Effects of Livestock Grazing Management on Occupancy of Mesocarnivores in a Northern Mixed-Grass Prairie Ecosystem

S.T. Vold, and L.B. McNew*

Department of Animal and Range Sciences, Montana State University, Bozeman, MT

IMPACT STATEMENT

Livestock grazing management practices that influence the occupancy of mesocarnivores should be considered for their potential indirect effects on prey populations such as ground-nesting grassland birds, a guild of recent conservation concern.

SUMMARY

Mesocarnivores have recently experienced population increases and range expansions as a result of anthropogenic extirpation of top predators in grassland ecosystems. Mesocarnivores are often major predators of grassland birds and their nests, so considering the effects of management actions on mesocarnivore occupancy is important for grassland bird conservation efforts. Our study evaluates the relative effects of livestock grazing management on mesocarnivore occupancy in a northern mixed-grass prairie ecosystem of eastern Montana. During 2016–17, we deployed camera traps at 90 locations within pastures managed under rest-rotation grazing systems, and at 90 locations within pastures managed under season-long stocking or summer rotational grazing systems. We found occupancy of mesocarnivores was highest in rest-rotation grazing systems, followed by season-long and summer-rotation systems, respectively, and showed a positive relationship with stocking rate.

INTRODUCTION

The extirpation or acute population reductions of top predators throughout much of their historic ranges in North America has resulted in increased abundances and range expansions of secondary predators (hereafter mesocarnivores), an ecological phenomenon known as "mesopredator release" (Crooks and Soulé, 1999; Prugh et al., 2009; Brashares et al., 2010). Expansion of mesocarnivore populations has increased pressure on their prey base within numerous ecosystems throughout North America, and has been attributed to ecosystem instability, along with population declines of birds, small mammals, and reptiles (Ritchie and Johnson, 2009; Brashares et al., 2010). Mesocarnivores can have a substantial impact on the annual fecundity of ground-nesting birds in grassland ecosystems through depredation of eggs and young at nest sites while foraging, as well as predation of fledglings and adults while hunting (Vickery et al., 1992; Rollins and Carroll, 2001; Hovick et al., 2011).

Grassland birds have undergone steep population declines throughout a majority of their historic range over the past century (Knopf, 1996; Peterjohn and Sauer, 1999; Sauer et al., 2013). Rangelands managed for livestock grazing contribute the majority of remaining native grassland bird habitat (Knopf, 1996; Davis et al., 2014). However, researchers have suggested that even large areas of native grassland habitat may not be adequate to sustain grassland bird populations in light of recent population trends (With et al., 2008). Although lowering rates of nest predation should benefit grassland bird conservation efforts (Johnson et al., 2012), research evaluating the effects of livestock grazing or rangeland management practices on grassland bird nest predators in prairie ecosystems is lacking. Researchers have hypothesized that livestock grazing increases

predator activity (Fuller and Gough 1999), and have found occupancy of certain mesocarnivores is higher in grazed than ungrazed grasslands (Gese and Thompson 2014). However, few studies have evaluated the direct effects of livestock grazing management on mesocarnivore occupancy.

PROCEDURES

Our study area was located within the northern mixed-grass prairie and centered on a ~3,000-ha Upland Gamebird Enhancement Program (UGBEP) project established by the Montana Department of Fish, Wildlife, and Parks, in eastern Richland County, Montana, 20 km southeast of Sidney (48° 30' N, 104° 04'W). The UGBEP project was managed under a 3-year, 3-pasture rest-rotation grazing system. Five pastures of ~4,300-ha bordering the UGBEP project were used as reference treatments, with three pastures located on private lands adjacent to the UGBEP project in Montana, and two pastures located on U.S. Forest Service lands adjacent to the UGBEP project in McKenzie County, North Dakota. The reference pastures were managed under season-long grazing or 2-pasture summer-rotation grazing systems. We interviewed landowners to gather grazing system data, as well as cattle turn-out/turn-in dates and number of head stocked to calculate stocking rates for the pastures within the study area.

