 2005. On one hand, high concentrations of protein were found in the meat of *Cyrtonyx montezumae* (26.99%) and secondly low content of fat (1.25%) on *Philortyx phasciatus*. Up to that moment there was not any data about the bromatologic characteristics of these birds' meat, resulting better in comparison with other domestic species. The sustainable utilization is achieved by knowing and respecting the hunting season of the species where they are distributed and the nutritional facts is empathized as aggregated value.

Key words: quail, nutrition, bromatologic, protein, *Colinus virginianus*, *Philortyx fasciatus*, *Callipepla squamata*, *Cyrtonyx montezumae*.

Temporal Variability in Survival of Non-breeding Northern Bobwhites in Ohio

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Abstract

Non-breeding season survival is one of the primary factors driving population growth rates in northern bobwhites (*Colinus virginianus*) across their range. The influence of non-breeding survival is particularly important in the northern portion of bobwhite range, where winter weather can differentially influence survival rates. We investigated survival of bobwhites during the non-breeding season (Oct- Mar) in a population near the northern extent of the bobwhite range. We captured and radio-marked bobwhites on 4 private lands sites during January 2009-March 2011. We used the known fates model in Program MARK to compare monthly survival estimates in 14 1-month intervals with all bobwhites that survived ≥ 7 days post-capture ($n=311$). We compared a set of temporal models and then evaluated the influence of sex, age and study site on survival. The best temporal model included different estimates for each interval across years. There was equal support for three models that contained age and site effects. The coefficients indicated that adults had higher survival than juveniles. Monthly survival estimates ranged from 30.0-94.1 % with the highest survival estimates ($\bar{x} = 93.2\%$) occurring in late winter in the absence of snow cover. The average fall survival rate (Oct.- Nov) was 83.23%. The lowest estimates ($\bar{x} = 64.6\%$) coincided with prolonged periods of snow accumulation ($>10\text{cm}$ for ≥ 7 days). Temporal patterns of survival illustrated a decreasing trend throughout fall and winter driven by variability in winter weather. Additional analysis will relate observed survival rates with weather patterns and investigate variability in cause-specific mortality in the non-breeding season.

Key words: *Colinus virginianus*, known-fates model, Northern bobwhite, Ohio, survival, winter weather

What's a Quail Worth? Assessing the Expenditure Patterns of Quail Hunters in Texas

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Abstract

Every five years, the U.S. Fish and Wildlife Service publishes its National Survey of Hunting, Fishing and Wildlife-associated Recreation with 50 state-specific reports. In 2006, this survey estimated hunting expenditures in Texas to be \$2.2 billion with 15% of hunters identifying quail as a preferred species. While useful, this survey reports only the representative demographics and spending patterns of the general hunting population with expenditure pattern breakouts only available for broad hunting categories (big game, small game, migratory bird, etc.) Here we present the results of a targeted survey of quail hunting enthusiasts to identify annual quail hunting related expenditures and demonstrated land access patterns. We sampled a population of quail hunters (members of Quail Unlimited residing in Texas) and landowners (across 13 counties who controlled >500 acres) in 2000 to assess spending patterns (of hunters) and lease income (from landowners). The average quail hunter respondent spent \$10,354 in 1999 in pursuit of their avocation. Important from the standpoint of rural economic developments, about 65% of these expenditures were in the destination county. We used these results to characterize any trends or changes that have occurred and investigate the influence of macroeconomic forces that might be impacting the behavior of avid quail hunters. Land managers and owners can use this information to better manage their habitat and target a hunting population that is not described through the national survey efforts.

Keywords: survey, Texas, quail hunting, hunting related expenditures, categories of expenditures, travel distances, land access, leased acreage

Effectiveness of the Surrogator as a Propagation Tool for Northern Bobwhite in Southern Texas

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Abstract

Attempts to restore populations of northern bobwhite (*Colinus virginianus*) using game-farm quail have been documented since the early 1900s. However, documented low success rates are likely due to low post-release survival rates of 8-15 days (Buechner 1950, Roseberry et al. 1987), and long distance dispersal from release sites averaging 2331.72 meters (Baumgartner 1944). Claims have been made that the Surrogator[®] (hereafter, surrogator), a quail propagation tool, has increased success rates in both of these areas. Following steps outlined in the Wildlife Management Technologies 2009 Surrogator System Guide, we tested the effectiveness of the surrogator on quail survival and success by raising 250 bobwhite quail in two surrogators on a 989.5 ha ranch in Wilson County, TX. Twenty birds from each surrogator were fitted with a 3.5 g necklace transmitter 12 hours before release. Standard radio telemetry equipment was used to locate each bird daily for 3 weeks, and then 3 times a week until 100% mortality was observed. Bart and Robson's maximum likelihood estimator of daily survival rates calculated for birds released from both surrogators A and B were low (0.873 and 0.962, respectively). The mean distances traveled by quail post-release were 401.3 m (Standard Deviation = 228.3 m) and 1416.5 m (Standard Deviation = 543.6 m) for surrogators A and B, respectively. Our results do not support the use of surrogators as an effective means of restoring wild populations of northern bobwhite quail in southern Texas.

Key words: *Colinus virginianus*, surrogator, survival, dispersal, post-release survival, Bart and Robson's maximum likelihood estimator

Nesting Ecology of Northern Bobwhites on Rangeland versus Conservation Reserve Program Habitats in the Rolling Plains of Texas

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Abstract

Conservation Reserve Program (CRP) contracts account for about 1.7 million ha in Texas, and are often touted as habitat for upland game birds. We compared nesting ecology (i.e., nest site locations, hatch rates, and brooding habitat) for northern bobwhites (*Colinus virginianus*) on CRP vs. rangeland habitats at the Rolling Plains Quail Research Ranch (RPQRR), Fisher County, Texas from 2008-2010. Four pastures have CRP habitats and account for about 11% of the total area (remainder rangeland). The CRP sites on RPQRR consisted primarily of kleingrass (*Panicum coloratum*) whereas silver bluestem (*Bothriochloa saccharoides*) was the most common nesting substrate on native rangeland sites. Nest sites were monitored via the use of radio-marked females to determine if bobwhites preferred either habitat type. Simulated nests ($n=144/\text{yr}$) were used to evaluate hatch rates between the 2 habitat types. Arthropod abundance (as an indicator of brood habitat) was measured annually using sweep nets and pitfall traps. We documented 100 nest sites, 16% were in located in CRP while the remaining 84% were in rangeland. “Survival” of simulated nests (at 28 days exposure) across the 3 years averaged 73% for CRP and 74% on rangelands. We conclude that CRP habitats dominated by kleingrass were used for nesting in proportion to their availability, but that rangeland habitats afforded better brood habitat.

Key words: Conservation Reserve Program, nesting, Northern bobwhite, simulated nests, Texas

Evaluation of Survey Indices for Scaled Quail in West Texas

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Abstract

Wildlife biologists and land managers require information on population demographics in order to effectively plan harvest schedules and evaluate habitat modifications. Population indices can potentially provide an efficient way to gather reliable information on wildlife populations as long as they reflect population behavior. We evaluated the relationships among standard survey indices used to monitor scaled quail (*Callipepla squamata*) across 6 sites in west Texas from 2007-2010. We collected data on spring cock call counts, simulated nest survival, roadside counts, and helicopter counts, and where possible, compared them to hunter data (flush rates, age ratios) collected during hunting season. When we compared relative abundance, roadside counts and helicopter counts showed similar numerical trends. Simulated nest fate (i.e., dummy nests) tended to track trends in population abundance. Our survey indices also followed annual fluctuations in scaled quail abundance as estimated by Texas Parks and Wildlife Department's annual roadside surveys.

Key words: *Callipepla squamata*, population estimation, scaled quail, Texas

Impacts of Invasive, Exotic Grasses on Quail of Southwestern Rangelands: A Decade of Progress

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Abstract

Exotic grass invasions are a serious concern for state and federal agencies, non-government organizations, and private landowners engaged in quail conservation and management. Quail biologists started to recognize the potential negative impacts of exotic grass invasion on North American quail populations about two decades ago, and this issue was addressed in a review paper published in the proceedings of the 5th National Quail Symposium in 2002. Here we review the state of our knowledge on the impacts of exotic grass invasions on quail inhabiting southwestern rangelands. The objective of this manuscript is to provide an update on the progress of exotic grass/quail research on southwestern rangelands over the past decade. We highlight numerous studies and provide specific results about the impacts of exotic grass invasions on southwestern quail populations. We also discuss the results of studies that have quantified the impacts of exotic grass infestations on quail habitat and describe how exotic grass invasions negatively impact important components of quail habitat such as native herbaceous plant and arthropod species and diversity and abundance. Finally, we discuss progress on the management of exotic grasses and provide suggestions for direction of future exotic grass/quail research.

