C O L O R A D O   P A R K S   &   W I L D L I F E

2024 Avian Research Summary Report

FEBRUARY 2024

cpw.state.co.us

COVER PHOTOS

Top left: bald eagle with back-mounted transmitter (M. Middleton)
Top right: greater sage-grouse in northwestern Colorado
Bottom left: bitterbrush seedings in an experimental habitat plot (D. Johnston)
Bottom right: cinnamon, green-winged, and blue-winged teal captured for banding

Copies of this publication may be obtained from
Colorado Parks and Wildlife Research Library
317 West Prospect, Fort Collins, CO 80526

WILDLIFE RESEARCH SUMMARIES

JANUARY – DECEMBER 2024

AVIAN RESEARCH PROGRAM

COLORADO DIVISION OF PARKS AND WILDLIFE
Research Center, 317 W. Prospect, Fort Collins, CO 80526

Executive Summary

This Wildlife Research Report contains abstracted summaries of wildlife research projects conducted by the Avian Research Program of Colorado Parks and Wildlife (CPW) during 2024. These are long-term projects (2–10 years) in various stages of completion, each of which addresses applied questions to benefit the management of various bird species and wildlife habitats in Colorado. More technical and detailed reports of most of these projects can be accessed from the project principal investigator listed at the beginning of each summary, or on the CPW website at https://cpw.state.co.us/researchin-wildlife

In 2024, research projects in the Program address various aspects of the ecology and management of wildlife populations and the habitats that support them, human-wildlife interactions, and new approaches to field methods in wildlife management. This report includes summaries of 10 current research projects addressing management-related information needs for a variety of species of conservation concern and game species and their habitats. These projects are grouped under Wildlife Habitat Conservation, Wildlife Spatial Ecology, Bird Conservation and Energy Development, Raptor Conservation, Sagebrush Bird Conservation, Grassland Bird Conservation, and Wetland Bird Conservation.

Also included in this report is a listing of publications produced during 2024, and presentations, workshops, and participation on various committees and working groups by Avian Research staff during 2024. Communicating research results and using their subject matter expertise to inform management and policy issues is a priority for CPW scientists. Copies of peer-reviewed research publications can be obtained from the CPW Library.

We are grateful for the numerous collaborations that support these projects and the opportunity to work with and train graduate students and research technicians that will serve wildlife management in the future. Research collaborators include statewide CPW personnel, Bird Conservancy of the Rockies, Brigham Young University, Bureau of Land Management, City of Fort Collins, Colorado State University, Conoco-Phillips, Marathon Oil, Species Conservation Trust Fund, U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Geological Survey, Wildlands Photography and Bio-consulting, WPX Energy, and the private landowners who have provided access for research projects.

STATE OF COLORADO
Jared Polis, *Governor*

DEPARTMENT OF NATURAL RESOURCES
Dan Gibbs, *Executive Director*

PARKS AND WILDLIFE COMMISSION (December 2024)

Dallas May, *Chair* .... Lamar
Richard Reading, *Vice Chair* .... Denver
Karen Michelle Bailey, *Secretary* .... Boulder
Jessica Beaulieu .... Denver
Marie Haskett .... Meeker
Ty Jacober .... Carbondale
Jack Murphy .... Aurora
Gabriel Otero .... Fruita
Murphy Robinson .... Lttleton
James Jay Tuchton .... Hasty
Eden Vardy .... Aspen
Kate Greenberg, Department of Agriculture, *Ex-officio* .... Denver
Dan Gibbs, Executive Director, *Ex-officio* .... Denver

EXECUTIVE MANAGEMENT TEAM (December 2024)

Jeff Davis, Director
Heather Dugan, Deputy Director
Reid DeWalt, Deputy Director
Travis Black, Cory Chick, Brian Dreher, Fletcher Jacobs, Kelly Kaemerer,
Mark Leslie, Frank McGee, Matt Nicoll, Ty Petersburg, Mike Quartuch, Justin Rutter

AVIAN RESEARCH STAFF

James H. Gammonley, Avian Research Leader
Adam C. Behney, Wildlife Researcher
Reesa Yale Conrey, Wildlife Researcher
Jody Hergott, Program Assistant
Nick Jaffe, Spatial Ecologist
Danielle B. Johnston, Habitat Researcher
Casey Setash, Wildlife Researcher
Dan Thompson, Habitat Researcher
Brett L. Walker, Wildlife Researcher

TABLE OF CONTENTS
AVIAN WILDLIFE RESEARCH REPORTS

WETLAND BIRD CONSERVATION

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Mountain Shrub Establishment in Colorado

Period Covered: January 1, 2024 – December 31, 2024

Authors: Danielle B. Johnston Danielle.bilyeu@state.co.us and Nathan Nelson

Principal Investigators: Danielle B. Johnston (Habitat Researcher, CPW), Mark Paschke (Shell Endowed Chair of Restoration Ecology, Colorado State University)

Project Collaborators: Nathan Nelson, Colorado State University; Jacob Lucero, Texas A&M assistant professor; Trevor Balzer, CPW Habitat Coordinator; JC Rivale, Little Hills State Wildlife Area Property Technician; Zane Stewart, Byers Canyon Property Technician; Dillon Sanders, Cherokee State Wildlife Area Property Technician; Jim Sebastian, Boulder County Open Space

EXTENDED ABSTRACT

Mountain shrubs such as bitterbrush and mountain mahogany provide a critical food source for mule deer and other wildlife in Colorado. These shrubs can be lost from landscapes due to fire, land use change, drought, and other factors. As climate change alters plant communities, we will need the ability to restore these species to landscapes. However, seedings and transplants of these species often fail to survive, and the reasons for failure are not always clear. We seek to improve our understanding of establishment of these two key species with three experiments.

The first experiment is dubbed the RIB experiment, and it is designed to assess the relative importance of three factors known to impact the establishment of bitterbrush and mountain mahogany: weeds, insects, and rodents. A prior CPW study examined those three factors for bitterbrush only at Bitterbrush State Wildlife Area. Here, we seek to quantify the relative importance of these three factors more broadly across Colorado by expanding to 4 new sites and including mountain mahogany. The four sites are: Byer's Canyon (Byer's Canyon Rifle Range, Grand County), North Ridge (Little Hills SWA, Rio Blanco County), Hall Ranch (Boulder County), and Lower Cherokee (Cherokee SWA, Larimer County).

Rodent activity was manipulated by planting seed in rodent control cages that were either closed or had an opening cut to allow rodent access. Cheatgrass (*Bromus tectorum*) was manipulated by either hand-weeding or adding cheatgrass seeds. Seed of either mountain mahogany or bitterbrush were hand-planted in each plot. Insect control is via spring application of Bonide Eight® insecticide, a product that was shown to be effective for reducing herbivory on bitterbrush seedlings and increasing bitterbrush seedling density in a prior CPW study. Treatments are fully crossed and five replications per target species per site were established. The experiment is repeated twice, with plantings in the fall of 2023 and 2024.

Activities in 2024 included applying insecticide to the first planting of the experiment, monitoring seedling emergence and herbivory for the first planting, monitoring of 6 game cameras at each site to

characterize small mammal communities, graphing data from the first planting, and implementing the second planting of the experiment.

Seedling emergence from the 2023 planting was very good for bitterbrush, but virtually nonexistent for mountain mahogany. For bitterbrush, it is clear that that the factors having the largest impact on seedling density vary by site. For instance, rodent control had a large effect at Byer's Canyon and North Ridge, but not at the other two sites (Figure 1b). Because our seeding of mountain mahogany appears to have failed, we sampled the soils in a subset of our mountain mahogany plots and we plan to sieve these samples, collect mountain mahogany seeds, and conduct viability testing on those seeds.

In 2024 we began a second experiment called the Coated Seed Experiment. We coated bitterbrush seeds with activated carbon, which has been shown in a laboratory experiment to deter rodents from eating seeds. We planted coated and uncoated seed in a factorial experiment with closed and open rodent control cages, using the same 4 sites as the RIB experiment.

We also began a third experiment called the Greenhouse Shrub Experiment which will address limitations on the success of bitterbrush and mountain mahogany transplants. This experiment is not yet completely defined, but may explore how root inoculation impacts the response of seedlings to indaziflam application. For this purpose, we have been growing bitterbrush and mountain mahogany seedlings at the Colorado State University greenhouse.

In 2025 we will continue all three experiments. We will monitor the second planting of the RIB Experiment, analyze data, and may implement a third planting. We will monitor the Coated Seed Experiment and implement a second planting. We will further define our objectives and methods for our Greenhouse Shrub Experiment. In future years, we will synthesize results from all experiments to inform best practices for establishing mountain mahogany and bitterbrush in restoration efforts in Colorado.

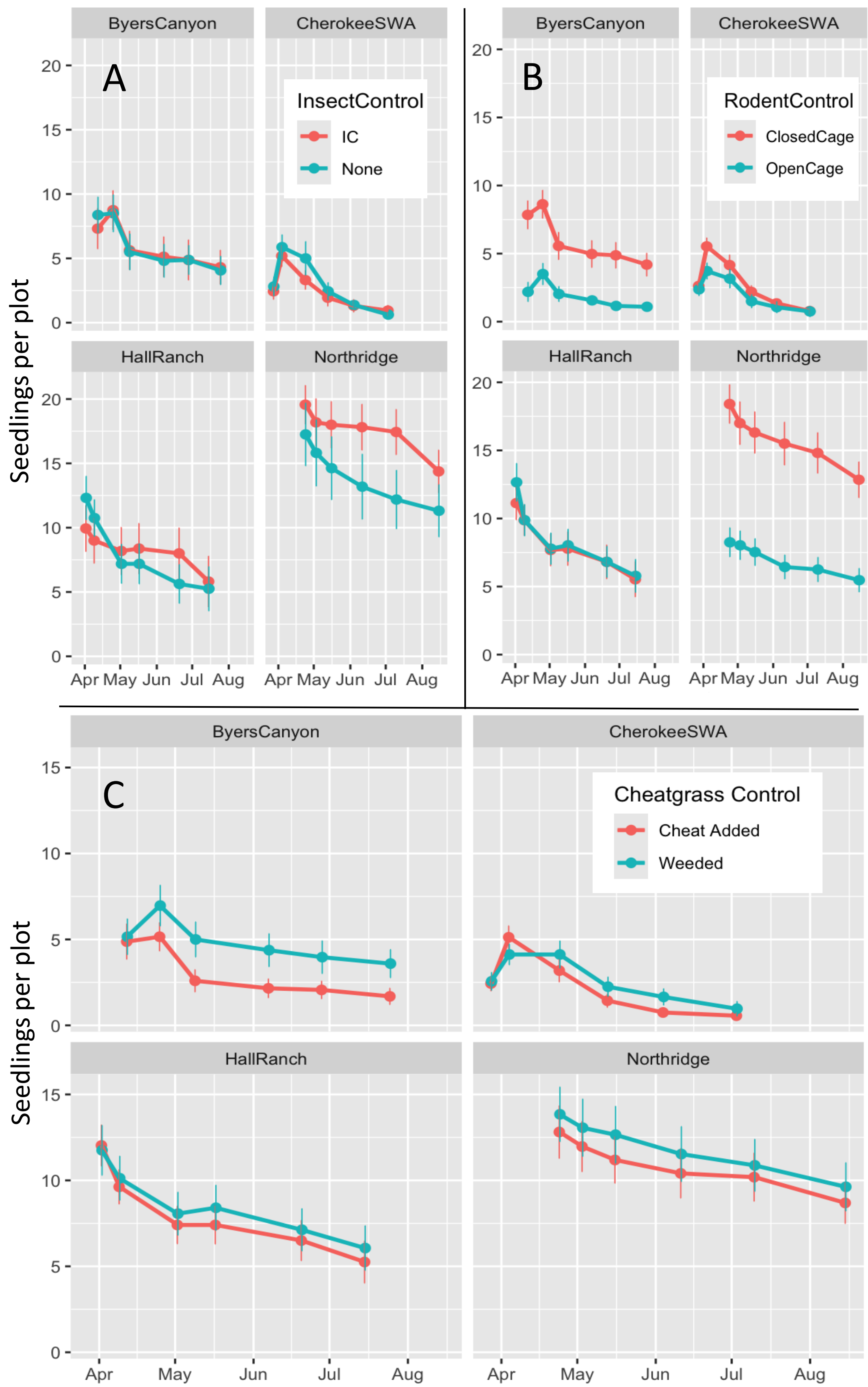


Figure 1. Main effects of insect control (a), rodent control (b), and cheatgrass control (c) on bitterbrush seedling density at four study sites during the spring and summer of 2024. Seeds had been planted in the late fall of 2023. Error bars = SE.

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Spatial ecology and analysis of avian and mammalian wildlife

Period Covered: January 1 – December 31, 2024

Principal Investigator: Nick Jaffe nick.jaffe@state.co.us

Project Collaborators: Casey Cooley, Michelle Cowardin, Michelle Flenner, Julie Mao, Alyssa Meier, Reesa Conrey, Amy Seglund, Liza Rossi, Jon Runge, Tony Apa, Brett Walker, Ellen Brandell, Brenna Cassidy, Eric Odell, Andy Holland, Nathaniel Rayl, and Chuck Anderson (Colorado Parks and Wildlife); Michelle Fink and Bort Edwards (Colorado Natural Heritage Program); Miranda Middleton (Colorado State University); Emily Macklin (South Dakota State University)

EXTENDED ABSTRACT

Evaluating wildlife location data provides substantial information for management. Location data reveal patterns of movement dynamics, species distribution (habitat suitability), and varying habitat use. Colorado Parks and Wildlife monitors myriad species of concern for conservation and hunting and thus needs to develop thorough and up-to-date assessments of the spatial patterns and processes of its target species. In collaboration with state wildlife biologists, avian researchers, and external partners, I have assisted in evaluating spatial data for several species and populations. Below, I list the active research projects I am associated with, and briefly detail the objectives and current status of each.

