From: "James Alan Martin" via NBGI Listserv
To: nbgi-listserv@nbgif.org
Subject: [External Email]Re: Bobwhite Digest July 2024
Date: Tuesday, July 16, 2024 8:34:45 AM
Attachments: image001.png
image004.png
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image009.png
image010.png

Hello everyone,

I hope you all are staying cool and enjoying your summer. I look forward to seeing some of you in a few weeks. The rest of you will be missing out on cool temps in Tupelo, MS.

Below are a few bobwhite related papers that have been published in the past few months. Apologies if I overlooked any, it was not intentional.

Regards,
JM

1. **Ouyang, M., Zhang, Q., Cai, M. *et al.* Dynamic analysis of a fuzzy Bobwhite quail population model under g-division law. *Sci Rep* 14, 9682 (2024). https://doi.org/10.1038/s41598-024-60178-4**

   This paper is concerned with a kind of Bobwhite quail population model

   +1=++−1−2, =0,1,⋯,
   where the parameters and initial values are positive parabolic fuzzy numbers. According to g-division of fuzzy sets and based on the symmetrical parabolic fuzzy numbers, the conditional stability of this model is proved. Besides the existence, boundedness and persistence of its unique positive fuzzy solution. When some fuzzy stability conditions are satisfied, the model evolution exhibits oscillations with return to a fixed fuzzy equilibrium no matter what the initial value is. This phenomena provided a vivid counterexample to Allee effect in density-dependent populations of organisms. As a supplement, two numerical examples with data-table are interspersed to illustrate the effectiveness. Our findings have been verified precise with collected northern bobwhite data in Texas, and will help to form some efficient density estimates for wildlife populations of universal applications.

2. **Williams CK, Terhune TM II, Parke J, Matseur EA, Cecil J (2024) Active forest stewardship benefits priority birds in the New Jersey Pine Barrens. PLOS ONE 19(6): e0302040. https://doi.org/10.1371/journal.pone.0302040**

   Fire suppression has negatively impacted thousands of acres of private and public lands in the United States. As a case study, the New Jersey Pine Barrens (NJPB) are a disturbance driven ecosystem that is experiencing serious ecological implications due to a loss of traditional forest thinning activities such as harvesting for forest products or thinning for wildfire fuel-load reduction measures coupled with a long-standing philosophy of fire suppression and dormant-season prescribed burning. Dense closed-canopy forest conditions, dissimilar to historic open-canopy forests of the NJPB, have reduced abundance and diversity of certain flora and fauna, including regionally imperiled breeding birds. In recent years, active forest stewardship (e.g., thinning, clear-cutting, and burning) has occurred on private and some public lands within the NJPB; however, the impact of such management on breeding birds is unclear due to a paucity of research on this subject within the NJPB. During 2012, 2013, 2016, and 2017, we conducted repeat-visit point counts (n = 1,800) for breeding songbirds across 75 control and 75 treatment sites within the NJPB to assess the influence of forest structure at three strata levels (groundcover, midstory profile, and canopy) on breeding bird communities. Specifically, we constructed a hierarchical community abundance model within a Bayesian framework for Bird Conservation Region (BCR) 30 priority upland birds (n = 12) within three species suites: Forested Upland, Scrub-Shrub (or Young Forest), and Grassland. At the community level, we found a negative relationship between bird abundance and live tree basal area. At the BCR 30 suite level, we found no relationship between Forested Upland suite-level abundance and any of the measured covariates; however, we found a negative relationship between percentage of woody groundcover and Scrub-Shrub suite-level abundance, and negative relationship between horizontal visual obstruction at 2 m above ground level and Grassland suite-level abundance. Furthermore, the two latter species suites exhibited a strong negative relationship with basal area. We recommend active forest stewardship that specifically targets opening the canopy to achieve basal areas between ~0–15 m^2/ha via selective thinning, shelter cutting, and small-scale clear cutting. Mechanical treatment and prescribed burning would produce such conditions and have the added benefit of reducing fuel loads across this ~4,500 km^2 landscape as well as assisting in carbon defense strategies for the region.