Key words: invasive exotic grass, quail, southwestern rangelands, results recent studies, future research recommendations

Preference and Nutrition of Quail Breeder 16[®], Common Agricultural Feeds, and a Mix of Native Seeds as Northern Bobwhite Food

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Abstract

Agricultural feeds are commonly dispersed along roads or in openings as an attractant or dietary supplement for northern bobwhites. Quail Breeder 16[®] is a pelletized ration specifically developed by Lyssy & Eckel Feeds for breeding bobwhites to maximize nutritive content for diets of wild bobwhites. Captive bobwhites were used to determine relative preference of the pellets, sorghum (*Sorghum bicolor*), corn (*Zea mays*), soybean (*Glycine max*), and a mix of seeds of 8 native plant species. Protein, fat, acid detergent fiber, gross energy, and mineral content of the feeds were determined. We also examined changes in body mass of bobwhites fed exclusive diets of each of the five feeds. A Latin square design, with single and multiple-offer treatments, was used to compare feed preference. Sorghum was the most highly preferred feed for both the single and multiple offering experiments. Soybeans and the pelletized ration were the least preferred feeds. The native seed mix and corn were intermediate in preference. Nutritionally, soybeans had the highest protein (40%), highest fat (19%), and highest gross energy (5 kcal/g). Bobwhites fed exclusive diets of the native seed mix exhibited the greatest increase in body mass (+4%), and birds fed the sorghum diet had the greatest decrease in body mass (-8%, $P < 0.05$). Providing supplements such as pelletized rations and agricultural feeds should not take precedence over managing bobwhite habitat to produce a variety of native grasses and forbs when improving bobwhite nutrition is a management objective.

Key words: Quail Breeder 16[®], northern bobwhite, supplement, Latin-square, relative preference, *Colinus virginianus*, nutrition

Spring Dispersal of Northern Bobwhites in Southwestern Ohio

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Abstract

Information on dispersal of northern bobwhites (*Colinus virginianus*) is important to understand population dynamics and the species' capacity to recolonize unoccupied habitats. Bobwhites were historically found throughout Ohio but their core range has contracted to 18 southwestern counties. Trap and transplant of wild birds is used by the Ohio Division of Wildlife to reintroduce wild bobwhites to unoccupied habitats within the species' historic range. We captured and radio-marked bobwhites on four private-land study sites in southwestern Ohio during 2009-2011. Radio marked birds (n=39) were tracked by homing or triangulation during spring 2010. Dispersal was defined by break up of coveys and subsequent occupation of breeding habitat. Bobwhites dispersed during 4 April to 20 May as determined from non-affiliation with coveys, daily movement patterns, and breeding activity. Dispersal distances were measured as the Euclidean distance between locations recorded at the beginning and end of dispersal. Dispersers were defined as birds that moved >2X the diameter of mean home range size (43.76 ha) observed during October-March. Non-dispersing bobwhites traveled <1 home range diameter and intermediate movements (>1 to < 2 home range diameters) were classified as a home range shift. Eighteen (46%) radio marked bobwhites were classified as non-dispersers, 10 (26%) shifted their home range, and 11 (28%) dispersed. Non-dispersers moved on average 0.42km, home range shifts averaged 1.1km, and dispersers traveled a mean distance of 5.3km (range 2.5 – 11.5 km). Our results suggest that Ohio bobwhites are capable of expanding their range into historically populated areas if suitable habitat is present.

Key Words: Northern bobwhite, *Colinus virginianus*, dispersal, home range shift, southwestern Ohio, habitat, re-colonization

Monitoring Northern Bobwhite Breeding Populations in the Central Hardwoods Bird Conservation Region

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Abstract

Northern bobwhite (*Colinus virginianus*) populations declined by 3.8% from 1980-2006 in the Central Hardwoods Bird Conservation Region (CHBCR). Monitoring bobwhite populations and developing accurate population estimates by incorporating detection functions, and occupancy estimates is an important component of the conservation initiative in this region. We developed a roadside-based monitoring strategy for bobwhite populations within bobwhite focal areas in the CHBCR (n = 37 counties). We randomly located five 15-km monitoring routes in each focal county along secondary roads. We conducted 5-min unlimited distance point counts along each route (30 counts/route). We conducted roadside and off-road point counts to assess roadside bias and used radio-tagged bobwhites to document calling rates by time of day and day of season. We used count data and adjusted abundance estimates with a time-removal model with a distance covariate. We used occupancy and Huggins closed capture modules in program MARK to model occupancy and detection probabilities. We calculated relative abundance for three years of survey data as individuals/route (n = 360 routes, $\bar{x} = 11.1 \pm 4.1$). We compared a set of ten a priori models to determine if detection probabilities were most influenced by distance from road, time of year, site, or occupancy. Distance had less influence on detection probabilities than day of season. Detection probabilities were greater (>20%) during the second point count visit ($\rho = 0.61 \pm 0.046$), versus first ($\rho = 0.49 \pm 0.045$) and third ($\rho = 0.44 \pm 0.044$) visits (n = 153). Results indicate a peak in bobwhite detection probabilities occurs between June 1st – June 25th, an important consideration for population models that use from summer survey data. We will ultimately provide annual population estimates for bobwhites based on roadside based counts that can be corrected for detection and occupancy in the CHBCR.

Key words: Detection probability, *Colinus virginianus*, Central Hardwoods, Northern Bobwhite, point counts, time-removal, roadside-based survey

Scaled Quail Reproduction in the Trans Pecos Region of Texas

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Abstract

Water harvesting efforts (i.e., “spreader dams”) have received growing attention for increasing herbaceous biomass, species diversity, and arthropod biomass on semiarid rangelands. These more mesic areas could conceivably improve nesting and brood habitat for scaled quail (*Callipepla squamata*). We evaluated the effectiveness of spreader dams on nesting ecology of scaled quail in Pecos County, Texas during the summers of 1999–2000. We monitored radiomarked female scaled quail ($n = 210$) through the nesting seasons of 1999 and 2000. Hatch rate was high (i.e., $\bar{x} = 67$ and 84% for 1999 and 2000, respectively). Spreader dams were not used as nest locations as only 2 of 74 nests were located in or adjacent to them. Simulated nest hatch rates also were high ($\bar{x} = 81$ and 82% for 1999 and 2000, respectively). The moist-soil areas provided by spreader dams supported a 23-fold increase in herbaceous biomass ($\bar{x} = 98.8$ g inside, $\bar{x} = 4.3$ g outside) compared to adjacent uplands and a 4.5-fold increase in arthropod biomass ($\bar{x} = 0.9$ g inside, $\bar{x} = 0.2$ g outside). While moist-soil sites may have influenced subsequent brood habitat (i.e., arthropod availability) we failed to document any direct impacts on nesting ecology of scaled quail.

Key words: *Callipepla squamata*, nesting success, moist-soil management, scaled quail, spreader dams, Trans Pecos, Texas

Climate Change and Northern Bobwhites: The State of Our Knowledge, Possible Outcomes, and the Risk of Ignorance

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Abstract

No disturbance in the Holocene has received more scientific resources or public scrutiny than global climate change. This phenomenon and associated uncertainty in its' potential effects reduces our ability to effectively manage species such as northern bobwhites (*Colinus virginianus*). This uncertainty is complex because of the hierarchical nature of spatial and temporal scales of ecological and societal processes that can influence bobwhite persistence. A loss of financial resources can occur if the threat of climate change is false because of inefficient resource allocation. However, if effects are real and system dynamics are altered, management concerns and decisions must adapt in response to new information. Furthermore, decisions relative to climate change occur at time scales scientists are not accustomed. Climate change effects will likely be subtle in regions inhabited by bobwhites and occur over decades. The climate change paradigm (and all that it encompasses) should be viewed as a decision-making issue and not a scientific exercise. It behooves bobwhite scientists and managers to understand potential effects of climate change regardless of the casual agent. Ecological changes are likely to occur even if variation in climate is minimal; thus, the risk is too high to ignore. I propose addressing bobwhite management relative to climate change using a hierarchical decision framework that incorporates a mechanistic approach of relevant processes (e.g., land-use changes, raptor migratory patterns, and bobwhite life history) at multiple spatial and temporal scales.

Key words: Northern Bobwhite, *Colinus virginianus*, climate change, bobwhite management, raptor migration.

Impacts of Bermudagrass on Northern Bobwhite Chicks: Mobility and Heat Exposure

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Abstract

Conservation programs to benefit Northern Bobwhites (*Colinus virginianus*) and other agriculturally related wildlife species often target crop-field margins for management. The Bobwhite Quail Initiative in Georgia is one such program where 3-18 m strips are disked and left to remain fallow for 3-year cycles. However, several exotic grasses, such as bermudagrass (*Cynodon dactylon*), encroach in field margins--reducing the utility for avian species. We hypothesized that dense mats of bermudagrass would be a physical barrier to bobwhite chicks and also serve as a heat trap reducing habitat quality. We conducted two experiments to assess these factors. First, we used human-imprinted bobwhite chicks, 5 and 10 days of age, to assess mobility through vegetation with 3 levels (none, moderate, and high) of bermudagrass invasion. We found a significant impact of bermudagrass density on mobility of 5-day old chicks ($P=0.002$), but no effect on 10-day old chicks ($P=0.38$). Second, we placed temperature recorders at ground level in plots in field margins that had >75% coverage of bermudagrass and those with >75% coverage of forbs. We found that mean temperature of bermudagrass plots was greater than forb plots ($P=0.03$). The percentage of time above the 40 C critical threshold temperature for bobwhites was greatest in bermudagrass plots ($P=0.03$) and ranged over 33-38% of daytime hours, but only 6-26% for forb plots. Our data suggests that bermudagrass degrades the quality of field margins and control of exotic invasive grasses is warranted to improve their efficacy.