- **Model evaluation and selection for Species Habitat Conservation and Connectivity Plan (with Casey Cooley, Michelle Cowardin, Michelle Flenner, Michelle Fink [CNHP], and Bort Edwards [CNHP])** — We developed a method for evaluating the accuracy of CNHP produced movement corridor models using a subsample of GPS collared mule deer and elk migratory paths. Multiple candidate models were evaluated this way and, in combination with other metrics, used to select a final movement corridor models for both species. Corridor models served as one of several inputs into the final map product for Colorado's Statewide Habitat Conservation and Connectivity Plan (SHCCP). We also provided feedback and assisted in the selection of a final SHCCP map product as part of the associated working group, providing recommendations on the relative weighting of different regions and input layers. The final map product and overall SHCCP report are now undergoing final revisions.

- **Ungulate migration corridor mapping (with Michelle Cowardin, Julie Mao, and Alyssa Meier)** — I developed code for and provided guidance on producing migration corridors from GPS collar datasets to CPW biologists. Code was adapted variously from prior analyses (e.g., Chloe Beaupre, former WCU M.S. student, and Dave Lewis, former CPW employee) in order to be consistent and comparable with previous analyses. Julie Mao's mapping product will be published as part of a CPW report (CPW-R-T-66-25). Alyssa Meier's mapping output will be published in the USGS's "Ungulate Migrations of the Western United States" Vol. 4 report. These and other efforts have been

incorporated into an ongoing effort to develop standards and best practices for migration mapping, to be formalized in the future for broader use in CPW.

- **Bald Eagle home range and habitat selection analysis (with Reesa Conrey and Miranda Middleton [CSU])** — We provided advice and guidance to Miranda Middleton on design and implementation of habitat selection models, as part of her M.S. thesis examining bald eagle spatial ecology on Colorado's front range. We identified an effective model package and analysis structure. Miranda successfully defended her thesis and work is ongoing on finalizing her manuscript for publication in a professional journal. Future objectives included pursuing more targeted analyses beyond Miranda's work and updating results as data from new eagle locations is incorporated.

- **Pinyon Jay survey evaluation and analysis (with Amy Seglund, Liza Rossi, Jon Runge, and Emily Macklin [SDSU])** — We developed a predictive model to map the in-state breeding range of Pinyon Jays (PIJA) using data from surveys conducted in Western Colorado. The model also evaluates the effectiveness of existing PIJA mapping products (e.g., a species distribution model developed by USFWS) in identifying nesting locations. Results of this analysis will be used internally to develop efficient PIJA survey techniques and shared with the multi-state Pinyon Jay working group to provide guidance as other states and research groups develop their own surveys. The analysis includes data from surveys conducted by Emily Macklin (M.S. student at SDSU), which was recently acquired. Analysis is ongoing.

- **Columbian Sharp-tailed Grouse resource selection (with Tony Apa)** — We previously developed a scale-integrated habitat selection model, trained using a long-term dataset of Columbian Sharp-tailed Grouse (CSTG) VHF locations. Evaluation of the model suggested that some landcover variables were not accurately represented, specifically shrub cover types that are critical for CSTG. Currently, we are evaluating alternative means of modelling different types of shrub cover using environmental data (e.g., soil properties, weather data, and land use information). Analysis is ongoing.

- **Greater Sage-Grouse long distance movement analysis (with Brett Walker)** — We are using GPS telemetry locations of Greater Sage Grouse (GRSG) to identify long-distance movements and space-use around leks. A project workflow has been developed by Brett Walker, which I then adapted into code. Data processing and analysis is ongoing.

- **Gray Wolf monitoring and spatial analysis (with Ellen Brandell, Brenna Cassidy, and Eric Odell) —** We developed a new project examining post-release movement, space-use, and social behavior of gray wolves in Colorado. This project is distinct from ongoing wolf monitoring effort and will instead seek to explore how wolf spatial ecology differs under the novel conditions of Colorado's wolf reintroduction (e.g., hard-release into an open landscape), particularly at fine scales. We have finished writing the proposal and it is currently undergoing internal review.

- **Big game responses to hunting season structure changes (with Andy Holland, Nathaniel Rayl, Jon Runge, and Chuck Anderson)** — I conducted preliminary analyses examining habitat selection of elk before and after the onset of hunting seasons, comparing between different big game hunting structures (2015-2019 structure vs 2020-2024). Results were presented to associated CPW staff in order to ascertain the time and effort required for a comprehensive evaluation of this question. We continue to run analyses to identify specific questions for a potential graduate student or external researcher attached to the project. Notable findings may be developed for publication in collaboration with Nathaniel Rayl and other CPW staff.

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Assessing High-Priority Bird Species Interactions with Renewable Energy

Period Covered: January 1 – December 31, 2024

Author: Casey M. Setash casey.setash@state.co.us

Principle Investigators: Casey M. Setash, Jim Gammonley

Collaborators: CPW Energy Liaisons and Land Use Coordinators (Brandon Marette, Lexi Hamous-Miller, Karen Voltura, Taylor Elm, Danielle Neumann, Molly West, Peter Foote, Brian Magee, Cassidy English, Carolyn Craveiro De Sa, Andrew Newman)

EXTENDED ABSTRACT

Renewable energy infrastructure is being developed rapidly across Colorado. The technology that powers infrastructure is improving while the extent of infrastructure on the landscape is simultaneously expanding, often with unknown or unforeseen impacts on wildlife. Based on known seasonal distributions and habitat associations, approximately 11 of Colorado's Tier I SWAP bird species and 28 Tier II species have the potential to be impacted by existing and proposed renewable energy infrastructure. Many of these species are grassland- or sagebrush-obligates, which are ecosystems that also lend themselves well to wind and solar development given their flat topography, wind and solar resources, and relationship to existing transmission lines. CPW Energy Liaisons and Land Use Coordinators are frequently contacted by developers and utilities companies to provide best management and mitigation practices, and have thus far based recommendations on limited peer-reviewed research and anecdotal observations. I initiated this project to better inform those recommendations using empirical data.

There is limited information on changes in bird use and density on photovoltaic (PV) solar facilities to date. The habitat needs and life history strategies of this broad array of species are diverse, and few of the direct and indirect impacts of renewable energy have been extensively studied. Direct (i.e., collision-related) impacts of wind turbines are often the primary focus of study in the avian literature, and to a lesser extent the degree to which energy infrastructure results in displacement or altered vital rates for species of conservation concern (e.g., greater sage-grouse [*Centrocercus urophasianus*], grassland Passerines; Shaffer and Buhl 2016, LeBeau et al. 2017). Very little research has been conducted on the displacement impacts of solar infrastructure and the changes in avian community structure related to solar development. The degree to which bird communities use various habitats once they are covered by solar panels and associated infrastructure (e.g., fencing, transmission lines, etc.) has yet to be determined.

Past research and reviews have also highlighted the need to evaluate the mechanisms underlying changes in avian ecology at newly-constructed energy facilities and how these mechanisms may change over time (Lloyd et al. 2022). Energy development may alter both biotic and abiotic mechanisms of avian habitat use and biodiversity change, including vegetation and physical structure modifications (Lovich and Ennen 2011, Keehn and Feldman 2018), predator responses (Smallwood 2022), and anthropogenic noise/light

disturbance (Stantec 2011). By specifically monitoring potential hypothesized mechanisms we can begin to evaluate causal relationships and target post-construction mitigation actions to minimize negative impacts on species of conservation concern.

I initiated a pilot field project during 2024 to determine necessary field protocols to estimate bird density and species richness at solar facilities in Colorado before and after construction. The specific objectives of this project are to:

1. Identify post-construction changes in breeding bird density and diversity within the construction area at solar facilities.
2. Monitor changes in potential mechanisms of bird community composition, density, and diversity changes associated with renewable energy infrastructure facilities.

I conducted point counts in addition to monitoring potential mechanisms of change, including potential nest predator density, vegetation characteristics, and anthropogenic disturbance. Data processing and analysis are ongoing, but I used the data collected this year to validate that bird density did not initially differ among treatment and control sites. I will also be using these data to determine the number of trail cameras and acoustic recording units (ARUs) that will be necessary to estimate the density of other species using the sites in coming years. Average bird density of all species combined was 0.42 individuals/ha (SD = 0.03) across all sites. Average probability of being available for detection within the maximum truncation distance (250 m) was 0.92 (SD = 0.01) and probability of being detected was 0.27 (SD = 0.01). This information will help me to modify and improve methods for upcoming field seasons.

STUDY AREA

This project is being conducted statewide at sites that will be developed as renewable energy facilities within the next five years (i.e., construction is likely to begin in 2025-2030). As of December 2024, the study areas included four potential solar facilities statewide with plans to begin construction in 2025 or 2026. I am keeping specific names and locations of facilities anonymous until developers finish construction and I finalize analyses in coming years. Each facility was in a different quadrant/region of the state, and habitats were primarily grassland and shrub-scrub (e.g., sagebrush [*Artemesia* spp.] or greasewood [*Sarcobatus* spp.]).

METHODS

Experimental Design

While experimental manipulations are challenging in the case of rapidly developing infrastructure, a before-after-control-impact (BACI) sampling design can help control confounding variables and evaluate specific development and conservation actions in terms of pre-defined avian biodiversity and abundance metrics. I employed a BACI design during pilot field work, selecting control sites within 10 km of planned development sites in similar habitat and delineating sites of a similar size and shape as the planned facility. I randomly selected 16 point count locations within each of these plots to evaluate treatment effects on avian species richness and abundance of focal species.

Point Counts

I conducted point counts according to the Integrated Monitoring in Bird Conservation Regions (IMBCR) program protocol (Pavlacky Jr. et al. 2017). Each survey lasted for six minutes, and I recorded the original location of birds flushed upon arrival to the point, species and sex of each individual, minute of the count wherein an individual was first detected, whether the observed individual was likely migrating and therefore not a breeder, and all flyover individuals. Surveys began up to 30 minutes before local sunrise and ended no later than five hours after sunrise. Points were > 150 m apart to reduce areal overlap and thus double-counting of birds, and I recorded the radial distance to each bird using a digital laser rangefinder. Surveys only took place when wind was < 18 kph and there was no precipitation. I conducted counts once at each point during the peak breeding season (late May-June). I conducted all counts at a paired treatment and control site in the same 1-4 day period to meet closure assumptions as best as possible. I also recorded mammals during point counts using the same methodology, but excluded prairie dogs because distance sampling is not the most appropriate method to estimate density for subterranean species (Biggins et al. 2013). I did record whether each point was located in a prairie dog colony and whether that colony was active. I used Survey123 in combination with FieldMaps as a data entry platform.

To estimate bird density at sampled sites, I constructed a hierarchical distance sampling and time removal model (Amundson et al. 2014). For this preliminary analysis, I included all bird species together to evaluate overall density, but will eventually modify the model to incorporate multiple species. I allowed the scale parameter dictating the distance-sampling component of the model (i.e. detection probability) to vary with a categorical wind speed indicator and included a species random effect. I included Julian date and time of day as predictors for the probability that a bird was available for detection, as well as a species random effect. I allowed abundance to vary with whether the site was a treatment or a control. The treatment effect allowed me to ensure initial bird abundance was relatively similar between selected control sites and treatment areas before construction begins. I also included a spatially autocorrelated intercept on abundance to account for the fact that points within each site likely had similar bird densities and a random effect for species. I removed observations farther than 250 m from the point to improve model fit and I used posterior predictive checks (Bayesian p-values) to assess model fit. I conducted this preliminary analysis in a Bayesian framework using Nimble (de Valpine et al. 2017) in Program R (version 4.4.1; R Core Team 2024). I ran three chains with 150000 iterations after 7500 iterations of burn-in.

Nest Predator Monitoring

I assessed predator density at the site using paired trail cameras and ARUs at a randomly-selected subset of the point count locations. Cameras were programmed to take a photo once every two minutes so that all cameras recorded an instantaneous snapshot of the viewshed area (Moeller et al. 2018). I placed flagging in the ground 10 m from the camera at both 45° angles and at a 90° angle to account for imperfect detection and to estimate a maximum viewable radius (Moeller et al. 2023). I deployed cameras and ARUs during point count visits and left them to record for a minimum of one week to a maximum of one month following the counts. The ARUs are meant to both increase detectability of predators that are difficult to detect via trail camera (e.g., avian predators like raptors) and provide an alternative data stream to evaluate Passerine changes across sites. In addition, they will enable monitoring of anthropogenic noise at study sites as a potential mechanism of avian community changes. I programmed ARUs to record for two hours centered on civil sunrise and two hours centered on civil sunset every day.

Vegetation Sampling and Landscape Covariates

I conducted vegetation surveys at each random point selected for point counts immediately prior to each count. I used a line-point-intercept sampling method at each point to estimate percent cover of each plant species (Elzinga et al. 1998). This method involved sampling a 10 m transect placed in a random direction and centered on the random point at 20 cm intervals. I recorded the plant species at each interval as well as visual obstruction at the point (Robel et al. 1970) and the height of the tallest vegetation within 1 m of the point. I also recorded general habitat information and local weather data. Additional anthropogenic covariates will eventually include the distance to and landscape composition of transmission lines, roads, mowed areas, and site-specific infrastructure (e.g., solar panels).