We collected data during two field seasons (May – July, 2016–17). We randomly generated 180 camera trap survey sites (90 each season) across gradients of habitat conditions within the UGBEP project and reference pastures. We deployed one passive infrared remote field camera (Browning BTC 5HD, Browning, Morgan, UT) at each camera trap site during three sampling sessions in 2016 and 2017 to estimate mesocarnivore occupancy among grazing systems. Mesocarnivores typically prefer to hunt and forage along habitat edges (Andrén 1995). We used ArcMap 10.4 to digitize the habitat edges that may influence mesocarnivore occupancy, such as wooded draws, fencelines, roads, and water features (ESRI 2011, v10.4).

We conducted all analyses using the statistical program R (R Core Team, 2016), with use of packages 'unmarked' (Fiske and Chandler, 2011) and 'AICcmodavg' (Mazerolle, 2013) to identify specific effects on occupancy of mesocarnivores. Occupancy modeling allowed for simultaneous estimation of detection probability and occupancy (MacKenzie et al., 2006).

RESULTS AND DISCUSSION

We recorded 178 mesocarnivore detections during 3,535 camera trap days at 164 remote camera sites, which were located within 8 pastures managed for cattle grazing. Sixteen of the original 180 camera sites were censored from the analysis due to lack of spatial independence (12), camera malfunction (2), cattle destruction (1), or camera theft (1). We detected 5 species of mesocarnivores during camera trap surveys: American badger, coyote, raccoon, striped skunk, and long-tailed weasel. We pooled observations for analysis, as previous researchers have suggested, in grassland ecosystems with relatively high predator diversity, management actions to reduce grassland bird nest depredation may not prove successful if they do not consider the entire predator community (Renfrew and Ribic 2003, Pietz et al. 2012). The mean (± SE) probability of detecting a mesocarnivore at the study area was 0.3 ± 0.03. Five models shared support (ΔAICc $\leq$ 2.0) for management-level effects on mesocarnivore occupancy. The top model included the main effects of grazing system and stocking rate (w_i = 0.24). Mesocarnivore occupancy was highest in rest-rotation grazing systems, followed by season-long (β = -3.54 ± 2.49) and summer-rotation systems (β = -3.44 ± 2.10), and the probability of mesocarnivore occupancy increased with stocking rate (β = 1.64 ± 1.10; Figure 1). The probability of mesocarnivore occupancy decreased sharply with distance to nearest fence (β = -1.92 ± 0.64).

Low livestock stocking rates typically result in higher cattle forage selectivity and higher within-pasture variation in vegetation structure, when compared to high stocking rates (Fuhlendorf and Engle, 2001; Toombs et al., 2010), which may act to decrease predator search efficiency (Bowman and Harris, 1980). We

found mesocarnivore occupancy increased with stocking rate, and these results were consistent with previous research suggesting that livestock grazing may facilitate increased use by mesocarnivores (Gese and Thompson, 2014). Within contiguous rangeland landscapes such as our study area, we hypothesized that fences may represent effective habitat edges, potentially due to their physical structure or differences in vegetation structure among pastures. We found a negative relationship between mesocarnivore occupancy and distance to the nearest fence, which was consistent with previous work regarding mesocarnivore use of fencelines (Pedlar et al., 1997; Smith et al., 2017). In areas beyond 500 m from fences, predicted mesocarnivore site occupancy declined sharply.

Our results have implications for mesocarnivore prey species occupying rangelands managed with multi-pasture rotational livestock grazing systems, such as rest-rotation or short-duration grazing systems. Intensively managed grazing systems often use fencing to divide larger pastures into multiple smaller pastures, to achieve the desired forage utilization as determined by the range manager (Hart et al., 1993). However, adding more fence to the landscape may facilitate mesocarnivore occupancy or improved foraging efficiency in these areas, potentially reducing survival or reproductive output of grassland birds and small mammals, common mesocarnivore prey in grassland ecosystems.

REFERENCES

Andrén, H. 1995. Effects of landscape composition on predation rates at habitat edges. In: Mosaic landscapes and ecological processes. Chapman & Hall, New York, New York, USA. Pages 225-255.

Bowman, G. B., and L. Harris. 1980. Effect of spatial heterogeneity on ground-nest depredation. J. Wildl. Manag. 44: 806-813.