3. **Nolan, V., Yeiser, J. M., Costanzo, B., Martin, M. R., McGuire, J. L., Delancey, C. D., Lewis, W. B., & Martin, J.**

A. (2024). Effects of management practices on Northern Bobwhite *Colinus virginianus* density in privately owned working forests across the Southeastern United States. *Ecological Solutions and Evidence*, 5, e12352. https://doi.org/10.1002/2688-8319.12352

a. Obtaining rigorous baseline density estimates of species of conservation interest is key when assisting landowners to achieve management goals on private lands. Northern bobwhite (*Colinus virginianus*) populations are declining throughout their range and despite being the focus of numerous private land conservation initiatives, baseline density estimates in privately owned pine forests are lacking.
b. We sought to address this knowledge gap across the Southeastern United States by sampling 105 privately owned pine stands throughout 2018 to 2020 using observer point count and autonomous recording unit (ARU) sampling data. Using Bayesian hierarchical models, we investigated the influence of stand management (brush management or applied fire) on bobwhite density, as well as four landscape-scale environmental variables. These included percentage cover of forest, herbaceous, agricultural or burnt land area across six different spatial scales ranging from 500-m to 10-km around each pine stand.
c. Baseline density on sites with no management was estimated to be 2.24 coveys per 100 ha (1.00–5.03, 95% BCI), with little impact of applying brush management, but a trend for a positive effect of fire management (0.19, −0.01 to 0.38 95% BCI).
d. This impact of fire was seen at both the stand-scale, correlated with an increase in acreage of applied prescribed burn management, and across the greater landscape area, correlated with cover of burnt area within a 2-km buffer around each site.
e. There were also strong positive influences of herbaceous vegetation and a strong negative influence of forest cover on bobwhite density.
f. Practical implication: our sampling efforts fill an important information gap regarding densities throughout private lands in the Southeastern United States. Our study also highlights the necessity of landscape scale planning for Northern Bobwhite conservation initiatives because the efficacy of conservation practices (i.e. prescribed fire and brush management) could be altered by the landscape surrounding the treated forest stand.

From: James Alan Martin <martinj@warnell.uga.edu>
Date: Tuesday, March 5, 2024 at 10:27 AM
To: nbgi-listserv@nbgif.org <nbgi-listserv@nbgif.org>
Subject: Re: Bobwhite Digest March 2024

Hello All:

I hope everyone is doing well. Below are a few bobwhite related papers that have been published in the past few months. Apologies if I overlooked any, it was not intentional.

JM

1. **Wyckoff, S. T., T. C. Judkins, N. M. Nemeth, M. G. Ruder, J. A. Martin, M. R. Kunkel, K. B. Garrett, K. G. Adcock, D. G. Mead, and M. J. Yabsley. 2024. Surveillance for Selected Pathogens and Parasites of Northern Bobwhite (*Colinus virginianus*) from Western Oklahoma, USA, 2018–20. Journal of Wildlife Diseases. <https://doi.org/10.7589/JWD-D-23-00102>.**

TABLE 4. Ectoparasites recovered from bobwhites (*Colinus virginianus*) in western Oklahoma, USA, in 2018–20.

Parasite species	Parasite type	No. infected bobwhites/No. sampled (%)				Range	Mean intensity ±SD	Total recovered
		2018	2019	2020	Overall			
Goniodes ortygis	Louse	8/73 (11)	49/91 (54)	24/42 (57)	81/206 (39)	1–11	2.6±2.3	213
Oxylipeurus clavatus	Louse	1/73 (1)	24/91 (26)	20/42 (48)	45/206 (22)	1–7	2.2±1.7	96
Menacanthus spp.	Louse	8/73 (11)	22/91 (24)	8/42 (19)	38/206 (18)	1–6	2.1±1.6	81
Trombiculidae species	Mite	1/73 (1)	7/91 (8)	4/42 (10)	12/206 (6)	1–3	1.3±0.6	17
Haemaphysalis leporispalustris	Tick	8/73 (11)	22/91 (24)	18/42 (30)	48/206 (23)	1–40	5.9±8.1	292
Amblyomma maculatum	Tick	2/73 (3)	15/91 (16)	5/42 (12)	22/206 (11)	1–25	4.7±6.1	94
Amblyomma americanum	Tick	0/73 (0)	2/91 (2)	0/42 (0)	2/206 (1)	1–3	2±1.4	4