RESULTS

I conducted 83 point counts from 13 May 2024 to 5 June 2024 at four potential solar facilities and their paired control sites. I observed 1636 individuals of 66 known bird species and 3 unidentifiable bird species, and 143 individuals of 7 mammal species by sight and sound (Table 1). I placed 24 trail cameras and 23 ARUs across all four study sites. Two of the SD cards from ARUs and five of the SD cards from cameras were corrupted, however, and did not hold any usable data. Predominant habitat at each point location was grassland (n = 32 points), followed by desert/semidesert shrubland (n = 17), sage shrubland (n = 13), herbaceous meadow (n = 8), and others (n = 13). Average visual obstruction rating at points was 6.03 (SD = 7.5) and points consisted of, on average, 2% water, 6% litter, 13% herbaceous cover, 20% bare ground, 23% dead standing grass, and 36% live grass. Data processing and analysis are ongoing, and will be further developed in coming years.

Average bird density of all species combined was 0.42 individuals/ha (SD = 0.03) across all sites. Average probability of being available for detection within the maximum truncation distance (250 m) was 0.92 (SD = 0.01) and probability of being detected was 0.27 (SD = 0.01). Bird density did not differ in control sites and treatment sites (β_{trt} = -0.25, SD_{trt} = 0.23), indicating that control sites were appropriate for comparison to treatments. Availability was not affected by date (β_{date} = -2.28, SD_{date} = 2.01) or time of day (β_{time} = 0.04, SD_{time} = 0.07), and detection was not impacted by wind speed (β_{wind} = -0.02, SD_{wind} = 0.05). All parameters converged ($\hat{R} \leq 1.1$) and Bayesian p-values for probability of availability and detection were 0.56 and 0.73, respectively, indicating adequate model fit. Future modeling will incorporate vegetation and landscape covariates, mammalian and avian predator densities, and impacts associated with solar infrastructure once it is developed.

Progress and project components completed during 2024:

- Submitted the literature review conducted last year for publication in a peer-reviewed journal. It is currently under review.
- Wrote a proposal for an in-depth field study evaluating priority research questions identified by the literature review conducted last year.
- Initiated pilot field work at sites that have been selected for solar development but at which construction has not yet begun.
- Hired a master’s student to start in January 2025 at Colorado State University. This student will use eBird data products and renewable energy development forecasts to create mapping tools for biologists and energy liaisons. These tools will help identify potential conflict areas and important areas to protect and manage bird habitat, taking into consideration trade-offs in the number and diversity of species found there.

Project plans for 2025:

- Continue and expand upon pilot field work on solar facilities started in 2024.
  - Add a nest searching component.
  - Add mortality surveys, searcher efficiency trials, and carcass persistence trials.
- Begin processing audio data recorded on ARUs to identify species not observed during point counts.
- Begin processing trail camera photos and start building a model to estimate mammal density on solar sites.
- Work with the master’s student at CSU to identify focal bird species and begin laying out the conflict area mapping workflow.

Table 1. Bird and mammal species observed during six-minute point counts and while walking between points at four potential solar facilities (before construction) throughout Colorado in 2024.

Birds	**Mammals**
American avocet (*Recurvirostra americana*)	Coyote (*Canis latrans*)
American bittern (*Botaurus lentiginosus*)	Elk (*Cervus elaphis*)
American coot (*Fulica americana*)	Black-tailed jackrabbit (*Lepus californicus*)
American crow (*Corvus brachyrhynchos*)	Mule deer (*Odocoileus hemionus*)
American kestrel (*Falco sparverius*)	Pronghorn (*Antilocapra americana*)
Barn swallow (*Hirundo rustica*)	Red fox (*Vulpes vulpes*)
Black-billed magpie (*Pica hudsonia*)	White-tailed deer (*Odocoleus virginianus*)
Blue jay (*Cyanocitta cristata*)	
Brown-headed cowbird (*Molothrus ater*)	
Brewer's blackbird (*Euphagus cyanocephalus*)	
Brewer's sparrow (*Spizella breweri*)	
Broad-tailed hummingbird (*Selasphorus platycercus*)	
Bullock's oriole (*Icterus bullockii*)	
Burrowing owl (*Athene cunicularia*)	
Bushtit (*Psaltriparus minimus*)	
Canada goose (*Branta canadensis*)	
Cassin's sparrow (*Peucaea cassinii*)	
Chipping sparrow (*Spizella passerina*)	
Cinnamon teal (*Spatula cyanoptera*)	
Cliff swallow (*Petrochelidon pyrrhonota*)	
Common grackle (*Quiscalus quiscula*)	
Common raven (*Corvus corax*)	
Common yellowthroat (*Geothlypis trichas*)	
Columbian sharp-tailed grouse (*Tympanuchus phasianellus columbianus*)	
Eurasian collared dove (*Streptopelia decaocto*)	
European starling (*Sturnus vulgaris*)	
Gadwall (*Mareca strepera*)	
Grasshopper sparrow (*Ammodramus savannarum*)	
Great blue heron (*Ardea herodias*)	
Green-tailed towhee (*Pipilo chlorurus*)	
Green-winged teal (*Anas carolinensis*)	
Horned lark (*Eremophila alpestris*)	
House sparrow (*Passer domesticus*)	
Killdeer (*Charadrius vociferous*)	
Lark bunting (*Calamospiza melanocorys*)	
Lark sparrow (*Chondestes grammacus*)	
Loggerhead shrike (*Lanius ludovicianus*)	
Long-billed curlew (*Numenius americanus*)	
Mallard (*Anas platyrynchos*)	
Marsh wren (*Cistothorus palustris*)	
Mourning dove (*Zenaida macroura*)	
Northern harrier (*Circus hudsonius*)	
Northern mockingbird (*Mimus polyglottos*)	

Northern shoveler (*Spatula clypeata*)	
Redhead (A*ythya americana*)	
Rock pigeon (*Columba livia*)	
Red-tailed hawk (*Buteo jamaicensis*)	
Red-winged blackbird (*Agelaius phoeniceus*)	
Sandhill crane (*Antigone Canadensis*)	
Sage thrasher (*Oreoscoptes montanus*)	
Savannah sparrow (*Passerculus sandwichensis*)	
Snowy egret (*Egretta thula*)	
Sora (*Porzana carolina*)	
Song sparrow (*Melospiza melodia*)	
Swainson's hawk (*Buteo swainsonii*)	
Turkey vulture (*Cathartes aura*)	
Unknown passerine	
Unknown Empidonax flycatcher	
Unknown grebe	
Vesper sparrow (*Pooecetes gramineus*)	
Violet-green swallow (*Tachycineta thalassina*)	
Virginia rail (*Rallus limicola*)	
Western kingbird (*Tyrannus verticalis*)	
Western meadowlark (*Sturnella neglecta*)	
White-faced ibis (*Plegadis chihi*)	
Wilson's phalarope (*Phalaropus tricolor*)	
Wilson's snipe (*Gallinago delicata*)	
Wild turkey (*Meleagris gallopavo*)	
Yellow-headed blackbird (*Xanthocephalus xanthocephalus*)	

LITERATURE CITED

Amundson, C. L., J. A. Royle, and C. M. Handel. 2014. A hierarchical model combining distance sampling and time removal to estimate detection probability during avian point counts. The Auk, 131:476-494.

Biggins, D.E., J.G. Sidle, D.B. Seery, A.E. Ernst. 2006. Estimating abundance of prairie dogs. *In* Conservation of the Black-Tailed Prairie Dog: Saving North America's Western Grasslands, Ed. John Hoogland. Island Press, Washington, D.C., USA.

Conkling, Tara J., Hannah B. Vander Zanden, Sharon A. Poessel, Scott R. Loss, Taber D. Allison, Jay E. Diffendorfer, Adam E. Duerr, David M. Nelson, Julie Yee, and Todd E. Katzner. 2020. Learning From Real-World Experience to Understand Renewable Energy Impacts to Wildlife. California Energy Commission. Publication Number: CEC-500-2020-012.

de Valpine P, D. Turek, C. Paciorek, C. Anderson-Bergman, D. Temple Lang, R. Bodik. 2017. "Programming with models: writing statistical algorithms for general model structures with NIMBLE." Journal of Computational and Graphical Statistics, 26, 403-413. doi:10.1080/10618600.2016.1172487.

Elzinga, C.L., D.W. Salzer, J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. Bureau of Land Management Technical Reference 1730-1. Denver, CO.

Howell, J.A., J.E. DiDonato. 1991. Assessment of avian use and mortality related to wind turbine operations at Altamont Pass 1988-1989. US Windpower, Inc. Livermore, CA.

Keehn J E and Feldman C.R. 2018. Disturbance affects biotic community composition at desert wind farms. Wildl. Res. 45:383-96.

LeBeau C.W., G.D. Johnson, M.J. Holloran, J.L. Beck, R.M. Nielson, M.E. Kauffman, E.J. Rodemaker, T.L. Mcdonald. 2017. Greater sage-grouse habitat selection, survival, and wind energy infrastructure. Journal of Wildlife Management, 81:690-711.

Lloyd, J.D., C.L. Aldridge, T.D. Allison, C.W. LeBeau, L.B. McNew, V.L. Winder. 2022. Prairie grouse and wind energy: The state of the science and implications for risk assessment. Wildlife Society Bulletin, 46(3):e1305.

Lovich, J.E., J.R. Ennen. 2011. Wildlife conservation and solar energy development in the desert southwest, United States. BioScience, 61(12):982-992.McCrary, M.D., R.L. McKernan, R.W. Schreiber, W.D. Wagner, T.C. Sciarrotta. 1986. Avian mortality at a solar energy power plant. Journal of Field Ornithology, 56(2):135-141.

Moeller, A.K., P.M. Lukacs, J.S. Horne. 2018. Three novel methods to estimate abundance of unmarked animals using remote cameras. Ecosphere, 9(8):e02331.

Moeller, A.K., S.J. Waller, N.J. DeCesare, M.C. Chitwood, P.M. Lukacs. 2023. Best practices to account for capture probability and viewable area in camera-based abundance estimation. Remote Sensing in Ecology and Conservation, 9(1):152-164.

Orloff, S., and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989–1991. Final report P700-92-001 to Alameda, Contra Costa, and Solano counties and the California Energy Commission, Sacramento, California. Tiburon, CA: Biosystems Analysis, Inc.

Pavlacky, D.C., Jr., P.M. Lukacs, J.A. Blakesley, R.C. Skorkowsky, D.S. Klute, B.A. Hahn, V.J. Dreitz, T.L. George, and D.J. Hanni. 2017. A statistically rigorous sampling design to integrate avian monitoring and management within Bird Conservation Regions. PLoS One, 12:e0185924.

R Core Team. 2024. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>.

Robel, R.J., J.N. Briggs, A.D. Dayton, L.C. Hurlbert. 1970. Relationships between visual obstruction measurements and weight of grassland vegetation. Journal of Range Management, 23:295.

Shaffer, J.A., D.A. Buhl. 2016. Effects of wind-energy facilities on breeding grassland bird distributions. Conservation Biology, 30(1):59-71.

Stantec Consulting. 2011. Bird mortality event at Laurel Mountain substation. Unpublished report. https://www.windaction.org/posts/32389.

Western EcoSystems Technology, Inc. (WEST). 2016. Ivanpah solar electric generating system avian and bat monitoring plan, 2014–2015 annual report and two year comparison.

Colorado Parks and Wildlife

WILIDLIFE RESEARCH PROJECT SUMMARY

Behavioral and demographic patterns of nesting bald eagles along a gradient of human disturbance on the Front Range corridor in Colorado

Period Covered: January 1 – December 31, 2024

Authors: Reesa Yale Conrey reesa.conrey@state.co.us

Principle Investigators: Reesa Yale Conrey, Miranda Middleton, Jim Gammonley

Project Collaborators: Matt Smith, Bruce Snyder, Jean Snyder (Bird Conservancy of the Rockies); Mike Lockhart (Wildlands Photography and Bio-consulting); William Kendall (Colorado Cooperative Fish & Wildlife Research Unit); U.S. Fish and Wildlife Service; Front Range cities and counties; private landowners

CPW staff: Mike Sherman, Lance Carpenter, Rebecca Boyce, Liza Rossi, Robert Sacco, Northeast Region staff from Areas 2, 4, and 5

External funders: Denver Audubon's Lois Webster Fund; U.S. Fish and Wildlife Service Region 6 Migratory Bird Program

EXTENDED ABSTRACT

Urbanization results in habitat loss and fragmentation (Czech et al. 1997), but some generalist species have adapted to urban environments (Rullman & Marzluff 2014). The bald eagle (*Haliaeetus leucocephalus*) is a Tier 2 species of greatest conservation need in the Colorado State Wildlife Action Plan (Colorado Parks and Wildlife 2015), with legal protections from the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. Historically, bald eagles occurred in northcentral Colorado during migration and winter, but the state was considered to be only a peripheral part of the breeding range (Craig 1979). Following the banning of DDT, bald eagles have recovered from dramatic population declines. Although the number of breeding pairs of bald eagles in the contiguous United States has doubled over the past 10 years (USFWS 2020), there is still concern about the status of local and regional populations and the potential impacts of land use changes on bald eagles. Bald eagles are a high-profile species with strong interest from the public, and in late 2024, bald eagles officially became the national bird of the USA when S.4610 became law. Along the Colorado Front Range corridor where bald eagles and humans coexist in close proximity, public awareness of bald eagles is high and citizens closely track individual bald eagles and their nests. With a rapidly expanding human population along the Front Range, development and other forms of land use change regularly create concerns about impacts on bald eagles, and Colorado Parks and Wildlife (CPW) is required to provide consultation on land use issues affecting eagle nests.