Keywords: bermudagrass, chick ecology, *Colinus virginianus*, *Cynodon dactylon*, exotic grass, field margin, Northern Bobwhite, thermal ecology

Northern Bobwhite Population Structure and Diversity in Texas and the Great Plains

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Abstract

Throughout its range, many northern bobwhite (*Colinus virginianus*) populations have been experiencing severe declines. Due to the popularity of this species as a game bird, this decline is concerning wildlife biologists, landowners, and legislators. Previous molecular genetic analyses for intact habitats in south Texas indicate that the northern bobwhite population in this region is genetically diverse with a low degree of population structure. Our goal is to assess the population structure and diversity in intact and fragmented habitats in Texas and the Great Plains as a comparison to south Texas. We extracted mitochondrial DNA from 8-12 northern bobwhites per site (we have received samples from 24 sites to date), collected by hunters during the 2010-2011 hunting season. We amplified the 5' control region and analyzed 7 microsatellites. We also used data from an 8-year radiotelemetry study on a northern bobwhite population from a large ranch in south Texas. Using both radiotelemetry and molecular genetic data from 2010-2011, we examined the influence of intact and fragmented habitats on northern bobwhite population structure. We present preliminary results using a portion of the data from our ongoing research in northern bobwhite population structure.

Keywords: causal modeling, *Colinus virginianus*, Great Plains, landscape, molecular genetics, northern bobwhite, radio telemetry, Texas

A Comparison Between Adult and Juvenile Northern Bobwhite Productivity in North Florida

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Abstract

Greater reproductive productivity of adult versus juvenile northern bobwhites (*Colinus virginianus*) has been hypothesized as a factor for rapid population growth. Research on bobwhites in the western portions of the bobwhite range has not supported this hypothesis; however no effort has been made to investigate age-specific reproduction on population dynamics in the southeast. Therefore, we measured age-specific reproductive parameters between adult and juvenile bobwhites over 6 years. We radio-tagged 726 females (197 adults, 529 juveniles) and monitored 479 nests (143 adults, 336 juveniles) to compare nesting rates, nesting success, initial clutch sizes and date of first incubated nest. We found nesting success to be 58.6% for adults and 61.1% for juveniles. The average clutch size was also similar between adults and juveniles with 12.48 ± 0.84 eggs for adults and 12.93 ± 0.97 eggs for juveniles. The mean initial incubation date for adults was June 16 and June 22 for juveniles. We found nesting rates of $1.39 \text{ nest/hen} \pm 0.65$ for adults and $1.13 \text{ nest/hen} \pm 0.69$ for juveniles. While we observed slightly higher nesting productivity for adults than juveniles, the increase did not translate to greater autumn populations. Environmental factors, such as weather and predator-prey relationships, influence reproductive demographics in an age-independent manner and appear to have a larger impact on productivity than population structure of hens at the beginning of the breeding season.

Key words: age-specific reproduction, *Colinus virginianus*, Florida, northern bobwhite, population dynamics, reproductive ecology

A County-based Northern Bobwhite Habitat Prioritization Tool for Kentucky

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Abstract

Planning the management of northern bobwhite (*Colinus virginianus*) habitat at a statewide-scale is daunting. Native grassland restoration may prove to be one of the most difficult to manage in Kentucky, because over 99% of their original extent has been lost to agriculture, succession, and development. Since more than 90% of the land is privately owned, we created a decision support tool designed to target areas of native grasslands and landowners likely to participate in conservation programs. Our goal was to identify 10% of the land base at the county level as “high priority”. Given the diversity of Kentucky’s landscape, we created an eastern and western model, divided by the Appalachian Mountains. The western model was designed to target production-oriented operators farming marginal lands, whereas the eastern model targeted reclaimed mine lands. We review the variables used in the models, which included mail carrier survey data, agricultural statistics, State Wildlife Action Plan priority areas, land cover data, staff feedback on potential for quail restoration, and USDA service in a county. Upon completion of the two independent models, acreages were summed yielding 15.75% of the land base. However, if acreages of prime agricultural grounds and large contiguous blocks of forests were excluded, then the acreage total was much closer to the 10% target. Given the dynamic nature of some county-level metrics, re-applying models periodically could change conservation targets. Including a combination of ecological and societal parameters in decision support tools may further refine their value and applicability, especially in the eastern US.

Key words: *Colinus virginianus*, prioritization, decision support tool, habitat, Kentucky, northern bobwhite, model, target, grasslands, restoration

Effects of Conservation Reserve Program Mid-Contract Management on Consumption of Arthropods by Northern Bobwhite Chicks

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Abstract

An extensive amount of Conservation Reserve Program (CRP) habitat for northern bobwhite (*Colinus virginianus*) has been lost to the planting of tall-fescue (*Festuca arundinaceae*). We conducted foraging trials using human-imprinted bobwhite chicks ($n = 248$) to assess the effects of 3 mid-contract management (MCM) options including 1) fall disking, 2) fall glyphosate, and 3) fall glyphosate with spring legume drill-seeding on the foraging rates and arthropod selection in fescue-dominated CRP in Illinois. We found that glyphosate and glyphosate drill-seeding provided greater brood habitat benefits for bobwhite chicks than did control or disking treatments. Across all treatments, chicks consumed a greater abundance ($P < 0.0001$) and biomass ($P = 0.0017$) of arthropods in MCM fields than in non-MCM fields. Compared to non-MCM fields, abundance and biomass of arthropods consumed by chicks were higher in glyphosate and glyphosate drill-seeded strips with 1-, 2-, and 3-growing seasons post treatment, but disking only provided this benefit for 1 growing season. We also found that vacuum sampling provided a poor index of the availability of arthropods to bobwhite chicks. Vacuum sampling indicated that arthropod abundance was greater in non-MCM fields than in MCM fields ($P = 0.170$). We conclude that vacuums are not appropriate tools for measuring the abundance of arthropods important to bobwhite chicks in fescue-dominated CRP. We also conclude that in situations where MCM in fescue-dominated CRP is limited to fall disking, fall glyphosate, and fall glyphosate with spring legume drill-seeding, that fall disking is an inferior MCM practice.

Key words: Arthropod prey selection, *Colinus virginianus*, Conservation Reserve Program, disking, foraging rates, glyphosate, human-imprinting, Illinois, legume drill-seeding, mid-contract management, northern bobwhite, tall fescue, vacuum sampling

Habitat Selection by Northern Bobwhites Broods in Pine Savanna Ecosystems

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Abstract

Habitat for northern bobwhite (*Colinus virginianus*) broods is a critical component of bobwhite management. Within pine savannas research has provided contradictory results regarding the value of macro-habitats with studies demonstrating selection for annually-disked fallow fields and others showing avoidance of fields and selection for burned uplands or hardwood bottomlands. Field establishment of up to 20% of a property is a common management recommendation for bobwhites in pine-savannas but there are significant annual costs with fallow-field management; information on what factors influence habitat selection by broods can improve management recommendations and facilitate weighing costs/benefits. Therefore, we examined 2nd order and 3rd order habitat selection of 377 broods on 3 sites during 1999-2009. All sites had similar macro habitat types but differed in soil quality and groundstory species composition. On lower fertility sites with predominantly grass and hardwood scrub groundstories, annually disked fields were preferred by broods in most years. However, rainfall mediated field use on these sites with hardwood drains being selected during exceptionally dry summers and burned uplands being selected when rainfall was sufficient to grow cover. On higher fertility sites burned upland pine savanna was preferred in 90% of years at the 3rd order level, fields were avoided or used according to availability 80% of years, and drains were avoided. Managers should consider how soil, weather, and vegetation community in pine savannas influences habitat use of bobwhite broods when determining the value of different macro-habitats. Field establishment may or may not provide brood habitat depending on site.

Key words: broods, habitat use, fields, northern bobwhite, pine, savanna

Value of Private Lands Managed for Wild Northern Bobwhites in the Deep South

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Abstract

In the Southeastern U.S., successful bobwhite management creating huntable bobwhite populations is largely practiced on private lands. These properties not only support high-density bobwhite populations, they also support biodiversity including many declining or endangered species associated with frequently burned pine savannas. The private land model has proven sustainable over centuries and has recently increased with over 50,000 acres of wild bobwhite lands added to the GA, FL, and SC since 2000. While the NBCI recognizes that private lands are critical to restoration of bobwhites and despite their conservation value, no studies have quantified areas under wild bobwhite management. Therefore, we mapped 259 properties totaling 854,000 acres with wild bobwhite management principally in GA, FL, AL, and SC, and are completing mapping in MS, VA, and NC. Our survey data found management actions were consistent across these properties including maintaining open pine canopy, reducing hardwoods in upland areas, prescribed fire at appropriate sizes and distribution, year-round supplemental feeding, nest predator management and conservative harvest rates. Adoption of these management practices is a result of long-term research demonstrating their efficacy. Density of bobwhites on a property was related to landscape composition with lower densities on more fragmented sites. Properties in core areas surrounded by other managed properties often achieve bobwhite densities of 5 – 8 quail/ha. Bobwhite densities on smaller isolated properties densities were ~ 2.5 quail/ha during fall. Aspects of this successful management model may be useful to other private lands as well as public management areas focused on northern bobwhite.