2. **Avila-Sanchez, J. S., H. L. Perotto-Baldivieso, L. D. Massey, J. A. Ortega-S., L. A. Brennan, and F. Hernández. 2024. Evaluating the Use of a Thermal Sensor to Detect Small Ground-Nesting Birds in Semi-Arid Environments during Winter. Drones 8.**

https://doi.org/10.3390/drones8020064

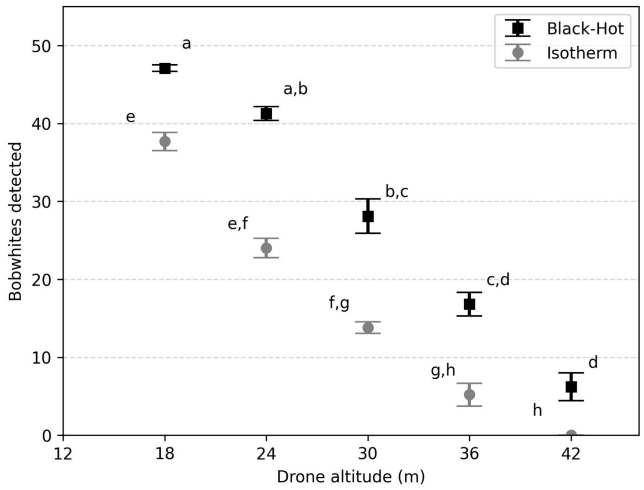
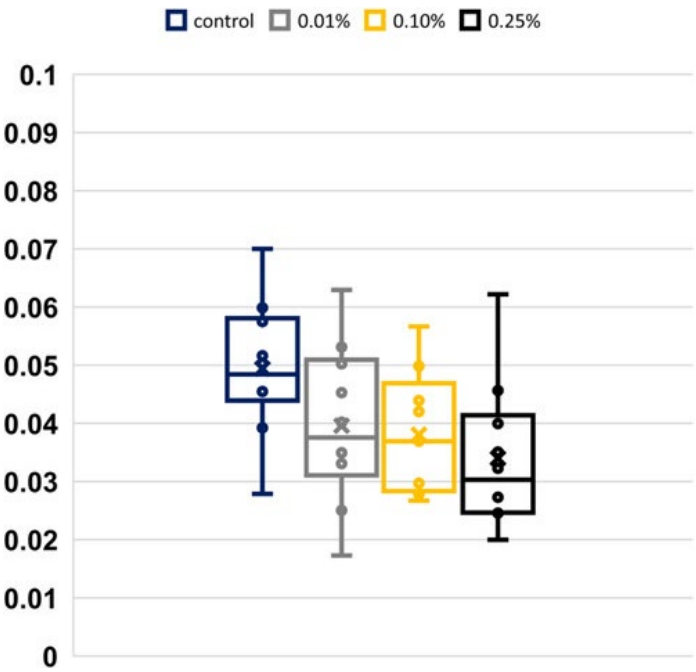


Figure 4. Average number of bobwhites counted per image at each altitude with different thermal color palettes and standard errors. Dunn's multiple pairwise comparison for each thermal color palette between altitudes. Different letters indicate differences between altitudes (adjusted $p < 0.05$).

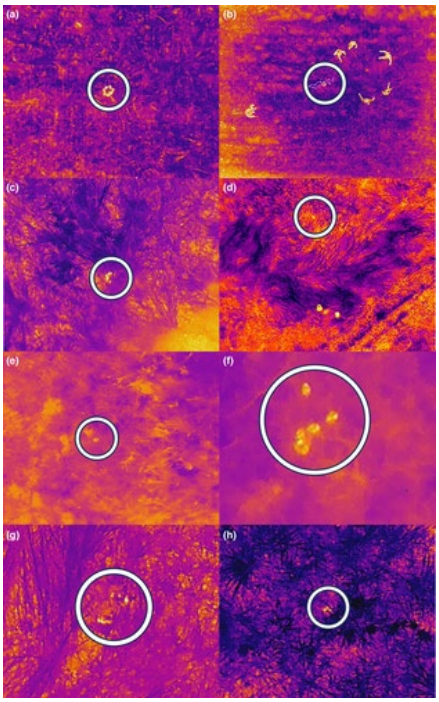
3. **Hossain, F., N. M. Dennis, A. Karnjanapiboonwong, S. Subbiah, A. S. Longwell, J. G. Suski, C. J. Salice, and T. A. Anderson. 2024. Evaluation of the Chronic Reproductive Toxicity of a Fluorine-Free Firefighting Foam and a Short-Chain Fluorinated Foam to Northern Bobwhite Quail (*Colinus virginianus*). Environmental Toxicology and Chemistry 43:211–221. https://doi.org/10.1002/etc.5765**



Liver lipid for 21-day northern bobwhite quail chicks following parental exposure to Buckeye. Each box plot displays the maximum, minimum, 25th, and 75th percentiles and the median of the liver lipid (percentage) data.