In recent decades, a relatively high concentration of breeding pairs has become established in the Colorado Front Range (Wickersham 2016), and the number of known occupied bald eagle nests has

increased exponentially (Fig. 1). In Front Range counties, the number of occupied bald eagle nests has risen from one nest in the 1980s to > 150 nests today. Human activity may negatively impact bald eagles at breeding sites or winter roosts (Buehler 2022). CPW and the U.S. Fish and Wildlife Service have recommended disturbance buffer distance and timing restrictions for bald eagle nests and roost sites (U.S. Fish and Wildlife Service 2007, CPW 2020). However, bald eagles exhibit a wide range of tolerance and responses to various human activities and their proximity (Buehler 2022), making it challenging to develop disturbance mitigation recommendations that are both defensible and consistent.

The goal of this study is to better understand current demographics and space use of bald eagles breeding along the northern Front Range, and the impact of human disturbance and changing land use on these measures. We are conducting this project during 2020–2025. Specific objectives include 1) Estimate demographic parameters (breeding effort, nest success, productivity, and adult survival) and trends for bald eagles breeding in the northern Front Range. 2) Examine land use, human activity, and eagle responses to disturbance near nests. 3) Quantify and compare space use (home range, foraging areas, resource selection, and daily movements) of bald eagles nesting along a rural to urban gradient.

The study area includes the Front Range corridor of northcentral Colorado in Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, Jefferson, Larimer, and Weld counties. This is an area of rapid human population growth (18% growth from 2000 to 2020) and a relatively high concentration of bald eagles throughout the year. Nests are routinely exposed to varying levels of disturbance and most have been closely monitored for multiple years.

In 2024, Bird Conservancy of the Rockies (BCR) continued its Bald Eagle Watch program, where volunteers monitor known bald eagle nests. Additional nests were monitored by CPW and other partners. Statewide during 2024, 304 nests were known to be occupied by breeding pairs (Fig. 1). In the northern Front Range, 150 nests were occupied by breeding pairs (including 18 new nests), 129 were initiated (incubation detected) with known fate, and 101 nests fledged young (78% apparent nest success). Of successful nests, 37% produced one fledgling, 54% produced two fledglings, and 9% produced three fledglings (mean = 1.7 fledglings per successful nest). Compared to 2022, when Highly Pathogenic Avian Influenza (HPAI) led to a 20% decline in apparent nest success, 2024 showed normal nest success but fewer fledglings per successful nest than pre-HPAI. No tagged eagles are known to have died from HPAI since December 2022. Average apparent nest success from 2016‒2024 was 76% (Fig. 2).

We are assessing home ranges, resource selection, and movement with solar-powered transmitters using a GPS/GSM (Global Positioning System/Global System for Mobile Communications) platform, in which the tag's location is determined and recorded everywhere via satellite connections, but data are only transmitted once per day when the bird is in a cell service area. These transmitters are smaller and less expensive than satellite tags. We are altering the fix frequency for each tag based on battery performance, with fix frequencies averaging once per hour to every 30 sec during flight. We are attempting to capture one member per pair of eagles at active nest sites, fitting them with a transmitter using a break-away backpack style X-harness. The harnesses are designed to drop off within 4 – 5 years after marking. The current model has a total weight ~50 g (1% body mass of an adult male). Blood samples are tested for toxic elements such as lead, and all eagles captured since 2022 are being swabbed for HPAI.

During 2020‒2024 we tagged 46 bald eagles, and 15 tags remained deployed and transmitting data as of 31 December 2024. We have tagged 35 breeding adults, two nonbreeding adults, two subadults, and seven juveniles, with similar numbers of males (N = 21) and females (N = 25). Some individuals have died, dropped their tags, had tag failures, or gone missing; therefore, the number of tag-days per bird has averaged 484 days, ranging from 9 to 1451 days. Blood lead tests have been completed for 20 captured eagles. Of these, one was considered lethal (but she survived), seven were subclinical (elevated but sublethal), and 12 were normal. We have seen 11 mortalities from electrocution (2), vehicle strikes (2), West Nile Virus (1), HPAI (1), lead poisoning (1), and unknown causes (4) among tagged eagles. Mean time to death was ~7.5 months among tagged eagles that died. Annual adult survival for eagles tagged at least 1 year was 73% for males and 85% for females. Thus far, five males and one female have abandoned or lost their territories due to mate loss or intruders that replaced them. These displaced adults have all survived and continued to spend most of the year as non-breeders in northern Colorado and southern Wyoming. These high rates of mortality and territory turnover suggest that eagle reproduction and immigration are important in sustaining population growth in our region.

Middleton (2024) used a subset of the data from CPW's in-progress study to complete her M.S. thesis at Colorado State University. Middleton (2024) described home range size and resource selection for bald eagles breeding in the northern Front Range of CO during the full annual cycle, based on tag data from 24 adult eagles. Home range size and core-use area varied with sex of eagle and time of year, and most were discontinuous (Fig. 3). Males generally had larger home ranges than females, and home ranges were largest during the pre-nesting and non-nesting seasons and smallest during the nestling and post-fledge periods (Fig. 3B). The mean home range (90% utilization distribution) was 60.75 ± 119.16 km^2, and the mean core-use area (50% UD) was 3.95 ± 8.92 km^2. In comparison, the area covered by CPW's recommended ¼ mile (400 m) buffer for year-round no new surface occupancy (CPW 2020) is 0.5 km^2: 13% of the mean core-use area and < 1% of the mean home range size for eagles that breed in our region. These buffers are protective of nesting sites and nearby areas important during the nestling period. Eagles used habitat in areas with low to moderate levels of human development and avoided high intensity development (Fig. 4). Eagles selected for areas near water and herbaceous wetlands (cottonwood habitat) with open canopies.

Territorial adults that breed in the Front Range are resident year-round, and some individuals rarely go farther than 5 km from their nests, even during the nonbreeding season. Others take a hiatus (days to weeks) from their home range during the post-fledge and non-nesting seasons. In contrast, all nonbreeding eagles have ranged widely and some have made extensive movements of up to 2300 km. It appears that rivers, reservoirs, and prairie dog colonies are used extensively for foraging.

We will continue to monitor nesting activity and land use patterns at all known nests through the 2025 nesting season. We will monitor the eagles currently tagged and mark at least three more eagles in 2025. We plan to investigate data on sources of anthropogenic disturbance and eagle responses. Results will be used to model bald eagle population trajectory and better understand the impacts of predicted future land use change, and to make recommendations on minimizing or mitigating disturbances near nests. This study will provide a better understanding of this species' tolerance of and adaptability to human activities and land use changes. The results will also improve long-term bald eagle monitoring efforts in Colorado.

Progress and project components completed during 2024:

- Completed M.S. thesis by Colorado State University graduate student Miranda Middleton: bald eagle space use in an urbanizing landscape.
- Monitored 150 occupied bald eagle nests on the Front Range with multiple visits per site.
- Captured and attached transmitters to seven more eagles, for total sample size of 46 eagles.
- Monitored tags, altering duty cycles as needed to maximize data and preserve battery life.
- Coordinated with many partners, volunteers, landowners, and others.
- Gave presentations for the American Ornithological Society conference, CPW Commission, five other events and various media interviews.

Plans for 2025:

- Monitor all occupied bald eagle nests on the northern Front Range at least every two weeks.
- Deploy tags on three or more eagles, redeploying recovered tags.
- Continue to evaluate movement data and space use by transmittered birds.
- Continue to process current and historical data on bald eagle nests, including human activity and potential disturbances near nests.
- Continue coordination and information sharing with partners.
- Complete the bulk of the remaining field effort for this project.
- Submit 1 – 2 manuscripts for publication from Middleton (2024).

LITERATURE CITED

Buehler, D. A. 2022. Bald Eagle (*Haliaeetus leucocephalus*), version 2.0. In Birds of the World (A. F. Poole and F. B. Gill, Editors). Cornell Lab of Ornithology, Ithaca, NY. https://doi.org/10.2173/bow.baleag.02

Colorado Parks and Wildlife. 2015. State wildlife action plan: a strategy for conservation of wildlife in Colorado. Denver, Colorado.

Colorado Parks and Wildlife. 2020. Recommended buffer zones and seasonal restrictions for Colorado raptors. CPW, Denver, CO.

Craig, G. R. 1979. Bald and golden eagle nesting studies. Project report, Colorado Division of Wildlife, Denver, CO.

Czech, B. and P. R. Krausman. 1997. Distribution and causation of species endangerment in the United States. Science 277:1116-1117.

Middleton, M. 2024. Bald eagle space use in an urbanizing landscape. M.S. Thesis, Colorado State University, Fort Collins, CO.

Rullman, S. and J. M. Marzluff. 2014. Raptor presence along an urban-wildland gradient: influences of prey abundance and land cover. Journal of Raptor Research 48:257-272.

U.S. Fish and Wildlife Service. 2007. National bald eagle management guidelines. Division of Migratory Bird Management, Washington D.C., USA.

U.S. Fish and Wildlife Service. 2020. Final report: Bald eagle population size: 2020 update. Division of Migratory Bird Management, Washington D.C., USA.

Wickersham, J. L. 2016. Bald eagle (*Haliaeetus leucocephalus*). Pages 172-173 *in* L. E. Wickersham, editor. The second Colorado breeding bird atlas. Colorado Bird Atlas Partnership and Colorado Parks and Wildlife, Denver, Colorado.

Figure 1. Number of observed occupied bald eagle nests, 1975–2024, in Colorado. These were nest observations reported to the CPW statewide raptor nest database, so some changes may reflect differences in effort or reporting over time.

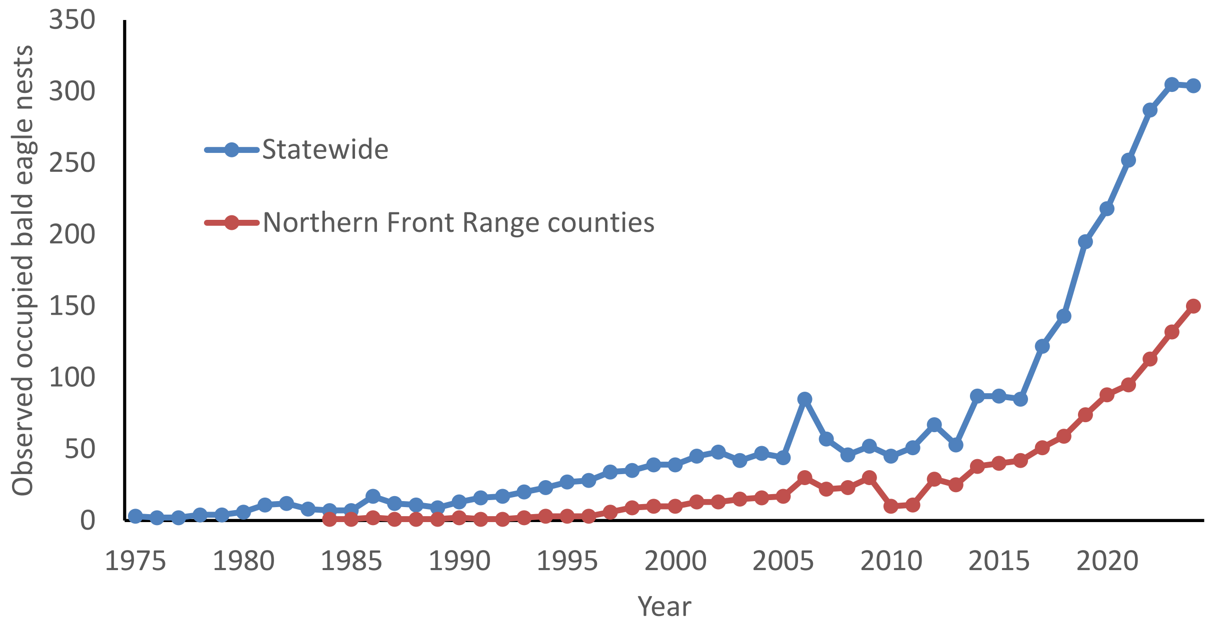


Figure 2. Apparent nest success for bald eagles in the northern Front Range of Colorado from 2016–2024, derived from repeat nest observations. The proportion of nests with undetermined fate, represented by the difference between the “high” and “low” estimates below, has declined since the research project was initiated in 2020. Excluding 2022 when Highly Pathogenic Avian Influenza reduced nest success, apparent nest survival has averaged 76%.