Key words: bobwhite, NBCI, lands, private, landscape, mapping, quail

Relationship between Summer Whistle Counts, Roadside Counts, and Fall Abundance for Northern Bobwhite

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Abstract

Reliable information on the fall abundance of northern bobwhite (*Colinus virginianus*) is important for proper harvest management. Aerial surveys can provide reliable estimates of abundance, but can be expensive. Alternatively, whistle counts and roadside counts are indices of abundance that are relatively inexpensive, simple, and commonly used by biologists. We compared whistle and roadside counts conducted during summer to fall relative abundance (coveys/km) estimates obtained using helicopter surveys. All data were collected at the pasture scale (mean = 1,716–2,762 ha) on the King Ranch (334,000 ha), which is comprised of 4 divisions across south Texas. Average survey effort was 245 km/year (1999–2001) and 1,194 km/year (1999–2007) for whistle and roadside counts, respectively, and 48 km/pasture/year (1999–2009) for fall helicopter surveys. Preliminary analyses demonstrate a moderate correlation between whistling males and fall relative abundance ($r = 0.68$). We collected age-based (i.e., chicks, juveniles, and adults) and population structure-based (i.e., singles, pairs, or coveys) data for roadside counts. Correlations between roadside counts and fall relative abundance varied by age and population structure. We found moderate correlation between total juveniles and fall relative abundance ($r = 0.49$); all other correlations were low ($r = <0.36$). Here, we explore the feasibility of using summer whistle and roadside counts as a surrogate for fall relative abundance and discuss optimum timing to conduct surveys.

Key words: aerial surveys, *Colinus virginianus*, index, northern bobwhite, relative abundance, whistle counts, roadside counts

Temporal and Spatial Trends in Bobwhite Survival, Nest Success, and Clutch Size Across Their North American Range

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Abstract

The northern bobwhite (*Colinus virginianus*) has been declining in abundance across North America for many years, but it is unclear if other demographic variables share this downward trajectory. We conducted a meta-analysis of the temporal and spatial trends of 3 demographic variables—annual survival, nest success, and clutch size—by reviewing 78 studies. Mean annual survival (\pm SD) was 0.15 ± 0.15 (1929–2004; $n = 32$ studies). Survival was non-trending prior to 1990 but increased by 0.02/year (95% CI = 0.01–0.02) afterwards. These increases after 1990 occurred along latitudinal and longitudinal gradients in which survival decreased at the northern and western periphery of the bobwhites range. Mean nest success was 0.44 ± 0.14 (1924–2008; $n = 33$), and increased by 0.02/year (95% CI = 0.01–0.03). We detected latitudinal and longitudinal gradients prior to 1990 but not after. Nest success was lowest at the northern and eastern periphery of the bobwhites range. Mean clutch size was 13.1 ± 1.0 (1931–2008; $n = 13$) and exhibited no biologically meaningful trend through time. We detected a latitudinal gradient in which clutch size increased by 0.2 eggs/degree of latitude (95% CI = 0.11–0.19). Despite continued bobwhite declines, some demographic variables exhibited positive trends, which may be a result of the conservation and management attention bobwhites have received over the past 2 decades. Our results also demonstrate spatial variation in some demographic variables, which suggest a need for greater management attention at the edge of their range.

Key words: annual survival, clutch size, *Colinus virginianus*, gradients, meta-analysis, nest success, northern bobwhite

Threat Avoidance by Northern Bobwhite in the Texas Rolling Plains

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Abstract

As an important game species with declining populations throughout their range, northern bobwhites (*Colinus virginianus*) have become a species of increased management interest. Current land management recommendations for bobwhites are based on data gathered in response to purely anthropogenic threats, which implies a general lack of research on bobwhite habitat use strategies in relation to non-anthropogenic predation threats. We began data collection in January 2010 to investigate the differences in habitat use and escape behavior of bobwhites exposed to four different predation threats: raptor, nocturnal mammalian, hunter, and researcher. To examine habitat use and escape behavior we are recording distance to flush, flush speed, over-all flight speed, flight distance, and cover use in response to the simulated threats. We will cease data collection at the end of March 2011; however, within currently analyzed data, bobwhites selected grasses as escape cover in response to nocturnal mammalian, hunter, and researcher threats at 100%, 71% and, 80% rates respectively and selected for shrubs or trees 77% when threatened by a raptor. These preliminary results suggest that land management recommendations based solely on anthropogenic threats may be insufficient to enable successful bobwhite escape strategies when confronted with threats from raptors.

Key words: Threat avoidance, *Colinus virginianus*, habitat use, predator prey interaction, escape behavior, Rolling Plains

Effects of Edge on Northern Bobwhite Nest Success in Field Borders

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Abstract

Northern bobwhite (*Colinus virginianus*) populations have declined because of habitat loss and fragmentation. Field borders may provide additional habitat for northern bobwhites and other wildlife that depend on early-succession habitat to meet their life history requirements. The primary objective of this study is to determine if northern bobwhite nest survival in field borders decreases with increasing proximity to various edges such as crop field, ditch, road, and woody edges. We also want to determine if snakes are the primary nest predator via 24-hour video camera surveillance. We searched for and monitored northern bobwhite nests on 190 acres of field borders in southeast North Carolina during the summer of 2010. We found 9 nests and monitored them every 3-4 days. Five nests were monitored with cameras. Using program MARK we built models using the covariates of field border width and distance to nearest crop field, ditch, road, or woody edge. The top model was constant northern bobwhite nest survival with an estimated daily nest survival of 0.93 ($\pm 0.03se$) (AICc weight=0.31). Models with covariates suggested similar daily nest survival rates. One snake and mammalian depredation event was caught on camera. A second and final field season will be completed during the summer of 2011. Our findings will allow us to recommend the best field border placement to maximize nest success for northern bobwhites. Preliminary results suggest field border placement has little influence on nest survival. However, this should be interpreted with caution as our 2010 sample size was small.

Key words: *Colinus virginianus*, nest predators, nest survival, North Carolina, northern bobwhite, field borders, Program MARK

Pithy, Personalized Notes on the Powerful Founding Ideas of Quailology

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Abstract

Powerful ideas in quailology affect thinking over generations, even if the ideas are wrong. I discuss great ideas put forth by Aldo Leopold (1886–1948), Herbert Lee Stoddard (1898–1968), and Paul Lester Errington (1902–1962). Leopold, an extraordinarily good father, posited the Law of Dispersion/Interspersion, which became known as the Principle of Edge. The Law of Dispersion is a tautology (statement that is inevitably true) that can be paraphrased “edge-obligate animals require edge.” Leopold said the “law” held “within ordinary limits,” which he did not define but which may mean “within compositionally simple landscapes.” As a child, Stoddard, who dropped out of high school to support his family, recognized the value of fire in bobwhite habitat management in the Southeast; later he came to see that tenant farming (patchwork agriculture) set up conditions favorable to bobwhites. Stoddard was given to invention, or after-the-fact hypothesis formulation on the causes of events he observed. Through this logically weak process he bequeathed many “facts” that are untested guesses. Errington, a loner who survived polio as a child, had 2 great ideas. The threshold of security was a fairly constant spring density, which implied harvest up to a certain level is fully compensatory (doomed-surplus model). The principle of inversivity implies that relative productivity declines as breeding density increases. Errington’s own work refuted the doomed-surplus model because he could not have simultaneously observed a constant breeding population and inversivity, which requires a variable breeding population. The great founding ideas discussed above, though not without flaw, arose through observation of nature and thought, not through null hypothesis significance testing and model selection.

Key words: quailology, quail, Aldo Leopold, Herbert Stoddard, Paul Errington, Law of Dispersion/Interspersion, Principle of Edge, philosophy, science, model selection, statistical significance.

The Western Quail Management Plan

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Abstract

The Western Quail initiative was first proposed at Quail III in 1993. The reasons for creating such a group were then, as they are now, to improve management on Western Quail, assess populations range-wide, identify current threats, improve habitat, and identify research needs. The Western Association of Fish and Wildlife Agencies (WAFWA) approved the creation of the Western Quail Working Group (WQWG) in July 2009. The purpose of the group is to implement the habitat objectives and management recommendations outlined in the Western Quail Management Plan, published by the Wildlife Management Institute in January 2010. Membership to the WQWG includes representatives from state and federal wildlife agencies and non-governmental organizations involved in wildlife habitat improvement. At the first face-to-face meeting of the group at the January meeting of WAFWA in Tucson, Arizona, Memoranda of Understandings (MOUs) among the states and Federal Land Management Agencies were crafted and those MOU's were signed by WAFWA states and Federal agencies at the July, 2011 WAFWA meeting. The WQWG is poised to re-energize habitat restoration, research, and management of western quail throughout the Western United States. We welcome all partners who wish to be a part of this effort.

Key words: Western, quail, Arizona, Western Association of Fish and Wildlife Agencies, Wildlife Management Institute, Quail III

Do Beneficial Insect Habitats also Provide Quality Brood Habitat for Northern Bobwhite?