4. **Lappin, O., J. A. Elmore, L. R. Jones, E. A. Schultz, R. B. Iglay, and M. D. McConnell. 2024. Using drones equipped with thermal cameras to locate and count quail individuals and coveys: A case study using Northern Bobwhite Colinus virginianus in**

Mississippi, USA. Ecological Solutions and Evidence 5:e12306. https://doi.org/10.1002/2688-8319.12306



Panel of thermal images from flights finding bobwhite; bobwhite are circled in white rings. (a) Ring-shaped covey, (b) capture team approaching covey, (c) half ring-shaped covey, (d) covey from higher altitude with capture team approaching, (e) smaller covey, (f) close-up of covey without typical ring-shape, (g) another loosely formed covey and (h) single Northern Bobwhite.

5. **Suber, H. N., J. Leach, K. A. Conley, R. Rivera, J. G. Surles, and R. J. Kendall. 2024. IMPLICATIONS OF TREATING PARASITIC INFECTION IN NORTHERN BOBWHITE (COLINUS VIRGINIANUS) ON OVERALL HELMINTH LIFE CYCLE. Journal of Parasitology 110:1–7. https://doi.org/10.1645/23-21**

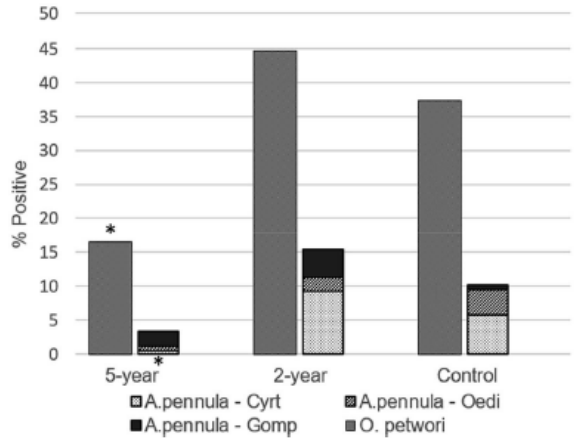


Figure 3. Prevalence of *Oxyspirura petrowi* and *Aulanocephalus pennula* across all 3 sites. *Aulanocephalus pennula* was separated by subfamily because of the interaction between subfamily and infection likelihood. Asterisk signifies a significant difference. Asterisk is below the 5-yr bar for *A. pennula* to signify that only the Cyrtacanthacridinae subfamily was significantly different. (Cyrt = Cyrtacanthacridinae, Oedi = Oedipodinae, Gomp = Gomphocerinae).

From: James Alan Martin <martinj@warnell.uga.edu>
Date: Friday, December 22, 2023 at 12:29 PM
To: nbgi-listserv@nbgif.org <nbgi-listserv@nbgif.org>
Subject: Bobwhite Digest Dec 2023

Hello All:

I hope everyone is doing well and avoiding the various viruses floating around. Below are a few papers and podcasts that are bobwhite related. Apologies if I overlooked any, it was not intentional.

Hope you all have a great holiday season.

JM

1. Wolske, J.M., Behney, A.C. and Powell, L.A. (2023), Nonbreeding season survival of northern bobwhite in northeastern Colorado. Wildlife Biology e01126. https://doi.org/10.1002/wlb3.01126

Northern bobwhites have experienced population declines in Colorado and range wide. Estimating vital rates can provide clues to factors limiting population growth rate. Although recent estimates of breeding season survival in the northwest corner of the northern bobwhite range are available, there have been no recent studies on nonbreeding season survival. We used radio-telemetry to estimate nonbreeding season (October–March) survival of northern bobwhites at two study sites in northeastern Colorado during winter 2019–2020 and 2020–2021. Based on our sample of 157 bobwhites, we found that survival was highly variable between years and was negatively affected by colder daily minimum temperatures and deeper snow depths. Seasonal (six-month) survival during the first year was 0.219 (SE = 0.040) and during the second year was 0.006 (SE = 0.005). We found no evidence that sex, age or study site influenced survival, and very weak support for an effect of body mass. During our study, there were two extreme winter weather events, during which we found unusually high numbers of non-predation mortality. Overall, northern bobwhite nonbreeding season survival in the northwest corner of their range appears to be generally similar to other regions, except during extreme winter weather events, which resulted in high mortality. We encourage managers to create or maintain vegetation characteristics that will provide shelter from winter weather while also providing abundant food in close proximity.