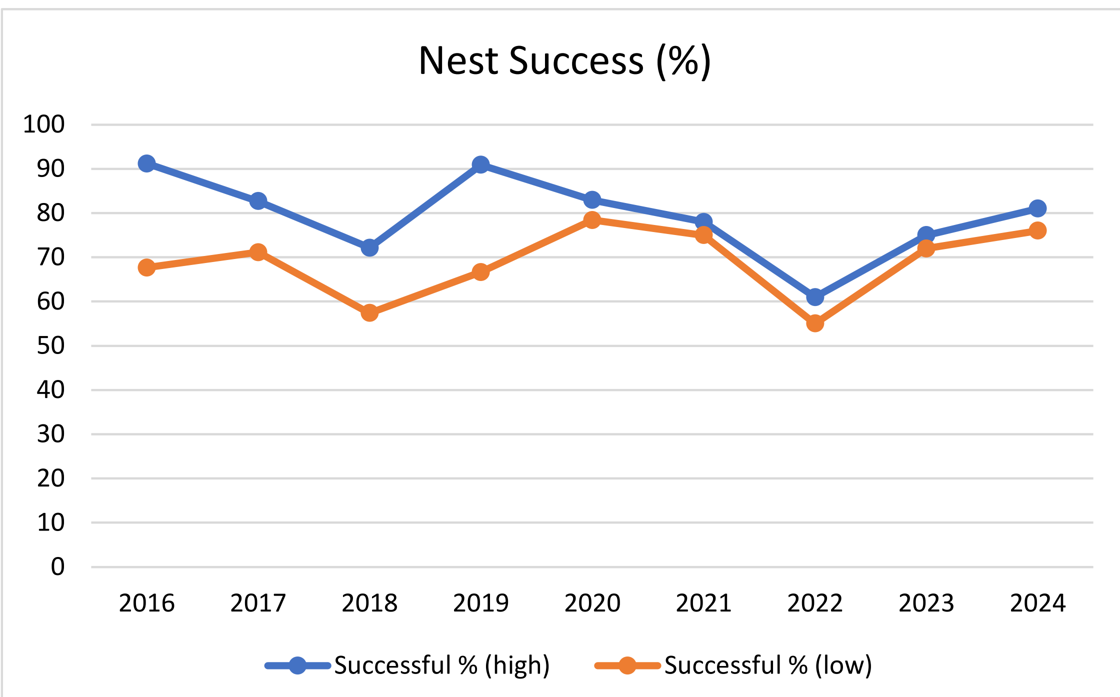
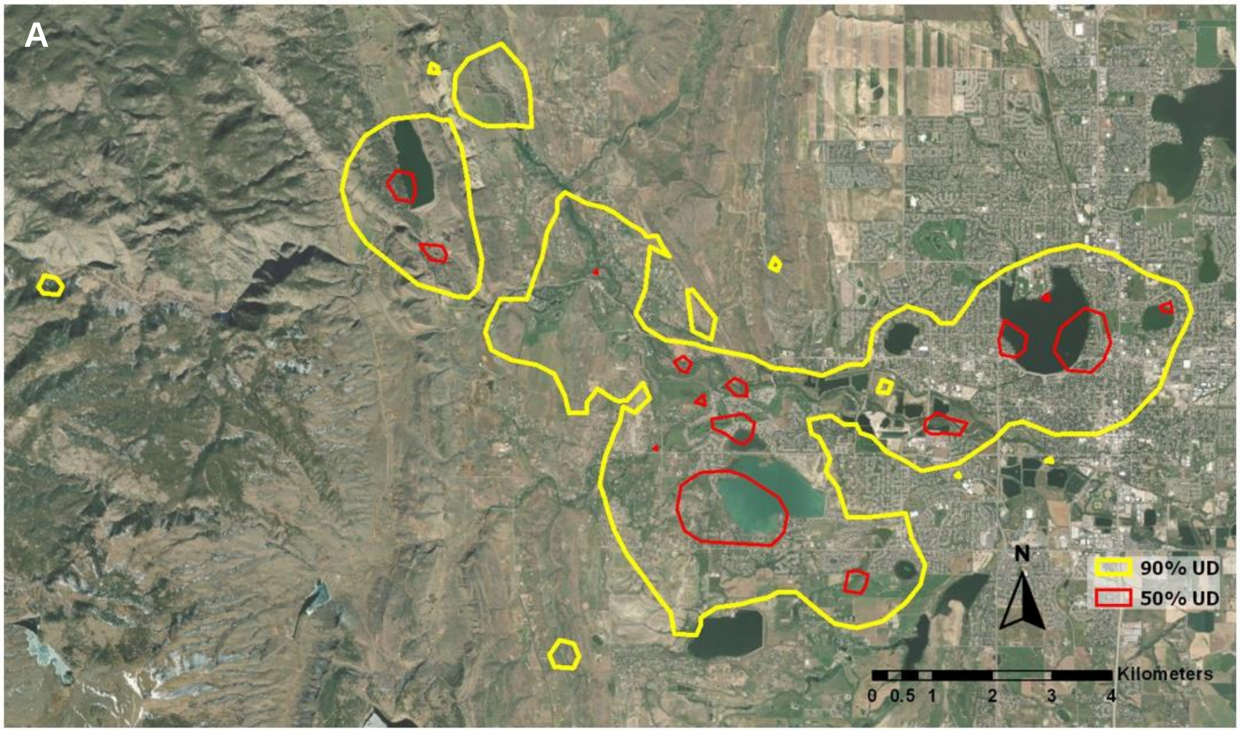


Figure 3. Example home ranges for two adult female breeding bald eagles in the Colorado Front Range. A) Comparison of discontinuous home ranges (90% Utilization Distribution in yellow) and core use areas (50% UD in red) during the pre-nesting stage (2022). B) Seasonal home ranges (90% UD), splitting the year into five stages, overlaid on a human modification layer developed by Theobald et al. (2020). Courtesy of M. Middleton.



B

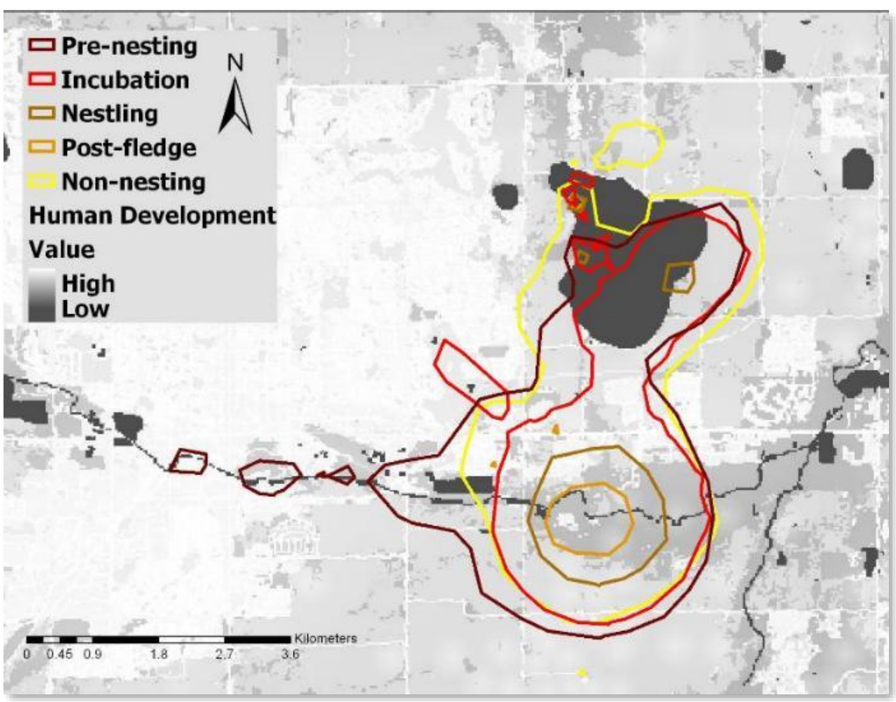
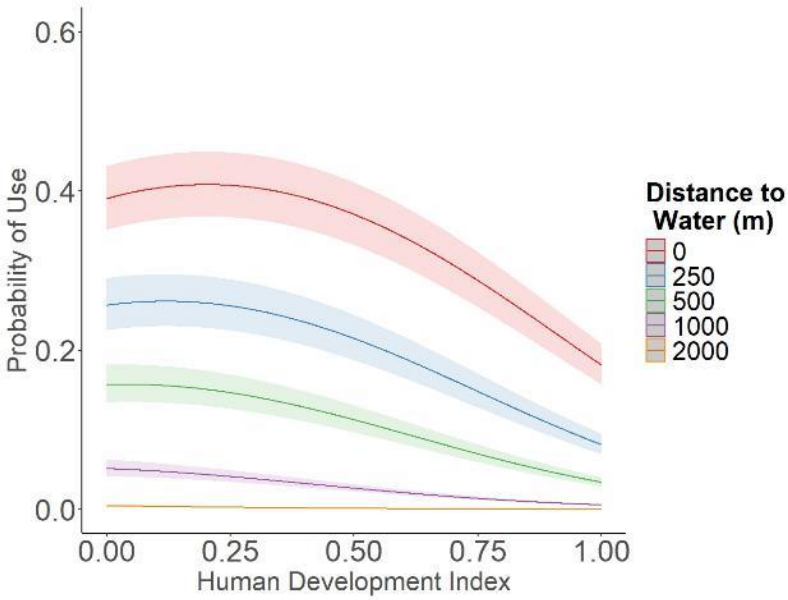


Figure 4. Habitat selection by adult breeding bald eagles tagged in the Colorado Front Range, averaged across sexes and stages of the annual cycle. Probability of use within the home range declined as human development and distance from water increased. Courtesy of M. Middleton.



Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Using GPS satellite transmitters to estimate breeding season survival, detectability on leks, lek attendance, and inter-lek movements of male greater sage-grouse in northwestern Colorado

Period Covered: January 1 – December 31, 2024

Author and Principal Investigator: Brett L. Walker, CPW Avian Researcher, brett.walker@state.co.us

Project Collaborators: Brian Holmes, Brad Petch, Bill deVergie, CPW; Rebekah Ruzicka and William Kendall, CSU-Fort Collins

EXTENDED ABSTRACT

Implementing effective monitoring and mitigation strategies is crucial for conserving populations of sensitive wildlife species. Concern over the status of greater sage-grouse (*Centrocercus urophasianus*) populations has increased both range-wide and in Colorado due to historical population declines, range contraction, continued loss and degradation of sagebrush habitat, and potential listing of the species under the Endangered Species Act. Despite untested assumptions, lek-count data continue to be widely used by state and federal agencies as the primary index of abundance to monitor greater sage-grouse populations. However, the use of lek counts to monitor and manage sage-grouse populations is controversial because how closely lek-count data track actual changes in male abundance from year to year is largely unknown. We deployed solar-powered GPS satellite transmitters on male greater sage-grouse to obtain data on male survival, lek attendance, inter-lek movements and conducted double-observer lek counts to estimate detectability of males on leks during the breeding season in and around the Hiawatha Regional Energy Development project area in northwestern Colorado in spring from 2011-2014. In conjunction with Dr. Rebekah Ruzicka and Dr. Bill Kendall at Colorado State University, we developed a multi-state, mark-recapture model with state and observation processes to estimate daily survival, lek attendance, and inter-lek movement rates of males during the breeding season. We are analyzing unreconciled, independent double-observer count data to estimate detectability of males attending leks. We will then use estimates of male survival, lek attendance, inter-lek movement, detectability of males on leks, the proportion of leks known and counted, and adult to yearling age ratios to simulate lek-count data and evaluate the reliability of current lek-based methods for monitoring greater sage-grouse population trends. Preliminary analyses indicated that, as expected, adult males had higher rates of mortality (especially while attending leks), higher lek attendance, and lower rates of inter-lek movement than yearling males, and that accounting for state uncertainty substantially increased estimates of both lek attendance and interlek movement for both age classes. Ongoing analyses for this project will include testing the effects of additional covariates on survival, attendance, and interlek movement and simulating lek counts to test their reliability.

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Assessment of Greater Sage-grouse Response to Combined Pinyon-Juniper and Mountain Shrub Removal in the Parachute-Piceance-Roan Population in Western Colorado

Period Covered: January 1, 2024– December 31, 2024

Author(s): Brett Walker, CPW Avian Researcher

Principal Investigator(s): Brett Walker, CPW Avian Researcher

Collaborators: Kelli Stone, Two Birds One Stone, LLC (now USFWS); Trevor Balzer, Bailey Franklin, Tom Knowles, Bill deVergie, CPW; Kelli Pauling, CPW (now WGFD).

EXTENDED ABSTRACT

Greater sage-grouse (*Centrocercus urophasianus*) in the Parachute-Piceance-Roan (PPR) region of western Colorado face at least two major potential stressors: projected habitat loss from energy development and a long-term decline in habitat suitability associated with pinyon-juniper (PJ) encroachment. Stakeholders in the PPR have also suggested that growth of dense, tall mountain shrubs (especially serviceberry [*Amelanchier* sp.] and antelope bitterbrush [*Purshia tridentata*]) within mountain big sagebrush (*Artemisia tridentata vaseyana*) ecosystems may also reduce habitat suitability for greater sage-grouse. Therefore, simultaneous removal of both encroaching pinyon-juniper saplings and dense, tall mountain shrubs may improve sage-grouse habitat suitability more than removal of pinyon-juniper alone and may help offset habitat loss from ongoing energy development. Starting in 2013, Colorado Parks and Wildlife (CPW) began a cooperative project with Conoco-Phillips and their grazing lessee, the Oldland-Uphoff Ranch, to use pellet transects to investigate the effectiveness of these combined treatments at restoring sage-grouse habitat in the PPR. In summer 2013, we established five adjacent, transect-based study sites on Bailey Ridge on Conoco-Phillips property in the southeastern portion of the PPR. Treatments were completed on three of the study sites in fall 2013 and on the remaining two study sites in fall 2014. Vegetation surveys in summer 2013 indicated that vegetation structure and composition was marginally suitable for greater sage-grouse prior to treatment, with nearly twice the mean non-sagebrush cover as that around sage-grouse winter use locations (Fig. 1). Mean sagebrush cover (Fig. 1) and sagebrush height (Fig. 2) both decreased slightly following treatment (due to incidental impacts during mechanical removal) then remained relatively stable for the remaining 9 years post-treatment. In contrast, non-sagebrush cover and height both decreased dramatically following treatment, as planned (Figs. 1, 2). Non-sagebrush cover increased slightly within 3 years post-treatment, then remained stable through 9 years post-treatment (Fig. 1), whereas non-sagebrush height steadily increased over 9 years post-treatment (Fig. 2). Pellet surveys in summer 2013 indicated little sage-grouse use on all five study sites prior to treatment (Fig. 3). Following treatment, pellet transects and vegetation surveys indicated a large , immediate increase in pellet counts within 1 year post-treatment and sustained or increasing use through 9 years post-treatment (Fig. 3). Overall, combined pinyon-juniper and mountain shrub treatments appear to have resulted in a substantial, sustained increase in grouse use post-treatment. The next steps in analyses

will be to use distance sampling data to generate distance-detection curves for pellets and convert pellet counts into estimates of pellet density so they are comparable with estimates from other studies.