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Abstract

Strips of fallow vegetation along cropland borders are an effective strategy for providing northern bobwhite (*Colinus virginianus*) habitat. However, a limitation of fallow borders is the lack of nectar-producing vegetation needed to sustain many beneficial insect populations. Planted borders that contain mixes of prairie flowers and grasses may harbor more diverse arthropod communities, but the relative value of these borders as brood habitat compared to fallow borders is unknown. We used groups of six human-imprinted bobwhite chicks as a bioassay for comparing four different border treatments (planted native grass and prairie flowers, planted prairie flowers only, fallow vegetation, or mowed vegetation) as bobwhite brood habitat from June-August 2009 and 2010. All field border treatments (0.33 ha each) were established around nine organic crop fields. Groups of chicks were led through borders for 30-minute foraging trials and immediately euthanized, and their crops and gizzards were later dissected and eaten arthropods were identified, measured, counted. We used allometric equations to estimate live weight of arthropods consumed. A modified leaf blower was used to sample arthropod availability in the borders. The mass of arthropods consumed per chick did not differ among treatments in 2009, but was higher in fallow borders compared to other treatments in 2010. Mean arthropod densities calculated from blower-vac samples did not differ among treatments in 2009 or 2010. Overall, our results suggest that field borders planted for promoting beneficial insects provide bobwhite brood habitat equivalent to fallow borders.

Key words: beneficial insects, field borders, *Colinus virginianus*, northern bobwhite, brood habitat

The Texas Quail Index: Evaluating Predictors of Northern Bobwhite Productivity and Abundance Using Citizen Science

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Abstract

Annual abundance of northern bobwhites (*Colinus virginianus*) fluctuates drastically in semi-arid environments (e.g., Texas), which complicates the ability of wildlife biologists and quail managers to predict annual bobwhite productivity, and the relative abundance of bobwhites for the ensuing hunting season. The Texas Quail Index (TQI) was a 5-year citizen-science project that evaluated several indices as predictors of bobwhite productivity and abundance during the subsequent fall. Indices included spring cock-call counts, habitat photo points, forb species richness, simulated-nest fate, potential nest site density, scent station visitation rates, and roadside counts. Spring cock-call counts explained only 41% of the variation in fall bobwhite abundance across all study sites in years 1–4; yet, they explained 89% of the variation in year 5. Further, the percentage of juveniles in the fall population (an index of bobwhite productivity) was significantly lower in year 5. According to the Palmer Drought Severity Index, all study sites experienced drought conditions throughout year 5. These results confirm that drought conditions in semi-arid environments result in reduced productivity as compared to non-drought years. Additionally, results suggest that low recruitment during drought years renders fall bobwhite abundance more predictable than during non-drought years. Consequently, by recording and analyzing spring cock-call counts and PDSI data, wildlife biologists and quail managers should have a better ability to predict bobwhite productivity and fall abundance in drought years.

Key words: population index, abundance estimates, northern bobwhite, call counts, citizen-science, *Colinus virginianus*, density estimate, population dynamics, predators, quail abundance, reproduction, productivity, Texas

Northern Bobwhite Age Ratios and Productivity at the Individual Property Scale in South Texas

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Abstract

Annual adult survival rate (\hat{S}) and finite rate of population growth (λ) are critical parameters that must be considered when subjecting a species to annual harvest. To estimate these parameters, we used a dataset of 148 estimates of northern bobwhite (*Colinus virginianus*) juvenile:adult age ratios (R) derived from hunter-harvested wings in the South Texas Plains. Data were collected from 1940 to 1976 and from 1983 to 2008. We used adjusted estimates of R to account for higher harvest vulnerability of juveniles, and the regional estimate of \hat{S} (30.6% based on a stable population) to calculate estimates of λ at the ranch (~800–2,000 ha) scale. Mean adjusted R was 2.79 ± 0.13 juveniles:adult. Assuming a stable population (i.e., $\lambda = 1$), mean (\pm SE) regional \hat{S} was $30.6 \pm 0.1\%$. Given an annual \hat{S} of 30.6%, mean regional λ was 1.16 ± 0.04 , and single year λ estimates ranged from 0.40–3.03 among individual properties. These data have important implications for bobwhite harvest management because they identify the potential for highly variable population growth rates (λ) at a localized scale. When local populations are declining, there is an increased probability of overharvesting the population. However, as our data indicate, using only a regional estimate of λ may mask local population trends, which carries the potential for mismanagement of harvest within a given property by making harvest recommendations that are too high (overharvest) or too conservative (loss of opportunity).

Key words: *Colinus virginianus*, South Texas, northern bobwhite

Application of Metapopulation Theory to Northern Bobwhite Conservation

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Abstract

Northern bobwhite (*Colinus virginianus*) populations have declined throughout the majority of the species' range, with the largest declines occurring in fragmented habitats. We used the results from a stochastic bobwhite population dynamics model and from a preliminary study of the landscape genetics of South Texas bobwhites as conceptual justification for the use of metapopulation theory in bobwhite management. Based on a single-population model, isolated bobwhite populations in South Texas that incur an annual harvest of 20% have a 95.1% probability of persisting at least 10 years, and a 60.5% probability of persisting up to 100 years. Given a 30% annual harvest rate, the single-population model indicated that bobwhite populations have only a 6.4% probability of persisting for at least 10 years. However, in scenarios where we modeled 5 occupied habitat patches, the probability of regional persistence at 30% harvest increased to approximately 100%. Thus, there seems to be a theoretical basis for the hypothesis that bobwhite population persistence is related to a metapopulation structure. Molecular genetics data provide empirical support for this conclusion. Ongoing population genetic studies appear to provide empirical support for metapopulation structure and suggest that dispersal among local populations must occur more frequently than previously thought. Given the high probability of extinction of isolated populations, these results have strong implications for bobwhite harvest management. To conserve and maintain huntable bobwhite populations, large patches of habitat must remain connected on a landscape scale.

Key words: *Colinus virginianus*, metapopulation, northern bobwhite

Field Application of Sustained-yield Harvest Management for Northern Bobwhite in Texas

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Abstract

Sustained-yield harvest (SYH) is considered a potentially viable strategy for managing harvest of northern bobwhites (*Colinus virginianus*). However, application of SYH in the field has not been evaluated for northern bobwhites. We evaluated the application of using SYH as a harvest management strategy for bobwhite during the 2007–2008 and 2008–2009 hunting seasons in 2 ecoregions of Texas (Rolling Plains and South Texas Plains). We collected field data on three study sites/ecoregions (900-1,900 ha each; 2 hunted sites and 1 control) to estimate 4 demographic parameters (fall and spring density, overwinter survival in the absence of hunting, and harvest rate). We used these data to parameterize the additive harvest model for bobwhites and compare predictions of spring abundance of the model with field estimates. Compared to field estimates, the additive harvest model consistently underestimated spring population density (mean % ± SE) by $55.7 \pm 17.8\%$ (2007–2008) and $34.1 \pm 4.9\%$ (2008–2009) in the Rolling Plains and by $26.4 \pm 25.3\%$ (2007–2008) and $49.1 \pm 2.1\%$ (2008–2009) in the South Texas Plains. Despite potential benefits of SYH, implementing SYH in the field will be challenging given the need for reliable estimates of three key population parameters (fall and spring density and natural mortality in the absence of hunting) and the high variation often associated with them. However, conservative harvest prescriptions based on the lower 95% CIs of fall density estimates may permit sustainable harvest despite variation in density estimates.

Key words: Northern Bobwhites, *Colinus virginianus*, Texas, hunting, sustained yield harvest.

Bobwhite Restoration in Mississippi: How Realistic Are Mississippi's NBCI Population Goals?

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Abstract

Northern bobwhite (*Colinus virginianus*) populations have declined dramatically throughout their range. The Northern Bobwhite Conservation Initiative (NBCI) is a habitat-based restoration plan developed in response to these significant declines. The Mississippi NBCI step-down plan identified long-term population goals of 1 covey/34.48 acres and short-term goals (5-10 years) of 1 covey/66.67 acres. A myriad of challenges remain in stepping down and delivering regional and state-level habitat goals. Of primary interest are two questions: 1) Are these goals achievable, and 2) What percentage of a landscape needs to be affected to produce these densities? We developed a monitoring program to evaluate the effects of landscape-level management on quail populations. Using distance sampling techniques, we monitored fall quail populations on three focal properties implementing a variety of conservation practices at varying intensities across a relatively large spatial extent (3000 – 7000 ac). Bobwhite densities averaged 1 covey/29 acres on the surveyed 5400 acre private property in Clay County, 1 covey/19 acres on a 3200 acre private property in Panola County, and 1 covey/55.5 acres on a 6400 acre property in Coahoma County. Based on these outcomes, we conclude that the NBCI goals are reasonable and achievable. The MS NBCI short-term goals are achievable by only affecting 8% of the landscape and 15% of row-crop acreage. Furthermore, the MS NBCI long-term goals are achievable with strategic planning and broadly applied comprehensive conservation management systems.

Keywords: northern bobwhite, quail, *Colinus virginianus*, NBCI, Mississippi NBCI, private lands, covey, distance sampling

Development and Implementation of a Successful Northern Bobwhite Translocation Program in Georgia

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Abstract

Gamebird translocations have been used for many years to establish or re-establish populations in North America. Long-term severe declines of Northern Bobwhites (*Colinus virginianus*) (hereafter bobwhites) over much of their range have brought this issue to the forefront for this species as well. A series of field studies conducted in Georgia over the last decade have documented site fidelity, high survival, reproductive success, and population response from bobwhites translocated into large blocks of well-managed habitat. As a result of these studies and a desire to help landowners expedite bobwhite recovery; the Georgia Department of Natural Resources Wildlife Resources Division implemented an official wild quail translocation policy in 2006. Three additional translocation projects have been permitted and conducted since the policy was established. In each case extensive large scale habitat modifications were required on the recipient sites while donor sites were required to have existing high density bobwhite populations. These projects have resulted in the translocation of over 600 birds and the establishment of 14,000 acres of new wild quail population centers thereby contributing to the National Bobwhite Conservation Initiative recovery goals. The latest of these projects is on-going and is significant in that it involves the interstate transfer of bobwhites from Florida and includes a previous translocation recipient as a donor. This paper will describe in detail the need for this effort, the research done on the topic, the policy itself, as well as the completed and on-going translocation projects in Georgia.