2. Lappin, O. A., Evans, K. O., Iglay, R. B. & McConnell, M. D. Northern Bobwhite (*Colinus virginianus*) breeding season roost site selection in a working agricultural landscape in Clay County, Mississippi. *Journal of Field Ornithology* **94**, (2023). https://doi.org/10.5751/JFO-00368-940404

Appropriate habitat management may be one of the most important factors contributing to Northern Bobwhite (*Colinus virginianus*) population persistence, but biologists lack information on how individual bobwhite select roost sites during the breeding season. Therefore, we examined breeding season third-order roost site selection on B. Bryan Farms, Mississippi, from 2021 to 2022. We observed a quadratic relationship with average vegetation height, where roost site selection increased with increasing vegetation height to a point and then slightly decreased ($\beta 1 = 0.14084$, 95% CI = 0.05, 0.24; $\beta 12 = -0.01005$, 95% CI = -0.06, 0.04). However, uncertainty in the quadratic term was notable. Similarly, we observed a quadratic relationship with litter ($\beta 1 = 0.25479$, 95% CI = 0.12, 0.39; $\beta 12 = -0.09606$, 95% CI = -0.16, -0.04). We also found selection decreased linearly with increasing bare ground ($\beta 1 = -0.20938$, 95% CI = -0.31, -0.11). Individual birds may require taller vegetation, greater visual obstruction, greater litter coverage, and lesser bare ground coverage for better concealment from nocturnal predators when they are roosting individually during the breeding season or are constrained by limited mobility (i.e., brooding). Understanding the vegetative composition, structure, and location of roost sites during the breeding season may provide land managers with a better understanding of the vegetative characteristics necessary during all phases of bobwhite life history. Our results provide the first information on bobwhite breeding season roost site selection, which will help to develop a more complete understanding of bobwhite habitat requirements and increase the effectiveness of habitat management and conservation efforts for this species of conservation concern. Appropriate habitat management may be one of the most important factors contributing to Northern Bobwhite (*Colinus virginianus*) population persistence, but biologists lack information on how individual bobwhite select roost sites during the breeding season. Therefore, we examined breeding season third-order roost site selection on B. Bryan Farms, Mississippi, from 2021 to 2022. We observed a quadratic relationship with average vegetation height, where roost site selection increased with increasing vegetation height to a point and then slightly decreased ($\beta 1 = 0.14084$, 95% CI = 0.05, 0.24; $\beta 12 = -0.01005$, 95% CI = -0.06, 0.04). However, uncertainty in the quadratic term was notable. Similarly, we observed a quadratic relationship with litter ($\beta 1 = 0.25479$, 95% CI = 0.12, 0.39; $\beta 12 = -0.09606$, 95% CI = -0.16, -0.04). We also found selection decreased linearly with increasing bare ground ($\beta 1 = -0.20938$, 95% CI = -0.31, -0.11). Individual birds may require taller vegetation, greater visual obstruction, greater litter coverage, and lesser bare ground coverage for better concealment from nocturnal predators when they are roosting individually during the breeding season or are constrained by limited mobility (i.e., brooding). Understanding the vegetative composition, structure, and location of roost sites during the breeding season may provide land managers with a better understanding of the vegetative characteristics necessary during all phases of bobwhite life history. Our results provide the first information on bobwhite breeding season roost site selection, which will help to develop a more complete understanding of bobwhite habitat requirements and increase the effectiveness of habitat management and conservation efforts for this species of conservation concern.

3. Sklarczyk, C.A., Evans, K.O., Greene, D.U. *et al.* Effects of spatial patterning within working pine forests on priority avian species in Mississippi. *Landsc Ecol* **38**, 2019–2034 (2023). https://doi.org/10.1007/s10980-023-01665-3.

Abstract

Context

Within dynamic ecosystems, research into how land use changes and patterns affect species diversity has led to a suite of ecological hypotheses to assess species-landscape associations. The Habitat Amount Hypothesis suggests that it is the total amount of habitat, regardless of configuration, whereas the Multi-dimensional Hypothesis suggests it is the suite of local, landscape, and landform characteristics that have the greatest influence on species diversity within its local landscape.

Objectives

Our study aims to understand how landscape pattern influences species abundance, in the context of these two competing hypotheses on priority avian species in working forest landscapes of the southeastern United States.

Methods

To examine these hypotheses, we conducted bird point counts and vegetation surveys in short-rotation loblolly pine (*Pinus taeda*) forests in east-central Mississippi during 2019–2020 and used abundance and richness models to assess avian species associations to amount vs. configuration of habitat in a 2 km^2 landscape.

Results

We found that habitat amount alone did not exhibit consistent positive associations with species abundance for both early-successional and mature forest associated avian communities. Most target species exhibited positive associations with patch proximity, measured by Euclidean distance, and proximity-area index. However, measures of species richness showed no association with amount or proximity. Associations with landform features generally had positive influences on early-successional species than mature-pine priority species.