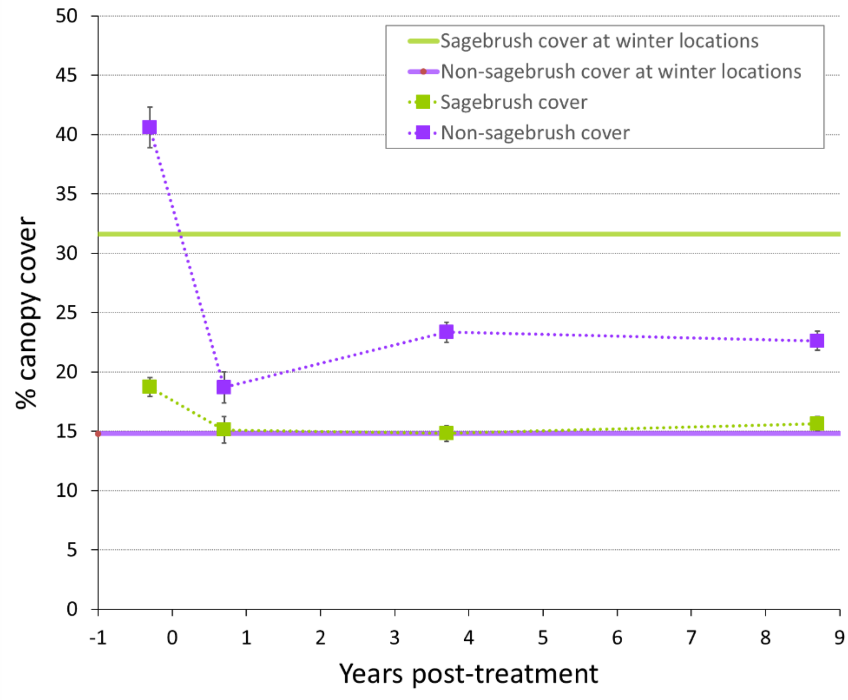


Fig. 1. Mean sagebrush (green) and non-sagebrush (purple) shrub cover (dashed lines) before and after combined pinyon-juniper and mountain shrub removal across five study sites on Bailey Ridge in the Parachute-Piceance-Roan population, western Colorado, from 2013-2023 in relation to mean shrub cover values at locations used by marked female greater sage-grouse in winter (solid lines).

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Assessment of Greater Sage-grouse Response to Pinyon-Juniper Removal in the Parachute-Piceance-Roan Population in Western Colorado

Period Covered: January 1, 2024– December 31, 2024

Author and Principal Investigator: Brett Walker, CPW Avian Researcher

Project Collaborators: Brian Holmes, Brad Petch, Tom Knowles, Bill deVergie, CPW; Heather Sauls, Ed Hollowed, BLM-WRFO

EXTENDED ABSTRACT

Greater sage-grouse (*Centrocercus urophasianus*) in the Parachute-Piceance-Roan (PPR) population in western Colorado face at least two major potential stressors: projected habitat loss from ongoing energy development (Walker et al. 2020) and a long-term decline in habitat suitability associated with pinyon-juniper encroachment. Pinyon-juniper removal may be useful as mitigation to offset potential habitat loss from with energy development. Although pinyon-juniper removal is commonly used to improve habitat for greater sage-grouse, until recently, few studies have quantified the timing or magnitude of how birds respond to treatments. Since 2008, Colorado Parks and Wildlife (CPW) has cooperated with industry and landowner partners to investigate the effectiveness of pinyon-juniper removal for restoring greater sage-grouse habitat in the PPR. We established nine "survey" study sites with area-based sampling in fall 2008 arranged in three groups of three, with each group consisting of one sagebrush control site, one untreated pinyon-juniper control site, and one pinyon-juniper treatment sites. We removed pinyon-juniper from the three treatment sites in fall 2010 and fall 2011. We completed unreconciled double-observer sampling on survey sites in 2013, 2014, and 2015 to estimate detectability of pellet within sample units. Summer pellet surveys from 2009-2015 indicated that, as expected, the mean proportion of sample units containing pellets was consistently highest on sagebrush control sites and consistently lowest on untreated pinyon-juniper sites (Fig. 1). The mean proportion of sample units containing pellets increased on two of three treated sites (Ryan Gulch and Upper Galloway) over time starting within 1-2 years post treatment (Fig. 1). We established an additional 14 transect-based sites in fall 2010 and summer 2011. We conducted pellet transects in summer on transect sites from 2011–2015. We completed distance sampling on transect sites in 2014 and 2015 to generate distance-detection curves for pellets on transects. We removed pinyon-juniper from five treatment sites in fall 2011. The mean no. of pellets/km detected on transects remained low on four untreated pinyon-juniper control sites for the duration of the study, was low on pinyon-juniper treatment transect sites prior to treatment, and was high but variable on sagebrush control transect sites (Fig. 2). Contrary to our expectations, the mean no. of pellets/km detected on transect sites remained low on treated sites for at least four years following pinyon-juniper removal (Fig. 2). Overall, sage-grouse response to pinyon-juniper removal appeared to be inconsistent in this population, with pellet counts only clearly increasing on only two of eight treated sites within 4-5 years post-treatment. Substantial variation in pellet counts on sagebrush control sites among sites and years also suggests substantial spatiotemporal variation in greater sage-grouse use of suitable habitat. Analyses for this project are ongoing.

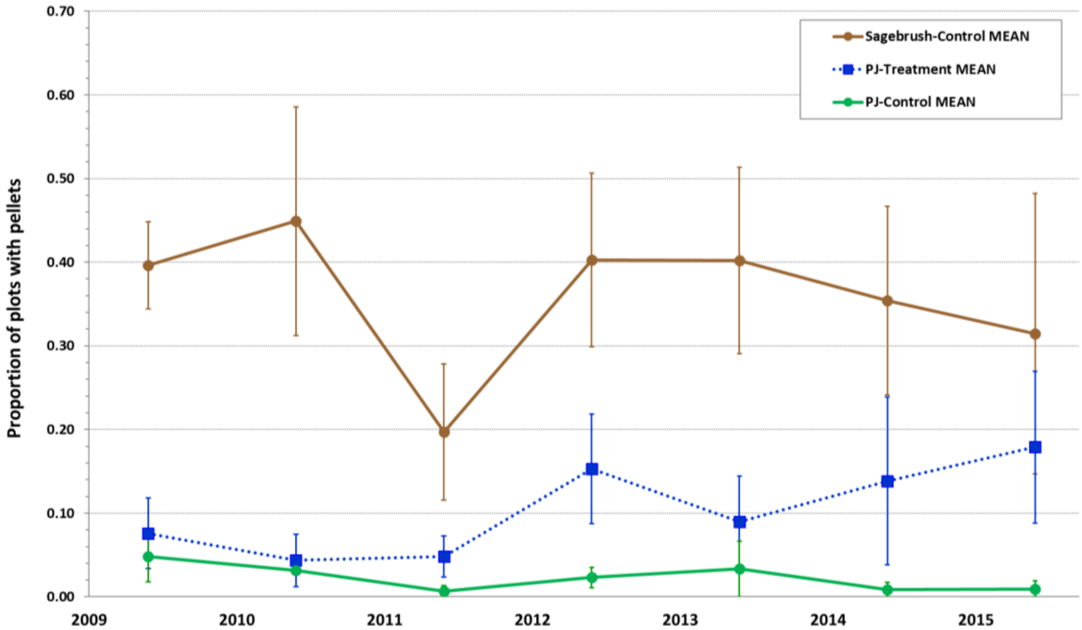


Fig. 1. Mean proportion of sample units with greater sage-grouse pellets detected in summer on sagebrush control sites (n = 3), treated pinyon-juniper sites (n = 3), and untreated pinyon-juniper sites (n = 3) in the Parachute-Piceance-Roan, western Colorado, 2008-2015. Treatments occurred in fall 2010 and fall 2011.

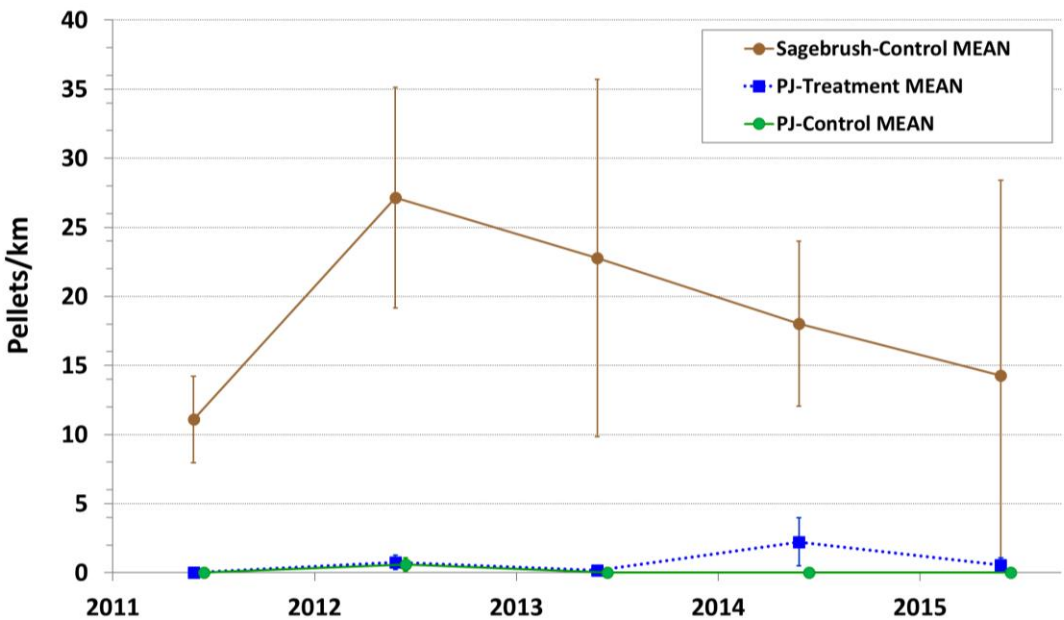


Fig. 2. Mean number of greater sage-grouse pellet clusters detected per kilometer of transect at sagebrush control sites (n = 4), treated pinyon-juniper sites (n = 5), and untreated pinyon-juniper sites (n = 5) in the Parachute-Piceance-Roan, western Colorado, 2008-2015. Treatments occurred in fall 2011. Points for PJ-Treatment and PJ-Control sites are slightly offset along the x-axis for visualization.

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Using Seasonal and Dispersal Movements of Greater Sage-Grouse to Inform Management for Connectivity

Period Covered: January 1, 2024– December 31, 2024

Author and Principal Investigator: Brett Walker, CPW Avian Researcher

Project Collaborators: Brian Holmes, Liza Rossi, Michelle Cowardin, Nick Jaffe, CPW

EXTENDED ABSTRACT

Wildlife often undertake long-distance movements, most commonly when migrating between seasonal ranges, when dispersing as juveniles or post-breeding adults, or when moving between populations. The locations, resources, and habitat features that animals use and select along long-distance movement paths, known as stopover habitat, often influence whether migration or dispersal is successful. Conserving and managing stopover habitat along movement paths, or corridors, is critical for maintaining connectivity between seasonal habitats within populations, maintaining demographic and genetic connectivity between populations, and ensuring the long-term persistence of local and regional populations. Loss of connectivity is often a problem for small, isolated, peripheral subpopulations with low effective population sizes, lower genetic diversity, reduced adaptive potential, and increased risk of inbreeding depression. Translocations from larger populations can prevent demographic and genetic problems caused by loss of connectivity, but proactive efforts to manage habitat in movement corridors between core and peripheral populations may be a more effective long-term conservation strategy. We are investigating habitat use and selection by greater sage-grouse during long-distance seasonal and dispersal movements to inform efforts to maintain connectivity among peripheral and core populations. There are numerous unresolved questions about how greater sage-grouse make such movements in terms of timing, distance, duration, movement strategies, the influence of landscape context and topography, and habitat use and selection during movements. Such information will be valuable for assessing current linkage zones and informing management, conservation, and restoration within those areas. We are using existing GPS telemetry data from greater sage-grouse management and research projects across Colorado to conduct this investigation. We have compiled telemetry data from all CPW projects planning to contribute data, and are developing analyses of movements, habitat use, and habitat selection.

Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Efficacy of using herbicide to control cheatgrass as a habitat management tool to improve northern bobwhite habitat

Period Covered: January 1 – December 31, 2024

Author and Principal Investigator: Adam C. Behney adam.behney@state.co.us, CPW Avian Researcher

Project Personnel: Trent Verquer, Josh Herz, Levi Kokes (CPW)

EXTENDED ABSTRACT

Cheatgrass is an exotic, annual grass that rapidly invades areas after a disturbance and outcompetes native plants. Areas that have been invaded by cheatgrass offer little heterogeneity in vegetation structure or species composition (Knapp 1996), which many animals rely on to satisfy their various resource needs. Northern bobwhites are a species of conservation concern and rely on heterogeneity in vegetation structure for various life-stages. Areas with abundant forbs and bare ground are necessary to support abundant invertebrates, which chicks eat, and allow chicks to move through the vegetation easily while foraging. Cheatgrass can outcompete native forbs, reducing the value of these areas to bobwhites, especially broods. Using a randomized block design, we evaluated the herbicide indaziflam as a treatment to reduce cheatgrass cover at Tamarack State Wildlife Area in northeastern Colorado. We sampled vegetation before and after treatment, and monitored northern bobwhite movements, survival, and habitat selection in relation to the herbicide treatments.