Key words: *Colinus virginianus*, Florida, Georgia, Georgia Department of Natural Resources, National Bobwhite Conservation Initiative, Northern Bobwhite, translocation

Comparison of Survival for Radio-tagged versus Unmarked Northern Bobwhite

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Abstract

With widespread reliance on radio telemetry to assess vital population parameters for northern bobwhite (*Colinus virginianus*), an understanding of the impact of radio-collaring on survival is essential. To date, no study has directly assessed contemporary survival estimates of radio-tagged and unmarked bobwhites within the same population. We conducted an assessment of bobwhite populations using banding and radio telemetry on Peabody WMA (8,213 ac), a reclaimed surface mine in western Kentucky. Peabody WMA is typified with low vegetative diversity and is likely a food-limited system. Therefore, we anticipated a higher potential for radio-handicapping. We captured bobwhites using baited funnel traps during a 112-day period (July 23–November 11, 2010). 192 birds were fitted with necklace-style radio-collars (≤ 6.5 grams) and 49 birds were only banded (double). Trap success was 15.5%. Birds were opportunistically recaptured in funnel traps. Age and sex structure of the radio-marked sample was adjusted to match that of the banded-only sample to remove bias. The Cormack-Jolly-Seber model in Program MARK was used to estimate seasonal survival rates (SSR) of radio-collared birds and banded-only birds. Estimated SSR of radio-tagged bobwhites ($40 \pm 27\%$) was higher than that of banded-only birds ($14 \pm 5\%$). However, SSR for banded-only bobwhites fell within the 95% confidence bounds of radio-tagged birds, suggesting that radio-handicapping was not occurring on our study area. Further research should create more robust survival models to fully assess the effects of radio-collaring bobwhites. Based on our study, it does not appear that radio collars adversely affect survival in northern bobwhite research.

Key words: *Colinus virginianus*, radio-handicapping, Program MARK, Kentucky, reclaimed mined land, capture-recapture, Cormack-Jolly-Seber, Peabody WMA

Using the Conservation Planning Tool (CPT) to Effectively Recover Northern Bobwhites: An Example for States to Effectively Step-down the NBCI Plan

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Abstract

The National Bobwhite Conservation Initiative (NBCI) 2.0 provides a sound foundation for recovering northern bobwhites (*Colinus virginianus*) range-wide, regionally and, to some extent, even locally. However, the NBCI does not provide detailed guidance for states on how to step-down the plan for efficacious delivery of on-the-ground management actions prescribed via biologists within the plan itself. Furthermore, states often must incorporate multiple planning efforts (e.g., state wildlife action plans) and geospatial layers not directly included in the NBCI plan to make tenable decisions which best guide allocation of resources and benefit multiple species of greatest conservation concern. The Conservation Planning Tool (CPT), developed as part of the NBCI 2.0, provides the infrastructure for states and conservation organizations to capture biologist information coalesced in the plan while incorporating other data (e.g., species emphasis areas, current CRP implementation, etc.) germane to conservation planning. Here we use three states (Kansas, Florida, and Virginia) to demonstrate the utility of the CPT and to develop a step-down implementation plan, via creation of a habitat prioritization model, for

recovery of bobwhites in each state. In doing so, we explore the implications associated with creation of focal areas with respect to high versus medium ranked areas and underscore the importance of inclusion of major land-use opportunities and constraints prescribed within the plan to garner successful bobwhite recovery. Finally, we propose a framework for the integration of monitoring efforts into the step-down model to assess bird response and evaluate NBCI success through estimating bobwhite population density.

Key words: bobwhite population density, Conservation Planning Tool (CPT), habitat prioritization model, National Bobwhite Conservation Initiative (NBCI), northern bobwhite, step-down plan

Hunter Harvest of Pen-reared Northern Bobwhites Released from the Surrogator®

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As Northern bobwhite (*Colinus virginianus*; hereafter bobwhite) populations have declined there has been increased interest in releasing pen-reared bobwhites to meet quail hunting and shooting objectives. The Surrogator® is a commercially available product for rearing and releasing game birds into the wild and is promoted as a means to enhance bobwhite survival, improve hunting and increase recruitment from natural reproduction. We used return-to-hunter bag data from three properties in Alabama, Georgia and Kentucky to evaluate the Surrogator® as a pre-hunting season release technique for pen-reared bobwhites. Across all sites a total of 3,859 five-week-old banded bobwhite chicks were released at varying times during June through October 2005 - 2010. Ninety-three quail hunts were conducted during November through January 2005 – 2011 comprising 431 hunt party hours, which resulted in 19 banded bobwhites being harvested. The mean return-to-hunter bag for all sites was 0.004 (range 0.000 to 0.008) and was considered to be unsatisfactory for a quality hunting/shooting experience. Including the costs of quail chicks, Surrogator® units, propane and feed, across all sites the mean cost per chick released was \$3.41 (range \$2.74 to \$3.88). The mean cost per bird returned-to-hunter bag (Alabama and Georgia) was \$655.80 (range \$489.91 to \$821.68). These costs did not include economic depreciation of Surrogator® units. Additional metrics from each of the three properties are presented and discussed.

Key words: Alabama, banded, bobwhite chicks, *Colinus virginianus*, Georgia, hunter harvest, Kentucky, Northern bobwhite, pen-reared bobwhites, return-to-hunter bag, Surrogator®

Exclosures: An Experimental Technique for Protection of Northern Bobwhite Nests

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Abstract

Nest predation has been implicated as a factor affecting northern bobwhite (*Colinus virginianus*) recruitment rates. Public stakeholders are increasingly questioning the use of lethal methods to manage predation. To address this issue, we evaluated a nonlethal method designed to protect nests from potential predators. The method consisted of single nest treatments using an exclosure. The exclosure treatment also included Amdro[®] (hydramethylnon) and Snake-a-way[®] repellents to deter red imported fire ants (*Solenopsis invicta*) and snakes, respectively. We compared nest success of treated (n = 8) to untreated nests (n = 18). Treated nests were 88% successful, which was a two-fold increase over unprotected nests. We did not observe any difference in hen behavior between treatment and controls. Our research suggests that this technique may be useful to study nest success in wild quail.

Key words: Amdro[®], *Colinus virginianus*, exclosure, fire ants, nest success, non-lethal control, northern bobwhite, predation, Snake-a-way[®], snakes

What Will It Take? Estimating Landowners' Willingness to Enroll in a Public Land Access Program, Missouri

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Abstract

As part of a quail and songbird habitat restoration initiative in northeast Missouri, we studied the USDA Conservation Reserve Program (CRP) in 8 Missouri counties where the CRP is prominent with 205,197 acres enrolled. To study landowners' willingness to enroll all or part of their acres in a public-access hunting program, we conducted a mail-back survey of all CRP contract holders on record in 2004, which amounted to 3,283 landowners being surveyed (response rate 59.5%). The questionnaire was designed to provide information about landowner demographics, attitudes toward wildlife and hunting, and knowledge of wildlife habitat management aspects of the CRP. For questions related to the concept of public hunting access we used the Kansas Department of Wildlife and Parks Walk-In Hunting Access program as an example and presented landowners with hypothetical lease payments for enrolling, using a discrete-choice modeling framework. We estimated the mean landowners' willingness-to-accept (WTA) compensation at \$84/hectare. We describe Missouri landowner interest in wildlife and public hunting-lease programs and the difficulties faced by state-agencies confronted by high WTA.

Key Words: landowner attitudes, motivation, economics, willingness-to-accept payment (WTA), Missouri, *Colinus virginianus*, financial incentives, cooperative, non-government organizations, private lands, values.

Spatial Analysis of Predator Abundance and Northern Bobwhite Nest Success in Southern Texas

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Abstract

Northern bobwhite (*Colinus virginianus*) sustains a high incidence of nest depredation across their geographic range, and predation is the primary cause of failure. Our objective was to evaluate the influence of predator relative abundance on northern bobwhite nest success. We used data from a long-term radio telemetry study conducted on 3 sites (800 ha each) in Brooks County, Texas, 2000–2007. We located bobwhite nests ($n = 456$) using radio telemetry and estimated Mayfield nest success each year. We also estimated relative abundance of nest predators using scent stations (400 m \times 400 m grid/site) during the nesting season (May–Aug). We then developed a gradient map of predator relative abundance and correlated this variable with location-specific bobwhite nest success. Mayfield nest success during the incubation period (23 days) varied between 0.43 and 0.60 during the course of the study. Scent-station visitation rates (% stations visited/night) ranged from 0% to 67%. Here, we discuss the findings of our study and the role of predator relative abundance on northern bobwhite nest success.