Conclusions

The dynamic mosaic of forest stand ages may be sufficient in providing habitat needs such that measures of richness are not driven by amount and proximity at the 2 km^2 scale in this working landscape. However, influences of proximity and landform on priority species abundance warrant further research to assess potential drivers of associations with stand proximity and effects of amount and proximity on measures of species diversity across scales. Given the growing demand for forest products, sustainable forestry guidelines that consider proximity of stands in similar age classifications could enhance landscape suitability for some target species.

4. https://speakthelanguage.podbean.com/. A three-part series on bobwhites in the SE.

From: James Alan Martin <martinj@warnell.uga.edu>
Date: Friday, October 13, 2023 at 11:09 AM
To: NBTCLIST@LISTSERV.UTK.EDU <nbtclist@listserv.utk.edu>
Subject: Bobwhite Digest Oct. 2023

Hello All,

It seemed like folks appreciated the email last month with the most recent papers so I will do this monthly. If you are aware of papers that I miss, please send them to me. I can add it to the next month's digest. I am trying to include all bobwhite papers and those related to bobwhite habitat management. I am only including snippets or abstracts associated with the papers so that you go read the full paper.

I hope everyone's fall surveys are going well and you are getting outside with a birddog. Those with GSPs I hope you enjoy your walks, too.

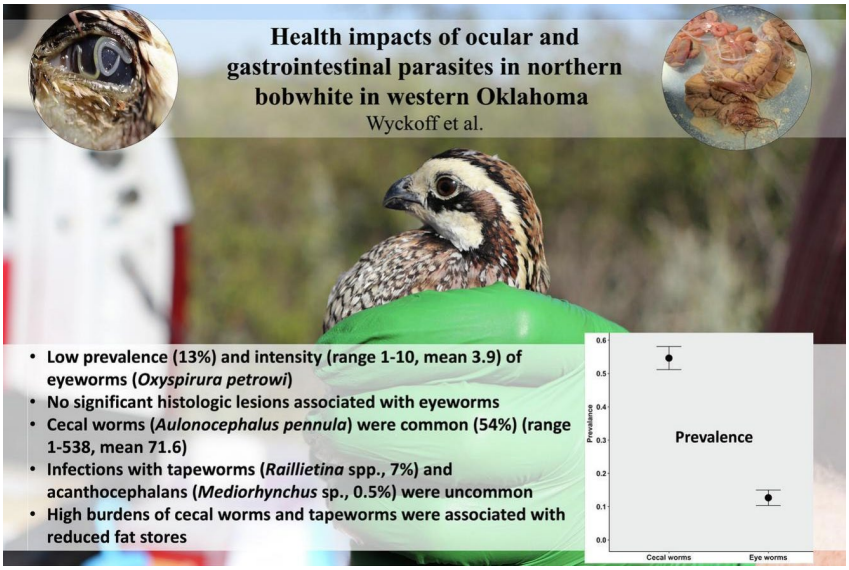
JM

McMillan et al. Growing Season Fires and Herbicide May not Be the Silver Bullet to Lespedeza cuneata **Management**

Rangeland Ecology and Management. https://doi.org/10.1016/j.rama.2023.08.002

Invasive species are generally managed across rangelands to achieve livestock productivity and biodiversity maintenance objectives. The invasive legume *Lespedeza cuneata* (Dum. Cours.) G. Don. is managed across much of the Great Plains with aerially applied herbicides that target broadleaf forbs and dormant season (late March−early April) fire. It is hypothesized that altering fire timing to the growing season or integrating late-season herbicide into fire management may lead to more successful reduction of *L. cuneata* without negatively affecting rangeland plant communities. However, most of the literature outlining the effects of *L. cuneata* and its management is limited to small scale (< 100 m^2), highly controlled studies that are not transferrable to large working rangelands. We manipulated eight large (333−766 ha) pastures managed with fire and grazing (i.e., pyric herbivory) to assess whether growing and dormant season fires, herbicide application, or the interactive effect of fire timing and herbicide reduced *L. cuneata* without negatively affecting broad rangeland plant composition (i.e., functional group cover) from 2019 to 2021. Our study was performed at two scales relevant to rangeland management: the pasture and burn patch scales. None of our treatments (i.e., fire timing, herbicide application, or the interaction of fire timing and herbicide) had a significant effect on *L. cuneata* canopy cover at either the pasture or patch scale. Our treatments also did not affect forb or shrub cover at the pasture or patch scales. Grass and sedge cover was significantly increased post herbicide at the patch scale, but not at the pasture scale. Grass and sedge cover was unaffected by any other treatment at both scales considered in this study. Our results add to nearly two decades of research, conducted elsewhere, that pyric herbivory alone may be sufficient to manage *L. cuneata* and promote rangeland biodiversity in the tallgrass prairie.