Brashares, J. S., L. R. Prugh, C. J. Stoner, and C. W. Epps. 2010. Ecological and conservation implications of mesopredator release. In: Trophic Cascades: Predators, Prey, and the

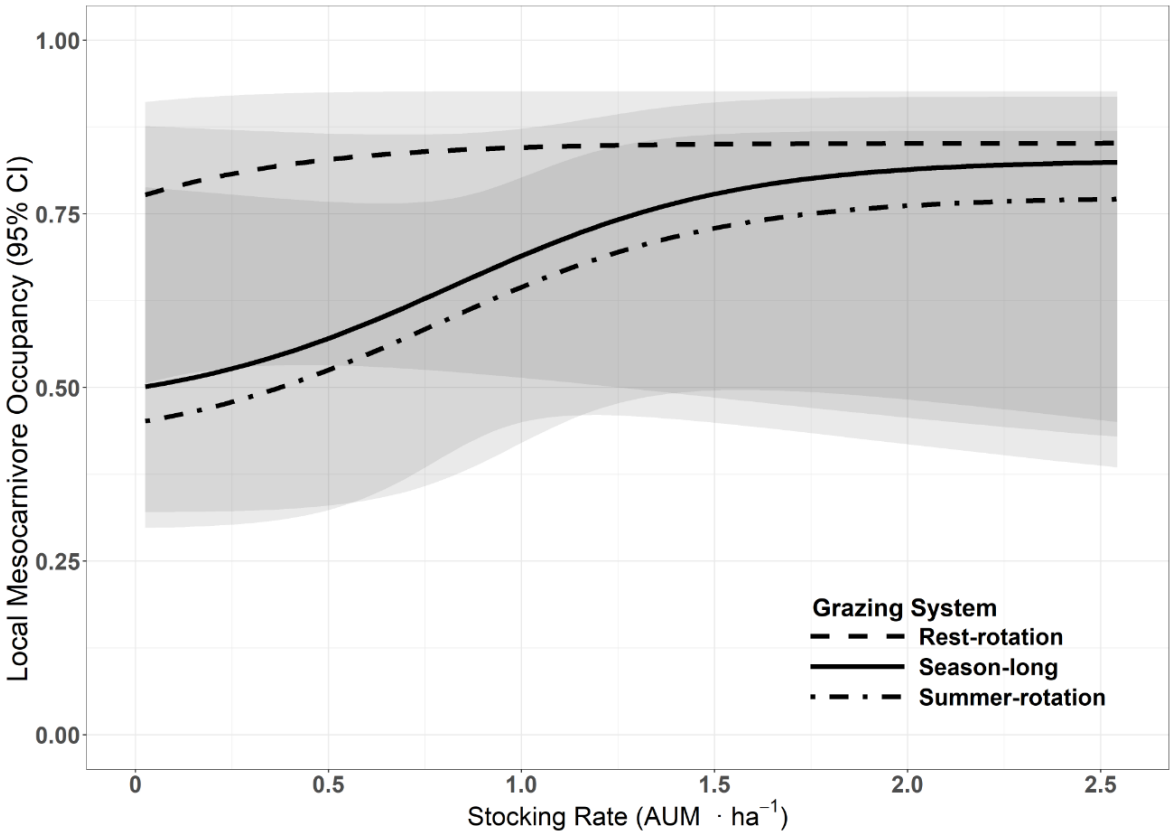

Figure 1. The top management-level model describing local occupancy of mesopredators in eastern Montana during 2016–17 included main effects of grazing system and stocking rate.

Changing Dynamics of Nature. Island Press, Washington, D. C., USA. Pages 221-240.

Crooks, K. R., and M. E. Soulé. 1999. Mesopredator release and avifaunal extinctions in a fragmented system. Nature 400: 563-566.

Davis, S. K., B. C. Dale, T. Harrison, and D. C. Duncan. 2014. Response of grassland songbirds to grazing system type and range condition. In: Proceedings of the North American Prairie Conference. Pages 110-119.

ESRI. 2011. ArcGIS Desktop: Release 10.4. Environmental Systems Research Institute. Redlands, CA

Fiske, I. J., and R. B. Chandler. 2011. Unmarked: An R Package for Fitting Hierarchical Models of Wildlife Occurrence and Abundance. J. Stat. Softw. 43: 1-23.