Key words: *Colinus virginianus*, nest success, northern bobwhite, predators, scent stations

Comparison of the Effects of Two Commercial Gamebird Feeds on Captive Bobwhite Chick Growth

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Abstract

Supplemental feeding of northern bobwhites (*Colinus virginianus*) is a widespread but neutral management practice. Bobwhite chicks in the wild consume only arthropods for the first 30-60 days of life. During times of drought, arthropods may become less abundant and bobwhite chicks must forage for other foodstuffs. We compared growth rates of captive bobwhite chicks consuming a newly-formulated, commercial 24% crude protein supplement to growth rates of bobwhites consuming a commercial, 30% crude protein complete ration. There was no sex bias related to chick growth. Chicks consuming the 24% protein diet grew slower and reached adult mass (150g) one month later than birds on the 30% protein diet. Birds in our study grew 4-6 times faster than documented rates from wild chicks in Florida, but this is attributed to a captivity bias. The 24% protein supplement has insufficient protein to optimize growth of bobwhites and is a poor substitute for arthropods in time of drought. Based on our results, a 30% protein diet has sufficient nutrient levels to justify further research as a supplement to mitigate a lack of arthropods in times of drought.

Key Words: chicks, growth, northern bobwhite, protein pellets, supplemental feed

Effects of a Commercial, Pelleted Ration on Wild Bobwhite Nesting and Harvest Demographics

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Abstract

Northern bobwhite (*Colinus virginianus*; hereafter bobwhite) reproduction is a nutrient intensive process. Arthropods are essential for breeding hens and their offspring. Traditional supplemental feeding programs typically neglect the protein needs of bobwhites. Commercial bobwhite rations are widely available but are seldom used in feeding programs due to high cost and lack of an appropriate supplement for field use. The objectives for this study were to compare the effect of a protein-carbohydrate ration (PC) to the effects of a carbohydrate only ration (CO) on (1) hen nesting demographics (clutch size, clutch initiation date, percent hens nesting, nest attempts per hen, and Mayfield daily nest survival) and (2) fall relative abundance (coveys moved per hour hunting). Based on a sample of 60 hens during the 2008 breeding season in south Texas, nesting parameters for bobwhites were similar based on 95% confidence intervals for both the PC and CO pastures. Mayfield nest success ranged from 73.1 – 75.2%. During 2008, the coveys moved/hour hunting estimates were not different between treatments. The 2009 nesting season was a complete failure. Weekly Kaplan-Meier survival estimates of bobwhite hens were 6 times higher in 2008 than 2009. In our study, using a PC ration to enhance wild bobwhite reproductive parameters was ineffective. The PC ration provided no benefit to bobwhite populations over the CO ration. The additional cost of using PC over CO is not justified based on our results.

Key words: *Colinus virginianus*, hens, nest success, northern bobwhite, protein, supplemental feed

Coyote Diet on the Rolling Plains Quail Research Ranch, Texas

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Abstract

Predation is a major cause of adult mortality and nest failure for northern bobwhites (*Colinus virginianus*) across its range. Coyotes (*Canis latrans*) are a potential predator of bobwhites. Only limited data exist regarding the importance of bobwhites in the coyote's diet in the Rolling Plains of Texas. Incidences of predation by coyotes on quail can be difficult to assess, as not much evidence of the predation event is left behind. The purpose of our study is to describe the seasonal and annual diets of coyotes on the Rolling Plains Quail Research Ranch, Fisher County, Texas. A total of 720 coyote scats were collected along two 18km transects from December 2008 to December 2010. Scats were analyzed macroscopically following standardized methods. During this time period, we also collected estimates of abundance for a range of potential food sources including bobwhites, small mammals, and insects. The impacts of our findings to quail management will be presented.

Key words: coyote diet, *Canis latrans*, northern bobwhite, *Colinus virginianus*, predation, Texas, scat analysis

Effects of Disking and Planting on Northern Bobwhite Home-range Size, Movement, and Habitat Selection on a Reclaimed Surface Mine in Kentucky

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Abstract

Reclaimed coalmines represent an opportunity to provide large tracts of early successional habitat essential to declining northern bobwhite (*Colinus virginianus*) populations. However, most were traditionally planted to non-native species, which may not provide suitable nesting or brooding cover. Fallow disking and planting food plots are part of current management efforts to improve structure and food availability. Understanding the response of northern bobwhite to these efforts is needed to guide future management. To determine habitat selection, we monitored 181 radio-collared birds on a reclaimed surface coalmine in western Kentucky (Peabody WMA), October 2009 through September 2010. Preliminary analysis using the Chesson index indicated disked and planted areas were used more than expected from October to March (n=95), but as expected April through September (n=86). Since the Chesson index does not adjust for landscape change during the monitoring period, we will analyze the data with Arthur's method, which accommodates the 402 acres (4.9% of total land area) disked during the monitoring period. We will determine if home-range size and average distance between successive locations of bobwhite encountering disked areas differ from those that do not. Our results should demonstrate how disking may affect bobwhite movement seasonally, which can be used to determine if disking and planting are valuable management tools on reclaimed mine land with low vegetation diversity. Results will also compare survival estimates of individual birds encountering disking with those that do not.

Key words: *Colinus virginianus*, disking, food plots, home-range size, Kentucky, reclaimed mined land, telemetry

Three-year Study on the Parasitic Eyeworm *Oxyspirura petrowi* in Northern Bobwhites From the Rolling Plains of Texas

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Abstract

Because of the long-term decline in northern bobwhite (*Colinus virginianus*) populations within the U.S., it has become increasingly important to assess the role that parasites and diseases have on the bobwhite. Before such evaluations can be made, it is necessary to examine the prevalence, intensity, and abundance of parasitic species that could influence the health of bobwhites. *Oxyspirura petrowi*, eyeworm, is an indirect lifecycle nematode that occurs under the nictitating membrane on the eye surface of certain bird species. Previous studies from western or northwestern regions of Texas have found that *O. petrowi* occurs in northern bobwhites, scaled quail (*Callipepla squamata*), and Montezuma quail (*Cyrtonyx montezumae*). The present study was initiated to learn more about *O. petrowi* in northern bobwhites from the Rolling Plains Ecoregion of Texas. We examined 173 bobwhites from the Rolling Plains of Texas collected during the 2007–2008 (N=33), 2009–2010 (N=86), 2010–2011 (N=54) hunting seasons. Overall, 99 (57%) bobwhites were infected with 596 *O. petrowi*. Mean intensity of *O. petrowi* was 6.0 ± 6.4 (SD) (range: 1–40) and mean abundance was 3.5 ± 5.7 (SD). These findings indicate that *O. petrowi* is a commonly occurring parasite of bobwhites in the Rolling Plains of Texas with relatively high levels of infection, compared to that found in other studies. Additional studies are needed to learn more about the geographic distribution of *O. petrowi* in bobwhites and to assess the possible negative effects of *O. petrowi* on northern bobwhite individuals and populations.

Key words: *Colinus virginianus*, eyeworm, helminth, Northern Bobwhite, *Oxyspirura petrowi*

Invertebrate Abundance at Northern Bobwhite Brood Locations

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Abstract

Northern bobwhites (*Colinus virginianus*), birds of significant ecological and economic importance throughout the Rolling Plains region of Texas, have experienced significant population declines due to reasons largely unknown to researchers and land managers. Though northern bobwhites have been the focus of extensive research for decades, little is known about the feeding ecology of adults and chicks during the breeding season. Invertebrates are a key spring and summer diet component for breeding hens and chicks and supply the necessary proteins and minerals needed to fuel rapid body development experienced by chicks. We sought to determine if brooding hens selected foraging sites based upon invertebrate abundance. We used radio-telemetry to locate hens and their broods during 2008-2010 on private and public lands within the Rolling Plains region of Texas. Insect samples were collected from brood points and random paired locations using sweep nets along 10-m transects. Samples were sorted by order, dried, and their mass determined. We will compare the differences in dry mass and frequency of occurrence of insect samples between brood locations and random locations using two-sample t-tests and chi-square tests, respectively.

Key words: *Colinus virginianus*, northern bobwhite, broods, rolling plains, Texas, feeding ecology, invertebrates, chicks

Calling Rates of Male Bobwhites during Summer in North Florida

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Abstract

The summer call count survey is a common method used as an index of abundance for male northern bobwhites (*Colinus virginianus*). Typically, abundance estimates have limited use and transference to other analyses because they lack estimates of detection and availability. Incorporating availability into abundance estimates has not been common because of the difficulty in attaining an availability estimate. In order to attain a direct measure of availability we monitored the calling rates of radio-tagged northern bobwhites, April – July, to determine the proportion of males available for detection within biweekly periods. Additionally, we determined the daily and seasonal peaks in the calling rate and investigated potential parameters that may influence the calling rate. Using a 5-minute survey period, we observed a mean calling rate of 0.40, but the calling rate increased to 0.493 when a 10 min survey period was used. The biweekly calling rates were similar during the months of May and June, but were significantly lower in April and July. Daily call rates within the 4-hour survey time period were consistent for May and June, but were more variable in July. Incorporating availability estimates into standard distance sampling procedures allowed us to produce more robust estimates of summer bobwhite density. Little is known on the variability of male calling rates regionally or at different densities and we encourage other researchers to attain availability estimates from other landscapes and population densities.