Each block in the experimental design encompassed three plots: a plot treated in summer 2022, a plot treated in summer 2023, and a control plot that remained untreated (Figure 1). Effects of the herbicide treatment were not expected to be evident until the year following treatment, as is the case with most pre-emergent herbicides such as indaziflam. We attempted to capture northern bobwhites in Feb-Apr, 2023, but were not able to catch any quail. The winter of 2022-2023 was severe, and presumably reduced the quail population at the study area, which is consistent with our observations of not seeing any quail during the trapping period. We trapped again in Sep-Oct, 2023, catching and deploying transmitters on nine quail in two coveys, and then again in Feb-Apr, 2024, capturing and deploying transmitters on three bobwhites. Of the 12 bobwhites that had radio transmitters, three died from predation, four survived, one transmitter failed, and four were unknown at the end of the project. We estimated overall annual survival to be 0.662 (SE = 0.151) and did not vary among season (breeding versus nonbreeding) or date within each season.

We conducted vegetation sampling in summer 2022, and early and late summer 2023 and 2024 at random points within each treatment and control plots to evaluate the vegetation response to treatments. Indaziflam treatment appeared to be effective at reducing cheatgrass abundance (Figure 2). Treated plots tended to have greater native bunchgrass abundance than untreated control plots. We conducted vegetation sampling at covey locations and four associated random points, during the 2023-2024

nonbreeding season to assess habitat selection. Bobwhites selected areas with more visual obstruction and taller vegetation (Figure 3).

We found five bobwhite nests during the summer of 2024. Two of the five nests successfully hatched. Nest sites had greater native bunchgrass coverage compared with surrounding available habitat (Figure 4). Of the two nests that hatched, one brood was depredated by day 22 and the other brood survived to at least 51 days. We did not detect any vegetation characteristics that explained brood habitat selection.

LITERATURE CITED

Knapp, P.A. 1996. Cheatgrass (*Bromus tectorum L*.) dominance in the Great Basin Desert: History, persistence, and influences to human activities. Global Environmental Change 6:37-52.

Table 1. Mean (SD) percent cover of cheatgrass, forbs, and native bunchgrasses at northern bobwhite used locations and random available locations during fall 2023.

Location type	Percent cheatgrass	Percent forbs	Percent bunchgrass
Used	0.07 (0.15)	0.24 (0.18)	0.09 (0.18)
Available	0.11 (0.18)	0.25 (0.23)	0.16 (0.21)

Figure 1. Experimental design of study to evaluate effect of indaziflam herbicide on northern bobwhites at Tamarack State Wildlife Area. Year one treatments were treated in summer 2022 and year two treatments were treated in summer 2023.

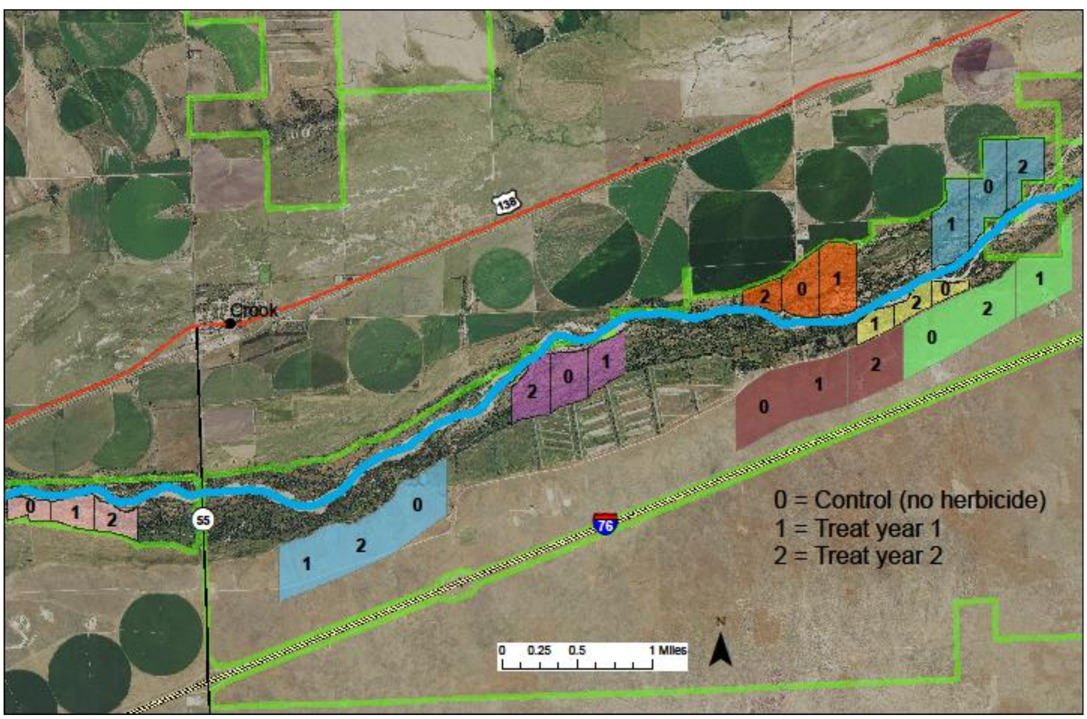


Figure 2. Cheatgrass percent cover from pooled control and treatment plots during two sampling occasions in 2023. Treatment plots included in this figure were treated in summer 2022 with indaziflam.

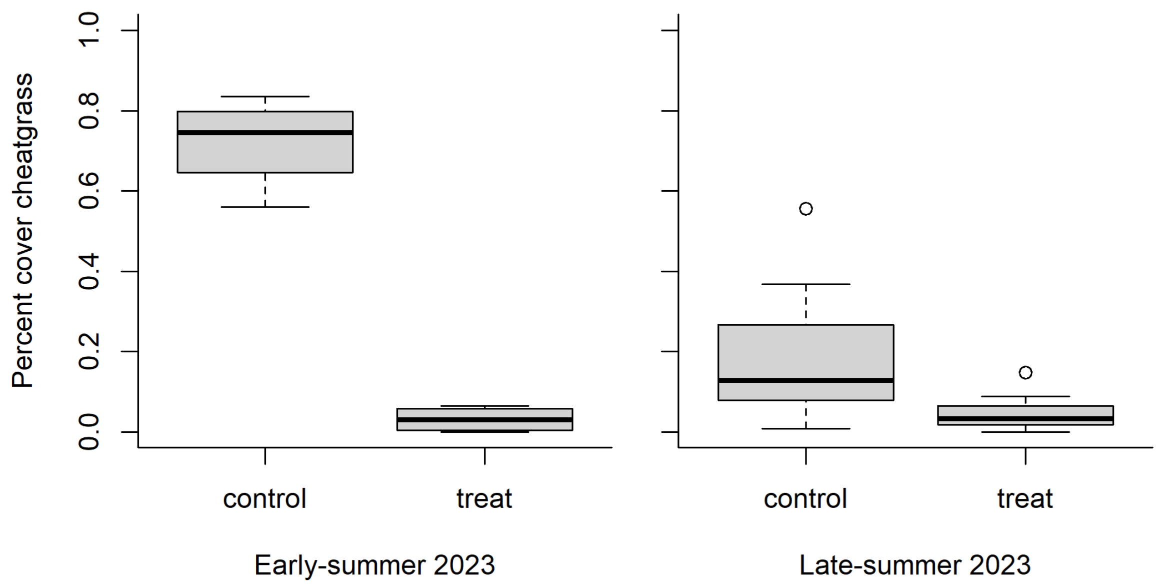


Figure 3. Forb percent cover from pooled control and treatment plots during two sampling occasions in 2023. Treatment plots included in this figure were treated in summer 2022 with indaziflam.

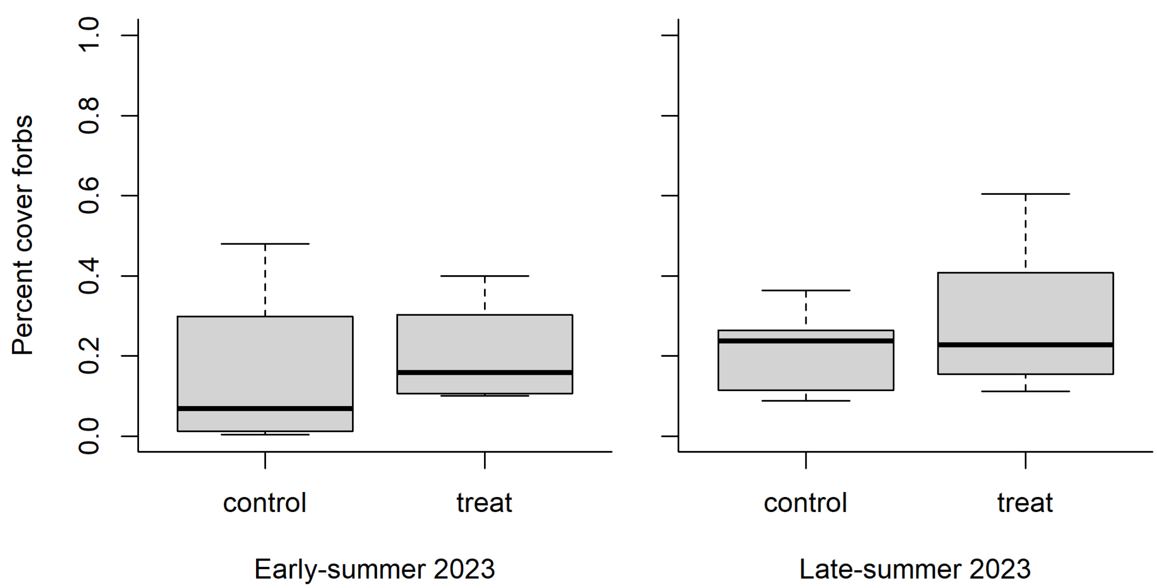
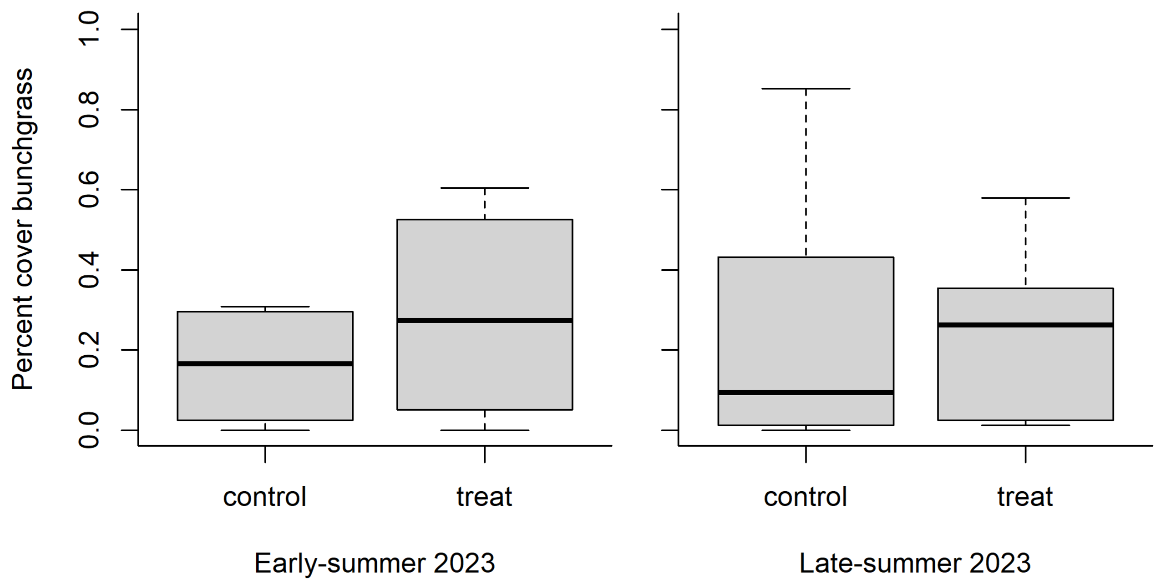


Figure 4. Native bunchgrass percent cover from pooled control and treatment plots during two sampling occasions in 2023. Treatment plots included in this figure were treated in summer 2022 with indaziflam.

F



Colorado Parks and Wildlife

WILDLIFE RESEARCH PROJECT SUMMARY

Estimates and determinants of duck production in North Park, Colorado

Period Covered: 1 January 2023 – 31 December 2023

Authors and Principal Investigators: Adam C. Behney adam.behney@state.co.us, CPW Avian Researcher; James H. Gammonley, CPW Avian Research Leader; Casey M. Setash, Colorado State University and CPW Avian Researcher

All information in this report is preliminary and subject to further evaluation. Information MAY NOT BE PUBLISHED OR QUOTED without permission of the author. Manipulation of these data beyond that contained in this report is discouraged.

EXTENDED ABSTRACT

Assessing waterfowl use and productivity throughout the Intermountain West can inform habitat management practices across various land use regimes. The North Platte River Basin (hereafter, North Park) in north central Colorado has historically held important breeding and stopover habitat for ducks and is expected to become increasingly important as water demands increase across the state. In 2018, we began a study to examine duck breeding populations and production in North Park, in relation to wetland habitat conditions. Specific study objectives include:

1) Use satellite imagery and annual measures of hydrology, salinity, and vegetation composition and structure on a representative sample of wetlands to quantify wetland habitat conditions annually.
2) Use breeding pair counts, adjusted for detection probability, on a sample of wetlands to estimate overall breeding populations of ducks annually.
3) Assess nest site selection and nest survival for nests located on private and public land to estimate habitat effects on reproductive success.
4) Use brood counts, adjusted for detection probability, on a sample of wetlands to estimate duck production annually.
5) Use annual pre-season capture and banding of ducks to estimate annual survival rates, fidelity rates, harvest rates, and harvest distribution.

Breeding Pair Abundance

At five large reservoirs (Walden Reservoir, Cowdrey Reservoir, Lake John, Muskrat Reservoir, and 18 Island Reservoir), we counted ducks weekly to track patterns of abundance in North Park through the end of the spring migration period. Observers drove around the site and counted the number of each species of duck present.