Wyckoff et al. Health impacts of gastrointestinal and ocular parasites in northern bobwhite (*Colinus virginianus*) in western Oklahoma, USA. Veterinary Parasitology: Regional Studies and Reports. https://authors.elsevier.com/c/1hvkD8Z31KqJNf



3. **Montalvo, A. B., and Woodard, D. A., 2023. *South Texas Bobwhites and Eyeworms: Regional History, Prevalence, and Implications for Management.* East Foundation Management Bulletin No. 9, 6P. https://eastfoundation.net/media/4vgntj0s/east_mbno92023_web.pdf**

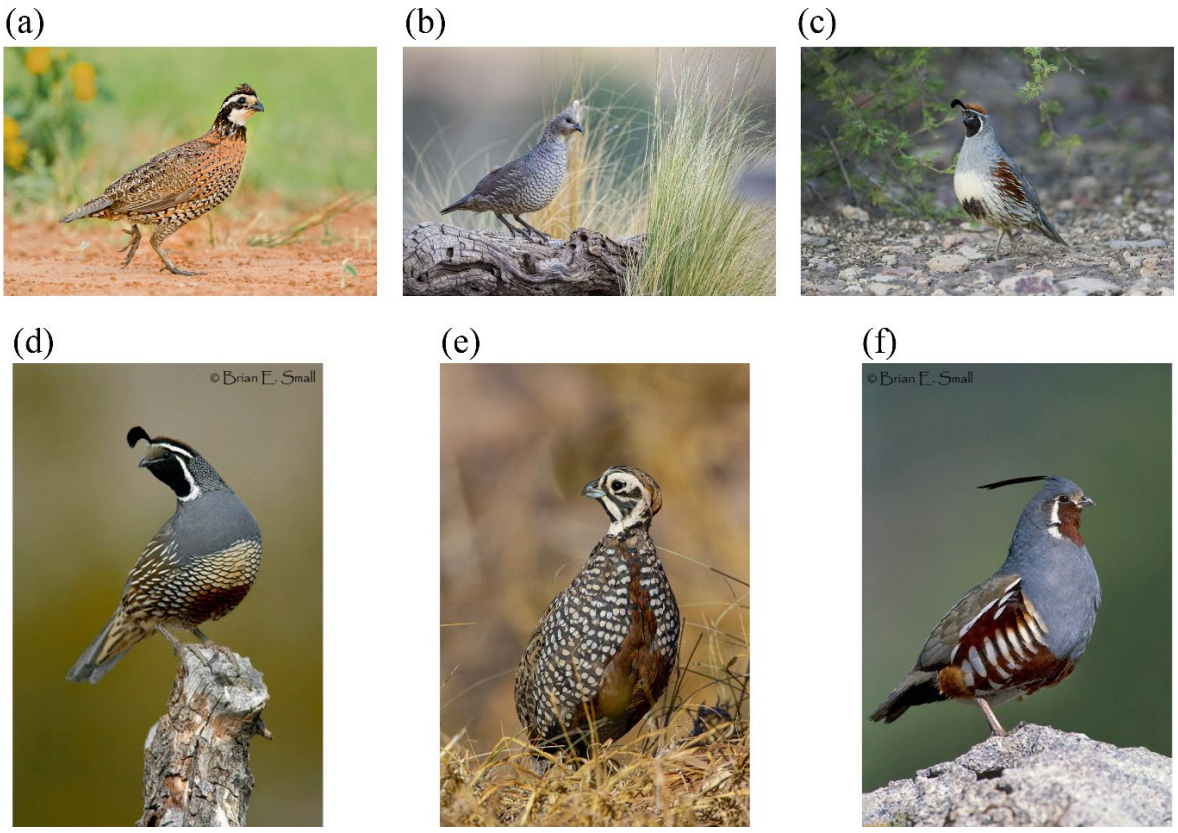
Eyeworms (Oxyspirura petrowi) are frequently claimed as a factor in the decline in Northern bobwhite (*Colinus virginianus*) quail populations during the last decade, particularly in the Rolling Plains Ecoregion of Texas. However, reports of *O. petrowi* infections in bobwhite populations from the South Texas Plains (Fig. 1) do not support this association.