Fuhlendorf, S. D., and D. M. Engle. 2001. Restoring Heterogeneity on Rangelands: Ecosystem Management Based on Evolutionary Grazing Patterns. We propose a paradigm that enhances heterogeneity instead of homogeneity to promote biological diversity and wildlife habitat on rangelands grazed by livestock. BioScience 51: 625-632.

Fuller, R., and S. Gough. 1999. Changes in sheep numbers in Britian: implications for bird populations. Biol. Cons. 91: 73-89.

Gese, E. M., and C. M. Thompson. 2014. Does habitat heterogeneity in a multi-use landscape influence survival rates and density of a native mesocarnivore? PloS one 9: e100500.

Hart, R., J. Bissio, M. Samuel, and J. Waggoner Jr. 1993. Grazing systems, pasture size, and cattle grazing behavior, distribution and gains. J. Rang. Manag. 46: 81-87.

Hovick, T. J., J. R. Miller, R. R. Koford, D. M. Engle, and D. M. Debinski. 2011. Postfledging survival of grasshopper sparrows in grasslands managed with fire and grazing. Condor 113: 429-437.

Johnson, T. N., P. L. Kennedy, and M. A. Etterson. 2012. Nest success and cause-specific nest failure of grassland passerines breeding in prairie grazed by livestock. J. Wildl. Manag. 76: 1607-1616.

Knopf, F. L. 1996. Prairie legacies—birds. In: Prairie conservation: preserving North America's most endangered ecosystem. Island Press, Covelo, CA. Pages 135-148.

MacKenzie, D. I. et al. 2006. Occupancy estimation and modeling: inferring patterns and dynamics of species occurrence. Elsevier, San Diego, CA, USA.

Mazerolle, M. J. 2013. AICcmodavg: model selection and multimodel inference based on (Q) AIC (c). R package version 1: 35.

Pedlar, J. H., L. Fahrig, and H. G. Merriam. 1997. Raccoon habitat use at 2 spatial scales. J. Wildl. Manag. 61: 102-112.

Pietz, P. J., D. A. Granfors, C. A. Ribic, and F. Thompson. 2012. Knowledge gained from video-monitoring grassland passerine nests. Video surveillance of nesting birds 43: 3-22.

Prugh, L. R. et al. 2009. The rise of the mesopredator. Bioscience 59: 779-791.

R Core Team. R: a language and environment for statical computing. R Foundation for Statistical Computing, Vienna, Austria.

Renfrew, R. B., and C. A. Ribic. 2003. Grassland passerine nest predators near pasture edges identified on videotape. Auk 120: 371-383.

Ritchie, E. G., and C. N. Johnson. 2009. Predator interactions, mesopredator release and biodiversity conservation. Ecology Letters 12: 982-998.

Rollins, D., and J. P. Carroll. 2001. Impacts of predation on northern bobwhite and scaled quail. Wildl. Soc. Bul. 29: 39-51.

Sauer, J. R., W. A. Link, J. E. Fallon, K. L. Pardieck, and D. J. Ziolkowski Jr. 2013. The North American breeding bird survey 1966–2011: summary analysis and species accounts. N. Am. Fauna 79: 1-32.

Smith, J., M. Brown, J. Harrison, and L. Powell. 2017. Predation risk: a potential mechanism for effects of a wind energy facility on Greater Prairie-Chicken survival. Ecosphere 8:e01835.

Toombs, T. P., J. D. Derner, D. J. Augustine, B. Krueger, and S. Gallagher. 2010. Managing for Biodiversity and Livestock: A scale-dependent approach for promoting vegetation heterogeneity in western Great Plains grasslands. Rangelands 32: 10-15.

Vickery, P. D., M. L. Hunter Jr, and J. V. Wells. 1992. Evidence of incidental nest predation

and its effects on nests of threatened grassland birds. Oikos 63: 281-288.

With, K. A., A. W. King, and W. E. Jensen. 2008. Remaining large grasslands may not be sufficient to prevent grassland bird declines. Biol. Cons. 141: 3152-3167.

ACKNOWLEDGEMENTS

Funding for this project was provided by the Montana Department of Fish, Wildlife, and Parks. The authors would like thank and acknowledge the local ranchers and ranching families who granted us access to their rangelands for this research. The project would not have been possible without this successful collaboration.

*Corresponding author email: voldskyler@gmail.com