Key words: availability, call rate, *Colinus virginianus*, detection, Florida, northern bobwhite, male, survey

Seasonal, Weather, and Supplemental Feeding Effects on Northern Bobwhite Hunting Success on a South Georgia Hunting Plantation

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Abstract

Success of wild northern bobwhite management programs on private lands is most often measured by the rate of covey finds during the hunting season. As such, managers of these properties are keenly interested in how weather, time of year, and time of day influences covey finds. We examined how coveys pointed per hour, a measure of hunting success, was influenced by time of hunting season, weather parameters and supplemental feeding on a intensively managed quail plantation over 4 years. As expected, there were significant annual differences in the coveys pointed per hour among the 4 years of the study. However, hunting success did not vary throughout the hunting season for all years. Afternoon hunts had consistently higher success rates than morning hunts however the effect size was variable from year to year. In the afternoons air temperature had a significant negative effect on hunting success. However, its effects were partially mitigated by relative humidity. Morning hunting success was more consistent than afternoon hunts. However, an increase barometric pressure did have a positive effect on covey finds/hour. The number of days since supplemental feed was spread had no significant trend in hunting success in 2 of the 3 years investigated. Knowledge of how these variables influence hunting success should improve hunting and provide realistic expectations of hunt success for a given set of circumstances.

Key words: *Colinus virginianus*, coveys pointed per hour, Georgia, hunting success, northern bobwhite, season, supplemental feeding, weather

Northern Bobwhite Habitat Selection, Survival and Nest Success in Kentucky During the Breeding Season

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Abstract

Northern bobwhite (*Colinus virginianus*) populations have experienced protracted declines over much of their range. In Kentucky, an area representative of the Mid-South where there is a lack of data on basic population parameters, there has been an annual decrease of 2.61% since the 1960's. Much of the decline is attributed to prevailing land-use practices and associated habitat loss. To assess survival rates, nest success rates, and habitat use in the Mid-South, we monitored northern bobwhite on a 535 ha (1324 ac) farm in Oldham County, Kentucky. The farm consisted of row crops, cool-season pastures and hay (primarily tall fescue), fallow native warm-season grass fields, and woods. We captured birds using baited funnel traps and fitted them with harness radio transmitters and monitored them daily during May – August 2009 and 2010. We collared a total of 88 birds (40 female, 48 male) and monitored 26 nests over the two years. Data analysis is currently underway. Once completed, we will report on adult survival rates and nest success, both based on analysis conducted using program MARK. Using a 95% kernel method, we will estimate home range size. Home ranges will also be used to evaluate and habitat selection patterns using a Chesson index.

Key words: *Colinus virginianus*, northern bobwhite; radio telemetry; survival rate; nest success; home range; habitat selection; Kentucky, USA

Efficacy and Effects on Survival of Targeted Mist Netting of Northern Bobwhites in Ohio

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Abstract

Mist netting is used as a capture technique for upland game birds and passive mist netting has been used to capture northern bobwhites (*Colinus virginianus*) during breeding season. Targeted mist netting, where nets are erected around radiomarked individuals, has been used to capture other upland game birds but has never been evaluated for bobwhites. We evaluated efficacy and effects of targeted mist netting on survival of non-breeding bobwhites in Ohio. We captured 284 bobwhites with targeted netting and concurrently captured 254 bobwhites using bait traps during 1 October and 31 March 2009-2011. We compared survival of radiomarked birds captured with the two techniques in a 45-day post-capture interval using the nest survival model in Program MARK. We compared models between the two groups that included covariates for 14, 7, and 3-day acute capture effects. The best-supported model contained a 7-day acute effect of capture. Survival was 12.9% (95% CI: 7.4-21.8) for netted birds and 4.2% (1.6-10.2) for bobwhites captured in bait traps. There was equal support for a model that contained no effect of capture technique (likelihood ratio test, $P=0.656$). Survival of bobwhites captured with targeted netting was equivalent or better than for those captured with bait traps. We captured ≥ 1 individuals in 71% of netting attempts ($n=191$). We also used targeted netting during the breeding season to capture individuals and fledging chicks. The efficiency and timing of the technique were more compatible with the constraints of working on private land than traditional capture techniques.

Key words: capture techniques, *Colinus virginianus*, mist netting, northern bobwhite, Ohio, Program MARK, radiotelemetry, survival, trapping

A Comparison of Northern Bobwhite Demographic Sensitivity Between a Mid-Atlantic and National Population Model

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Abstract

Numerous field studies have estimated vital rates for northern bobwhites (*Colinus virginianus*), but only recently a synthetic population model based on life-stage simulation analysis (LSA) was developed to examine demographic sensitivity for the species. Now the opportunity exists to compare regional bobwhite demographic parameters against the national compilation to identify limiting demographic factors for improved regional habitat planning and management. We parameterized our LSA model to examine the sensitivity of the finite rate of growth (λ) to simulated variation in 9 demographic parameters in a regionally declining population of New Jersey. Model results predicted population declines in New Jersey ($\lambda=0.65$) that were comparable to a compilation of rates nationwide ($\lambda=0.56$), but notable differences occurred in sensitivity of demographic variables. The national model predicted winter survival of adults made the greatest contribution to variance of λ ($r^2 = 0.45$), followed by summer survival of adults ($r^2 = 0.16$), and survival of chicks ($r^2 = 0.12$). The regional model predicted winter survival of adults would make the greatest contribution to variance of λ ($r^2 = 0.32$), followed by chick survival ($r^2 = 0.22$). However, an important difference in our regional model was that nest success and clutch size were next of importance ($r^2 = 0.18$ for both), whereas summer adult survival was not important ($r^2 = 0.02$). Overall, our simulation results suggest that management practices that improve winter survival rates will have the greatest potential benefit for recovery of declining populations. Moreover, habitat modifications that improve nesting success and chick survival would be beneficial.

Key Words: *Colinus virginianus*, fecundity, life-stage simulation analysis, New Jersey, northern bobwhite, population model, survival

Mitochondrial DNA Phylogeography of the Bobwhites

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Abstract

The genus *Colinus* is composed of four allopatric species, the northern bobwhite (*C. virginianus*), Yucatán bobwhite (*C. nigrogularis*), spot-bellied bobwhite (*C. leucopogon*), and crested bobwhite (*C. cristatus*). The four species are distributed from the northeastern and central United States south to Venezuela, Colombia, and Brazil. The systematic relationships of the four bobwhite species remain unclear. Each species is divided into several subspecies based largely on differences in male plumages. Northern, crested, spot-bellied, and Yucatán bobwhites are further divided into 19, 14, 6, and 4 subspecies, respectively. Subspecies divisions are based on differences in male coloration and plumage. We used mitochondrial DNA obtained from museum study skins to investigate the interspecific and intraspecific phylogenetics of the bobwhites. We obtained 306 mtDNA sequences from 242 northern, 16 Yucatán, 20 spot-bellied, and 28 crested bobwhites. Sequences resolved into 92 haplotypes and 2 clades of comprised of northern/ Yucatán bobwhites and spot-bellied/crested bobwhites. Yucatán bobwhites were nested within the northern bobwhite, and spot-bellied bobwhites within the crested bobwhite. Patterns of genetic variation and haplotype distribution were not concordant with current subspecies taxonomy of any of the four species. The comparatively smaller sample size of spot-bellied and crested bobwhites makes inferences of demographic history difficult and additional investigation is warranted. Overall, major systematic revisions should not be based on a single gene. However our data suggest that the bobwhites may be in need of a thorough reanalysis of the inter- and intraspecific taxonomy. Most accepted subspecies do not appear to represent historically independent or unique lineages.

Key words: phylogeography, northern bobwhite, *Colinus virginianus*, crested bobwhite, *Colinus cristatus*, Yucatán bobwhite, *Colinus nigrogularis*, spot-bellied bobwhite, *Colinus leucopogon*, mitochondrial DNA, subspecies

Phylogeography of the Scaled Quail in Southwestern North America

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Abstract

The scaled quail (*Callipepla squamata*) is distributed throughout much of the southwestern United States and northwestern Mexico. Four subspecies are recognized based largely on variations in plumage coloration and tone. Scaled quail have experienced significant declines in parts of their U.S. range. The genetic relationships among subspecies could be useful for the designation of management units, but genetic data are lacking. We extracted DNA trapped or hunter-harvested birds, or from museum specimens and amplified a portion of the maternally inherited mtDNA and included samples from each subspecies. We obtained mtDNA sequence data from 214 scaled quail from northwestern Mexico and southwestern US. The sequences were resolved into 16 haplotypes. Scaled quail haplotypes did not display geographical clustering and the distribution of haplotypes was not concordant with currently accepted subspecies. The scaled quail exhibited a star-like haplotype network, low haplotype and nucleotide diversity, and a unimodal distribution of nucleotide pairwise differences. Most genetic variation was within rather than between scaled quail subspecies. The overall shape of the haplotype network and lack of diversity suggest that the scaled quail may have undergone demographic expansion as recently as 4,000 years ago in the American southwest, possibly allowing scaled quail to expand from one or more isolated refugia. Additional genetic markers are required to fully assess relationships among subspecies or geographic races; however, our data suggest that the subspecies of scaled quail may not represent historically independent lineage groups. Therefore, management strategies should not be based solely on the current intraspecific taxonomy.

Key words: *Callipepla squamata*, scaled quail, phylogeography, subspecies, mitochondrial DNA