Year	n	Juvenile	Adult	Male	Female	*Oxyspirura petrowi*
2019	193	141	52	91	102	0
2021	166	136	30	89	77	0
2022	98	40	58	68	30	0
2023	286	0	286	190	96	0

Table 2. The total sample (n=743) of hunter-harvested northern bobwhites by year (2019, 2021–2023), age (Juvenile or Adult), and sex (Male or Female). No eyeworms (*Oxyspirura petrowi*) were found in the sample across Jim Hogg, Brooks, and Kennedy counties, Texas.

4. **Downey et al. Quails. Rangeland Wildlife Ecology and Conservation. https://link.springer.com/chapter/10.1007/978-3-031-34037-6_11**

Six species of quails occur on western United States (U.S.) rangelands: northern bobwhite, scaled quail, Gambel's quail, California quail, Montezuma quail, and mountain quail. These quails are found across a variety of vegetation types ranging from grasslands to mountain shrublands to coniferous woodlands. Given their ecological importance and gamebird status, there is considerable conservation, management, and research interest by ecologists and the public. Western quails in general are *r*-selected species whose populations are strongly influenced by weather. Based on Breeding Bird Survey data, 3 species are declining (northern bobwhite, scaled quail, and mountain quail), 2 species have inconclusive data (Gambel's quail and Montezuma quail), and 1 species is increasing (California quail). Grazing represents a valuable practice that can be used to create or maintain quail habitat on western rangelands if applied appropriately for a given species, site productivity, and prevailing climate. Invasive, nonnative grasses represent a notable threat to quails and their habitat given the negative influence that nonnative grasses have on the taxon. Numerous conservation programs exist for public and privately-owned rangelands with potential to create thousands of hectares of habitat for western quails. Although the taxon is relatively well-studied as a group, additional research is needed to quantify the cumulative impact of climate change, landscape alterations, and demographic processes on quail-population viability. In addition, research on quail response to rangeland-management practices is limited in scope (only 1–2 species) and geographic extent (mostly Texas, Oklahoma, and New Mexico) and warrants further investigation.



Six quail species inhabit the western rangelands of the United States. These quails are **a** northern bobwhite, **b** scaled quail, **c** Gambel's quail, **d** California quail, **e** Montezuma quail, and **f** mountain quail. Photographs by Larry Ditto (northern bobwhite, scaled quail, Gambel's quail, and Montezuma quail) and Brian Small (California quail and mountain quail)

Nolan et al. Distance sampling and spatial capture-recapture for estimating density of Northern Bobwhite. Ecological Informatics. https://doi.org/10.1016/j.ecoinf.2023.102330

- Four approaches to estimating northern bobwhite abundance were tested and provided accurate and precise estimates with spatial capture-recapture performing the best.
- Acoustic sampling provides a promising addition to the toolbox for estimating abundance.

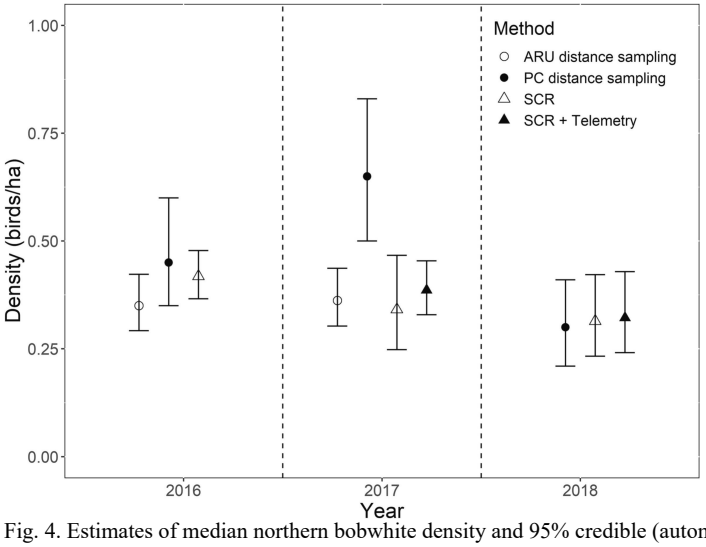


Fig. 4. Estimates of median northern bobwhite density and 95% credible (automated recording unit (ARU) and point count distance sampling (DS)) and confidence (spatial capture-recapture (SCR), SCR + telemetry) intervals for each analytical method based on empirical data collected during the autumns of 2016–2018 on Di-Lane Plantation WMA, Burke County, Georgia. ARU data was analyzed using a convolutional neural network with a score detection threshold of 0.95.

6. **YouTube channel for recent thesis defenses. https://studio.youtube.com/video/TuQJY1P1Ay4/edit**

Regards,
JM

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