We conducted duck pair counts on basin wetlands, reservoirs, and sections of ditches and riparian areas across public and private land in North Park. The methods we used for each count depended on the type of site. On riparian areas and ditches, we conducted independent double observer surveys to estimate detection probability. We randomly selected 500-m sections of riparian corridors along the primary river channel or ditch running through Arapahoe NWR and private lands. Two observers conducted each survey, walking on opposite river banks and feigning data-taking behaviors to maintain independence. Following completion of the survey, observers compared notes and determined if any ducks were missed by either observer which was used to estimate detection probability. For all detections, observers noted the social status of ducks (paired, lone male, etc.).

We found that the frequent movement of ducks within basin wetlands and reservoirs impeded the mapping process necessary to conduct independent double observer pair counts. Therefore, we conducted dependent double observer surveys (Nichols et al. 2000) on basin wetlands with two observers, one primary and one secondary. The primary observer scanned through the site noting the species and social status of each duck seen. The secondary observer recorded data but also scanned the site and made note of any ducks missed by the primary observer. With this system, the secondary observer sees all the ducks seen by the primary observer plus any missed by the primary observer.

We used the hierarchical multinomial-Poisson mixture model developed by Shirley et al. (2012) in a Bayesian framework to jointly estimate detection probability and duck abundance for dependent double observer pair counts. We modeled counts $y1_i$ (primary observer) and $y2_i$ (counted by secondary observer only) during survey *i* as Poisson variables, where the mean (μ_i) was equal to the product of latent abundance (λ_i) and the detection probabilities for each encounter history:

$$y1_i \sim \text{Poisson}\ (\mu1_i)$$
$$y2_i \sim \text{Poisson}\ (\mu2_i)$$

$$\mu1_i = \lambda_i * p1_i$$
$$\mu2_i = \lambda_i * (1\text{-}p1_i) * p2_i$$

where $p1_i$ and $p2_i$ were detection probabilities for the primary and secondary observer, respectively, during survey *i*. Detection probabilities were allowed to vary among people serving as primary and secondary observers.

For riparian sites where independent double observer surveys were used, within the same overall model, we estimated abundance and detection using another parameterization of the hierarchical multinomial-Poisson model (Kery and Royle 2016, Christianson and Winnie 2023). In this model, count $y1_i$, $y2_i$, and $y3_i$ represent the number of individuals detected by observer 1 only, observer 2 only, and both observers, respectively. Counts were modeled as a Poisson distribution with means (μ_i) as the product of true abundance during the survey (λ_i) and multinomial cell probabilities for each encounter history:

$$\mu1_i = \lambda_i * p1_i * (1 - p2_i)$$
$$\mu2_i = \lambda_i * (1\text{-}p1_i) * p2_i$$
$$\mu3i = \lambda_i * p1_i * p2_i$$

Again, $p1_i$ and $p2_i$ were allowed to vary by the person serving as each observer.

For both survey types, we allowed λ_i to vary among sites and with vegetation and hydrology characteristics during each survey:

$$\log(\lambda_i) = \mathbf{X\beta}$$

Where $\mathbf{X\beta}$ was a matrix of survey-specific covariates and a vector of coefficients. We included the following covariates for abundance: percentage of the surveyed wetland that was made up of open water, herbaceous emergent vegetation, robust emergent vegetation (e.g., bulrush and cattails), and shrub-scrub vegetation (e.g., willows, greasewood, etc.). None of these variables were correlated (max $|r| = 0.36$). We considered covariates important if their coefficient's 90% credible interval excluded zero. We calculated total indicated breeding pairs (hereafter IBP) for each site as a derived quantity in the model by extracting the maximum estimated abundance among the repeated surveys at each site.

We conducted 262 dependent double observer surveys on basin wetlands in 2023. Out of 3,469 duck detections during these surveys, 106 were missed by the primary observer. Detection probability varied among observers and ranged from 0.91 to 0.99. We conducted 24 independent double observer surveys on riparian areas, irrigation ditches, and hay fields. Out of 46 duck detections, 4 were missed by an observer. Detection probability varied among observers for independent double observer surveys and ranged from 0.50 to 0.97. We conducted breeding duck pair surveys at 84 sites in 2023.

Site maximum pair abundance for all species combined varied from 0 to 119 pairs and was positively influenced by the percent of the site classified as herbaceous emergent vegetation (β = 0.06, SE = 0.03) and robust emergent vegetation (β = 0.21, SE = 0.03). Gadwall were the most abundant species detected (n = 707), followed by mallards (n = 404), lesser scaup (n = 389), green-winged teal (n = 366), northern shoveler (n = 326), and ruddy ducks (n = 302). Overall we counted 16 species of ducks.

At 5 large reservoirs, we conducted 4 rounds of duck pair counts between 2-May and 29-Jun. Duck abundance decreased throughout the survey period (Figure 1). By the third round of sampling, pair counts for most species had declined and then remained somewhat steady or increased in the fourth count.

Nest Monitoring

We searched nest plots in flood-irrigated hay meadows on private and public land throughout the breeding season. Some of these plots were associated with restoration projects being conducted by Ducks Unlimited from 2019-2022. We therefore located nests associated with flood irrigation to evaluate the importance or impact of flood irrigation on nesting waterfowl.

We searched 1,141 ha for duck nests in 2023. We located 61 nests of seven species throughout the 2023 breeding season. Using all 191 dabbling duck nests located in North Park since the start of the study in 2018, nest density adjusted for nests that failed before being located was 0.06 nests/ha (SD = 0.03) in shrub-scrub habitat, 0.23 (SD = 0.09) in riparian, 0.12 (SD = 0.06) in hay meadows, 0.10 (SD = 0.02) in graminoid meadows interspersed with shrubs, 0.11 (SD = 0.03) in strictly graminoid meadows, and 0.22 (SD = 0.06) along irrigation ditches. The probability that a nest plot contained zero nests was 0.38. All but five of the nests located in 2023 (91.8%) were on Arapahoe NWR, with the others located on BLM land. Twenty-eight monitored nests successfully hatched at least one duckling in 2023, and most nests failed due to depredation (n = 22). The most parsimonious model of nest survival included a categorical predictor for whether the nest was on public or private land. Estimates of daily nest survival rate from the public/private model were 0.93 (SD = 0.04) on public land and 0.95 (SD = 0.02) on private land, which translate to 33-day nest survival rates of 0.14 (SD = 0.11) on public land and 0.20 (SD = 0.09) on private land.

Brood Abundance and Production

For counting broods, we used independent double observer surveys. Two observers in separate vehicles counted all ducklings by species and age at each site. At the end of the surveys, they compared notes and noted any ducklings missed by either observer. Brood counts were all conducted as independent double observer surveys and we estimated detection probability and abundance as described above for independent double observer pair surveys (Kery and Royle 2016, Christianson and Winnie 2023). Similar to pair counts, we extracted the overall number of broods per site as the maximum estimated number of broods among the repeated surveys at each site. Then as a derived quantity, we divided total brood abundance by total pair abundance (brood:pair ratio) at each site as an estimate of site productivity.

We conducted 177 independent double observer and three single observer surveys for broods. Out of 792 brood detections, 428 were missed by an observer. Brood detection varied by observer from 0.44 to 0.61.

Site maximum brood abundance for all species combined varied from 0 to 120 and was positively influenced by percent of site that was flooded (β = 0.45, SE = 0.15), percent of site containing robust emergent vegetation (β = 1.11, SE = 0.18), percent shrub cover (β = 0.35, SE = 0.16), and percent of site containing submersed aquatic vegetation (β = 0.61, SE = 0.21). Brood:pair ratio varied from 0 to 7 among sites for all duck species combined.

Duck Banding

We trapped ducks during 30 July – 10 September, using swim-in traps baited with cracked corn at 7 wetland sites, each with 1 – 2 traps per site (Mauser and Mensik 1992). We also captured ducks using an airboat and spotlights at night on four sites. We marked ducks with standard U.S. Geological Survey (USGS) legbands and released them at their capture sites. We classified captured ducks to species, age, and sex using plumage characteristics and cloacal examination. We classified age as local, hatch year, or after hatch year. We defined local birds as unfledged ducklings that we could reasonably assume had hatched locally, and only attached bands to ducklings with legs large enough to hold a legband. We recorded the band number of all recaptured ducks. We reported information on ducks we banded to the USGS Bird Banding Laboratory.

During pre-season trapping operations (15 August – 16 September) we banded 773 ducks of 13 species (Table 1). Our pre-season trapping effort was comprised of 324 trap-days with baited swim-in traps (45% of the banded sample), and 4 nights of spotlighting from an airboat (55% of the banded sample). Mallards were the most common species (42%) of our banded sample. We captured gadwall (24% of the banded sample) primarily (98%) with spot-lighting. We banded 94 cinnamon and blue-winged teal (12% of the total banded sample); of these, we classified locals (young incapable of flight), hatch year females, and after hatch year females as unidentified teal, because we could not reliably distinguish between the two species in these cohorts. However, given the much higher proportion of cinnamon teal than blue-winged teal in the study area, we suspect that most of these unidentified teal were cinnamon teal.

At the time of this report, 110 ducks we banded in 2018, 109 ducks we banded in 2019, 204 ducks we banded in 2020, 61 ducks we banded in 2021, 156 ducks we banded in 2022, and 43 (total = 683) had been harvested by hunters and reported to the USGS Bird Banding Laboratory, including 538 mallards, 73 gadwall, 14 cinnamon teal, 16 shovelers, 7 green-winged teal, 11 wigeon, 3 pintails, 2 Mexican ducks, 8 lesser scaup, 4 redhead, and 7 canvasback. Among mallards, juveniles and adult males have been harvested at higher rates than adult females (Table 2). Most mallards (71.3%) were harvested in Colorado, in 36 different counties (Table 3). Mallards banded in North Park during 2018-2023 were also harvested in 16 other states, including 78 different counties, and the provinces of Alberta and Saskatchewan in Canada (Table 3).

Future Work

We have completed field work related to this initial phase of the project. We will analyze data and submit publications in 2024. We plan to conduct some field work in summer 2024 (pair and brood counts, banding), to maintain data continuity before starting the next phase of this project.

LITERATURE CITED

Christianson, D., and J. Winnie. 2023. Estimating true density in large, alpine herbivores using Google Earth imagery. Wildlife Biology 2023:e01089.

Kery, M., and J.A. Royle. 2016. Applied hierarchical modeling in ecology-Modeling distribution abundance and species richness using R and BUGS. Volume 1: Prelude and Static Models. Elsevier, Academic Press.

Nichols, J. D., J. E. Hines, J. R. Sauer, F. W. Fallon, J. E. Fallon, P. J. Heglund. 2000. A double-observer

approach for estimating detection probability and abundance from point counts. The Auk, 117:393-408.
Shirley, M.H., R.M. Dorazio, E. Abassery, A.A. Elhady, M.S. Mekki, and H.H. Asran. 2012. A sampling design and model for estimating abundance of Nile crocodiles while accounting for heterogeneity of detectability of multiple observers. Journal of Wildlife Management 76:966-975.

Table 1. Numbers of ducks banded in North Park during pre-season capture efforts in 2023. LM = local male, LF = local female, HYM = hatch year male, HYF = hatch year female, AHYM = after hatch year male, and AHYF = after hatch year female.

Species	AHYF	AHYM	HYF	HYM	LF	LM	Total
Mallard	15	58	93	140	4	11	321
Gadwall	20	48	29	40	32	15	184
Cinnamon/blue-winged teal[a]	7	1	32	46	8	0	94
American wigeon	6	13	12	19	7	4	61
Lesser scaup	3	0	7	1	14	5	30
Shoveler	5	1	6	10	0	2	24
Canvasback	0	0	11	7	0	3	21
Green-winged teal	6	1	1	5	1	0	14
Pintail	1	0	5	2	1	2	11
Redhead	1	1	1	2	3	1	9
Mexican duck	0	3	0	0	0	0	3
Ruddy duck	0	0	1	0	0	0	1
Total	64	126	198	272	70	43	773

[a]We could not reliably distinguish between cinnamon and blue-winged teal for locals and females.

Table 2. Numbers of mallards banded in North Park during 2018-2023 in different age and sex cohorts and reported shot by hunters to the USGS Bird Banding Lab during hunting seasons through December 31, 2023.

Banded cohort	Band year	Number banded	Number harvested (% of banded sample)					
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
AHY male	2018	168	10 (6.0%)	11 (6.5%)	5 (3.0%)	0	2 (1.2%)	1 (0.6%)
	2019	234	-	23 (9.8%)	8 (3.4%)	9 (3.8%)	8 (3.4%)	1 (0.4%)
	2020	246	-	-	16 (6.5%)	14 (5.7%)	11 (4.5%)	5 (2.0%)
	2021	306	-	-	-	22 (7.2%)	10 (3.3%)	4 (1.3%)
	2022	239	-	-	-	-	25 (10.5%)	8 (3.3%)
	2023	58	-	-	-	-	-	4 (6.9%)
AHY female	2018	69	1 (1.4%)	2 (2.9%)	0	0	0	0
	2019	104	-	4 (3.8 %)	1 (1.0%)	1 (1.0%)	0	0
	2020	108	-	-	10 (9.3%)	2 (1.9%)	2 (1.9%)	2 (1.9%)
	2021	95	-	-	-	2 (2.1%)	0	2 (2.1%)
	2022	68	-	-	-	-	4 (5.9%)	0
	2023	15	-	-	-	-	-	2 (13.3%)
HY male	2018	221	29 (13.1%)	12 (5.4%)	2 (0.9%)	5 (2.3%)	3 (1.4%)	2 (0.9%)
	2019	109	-	12 (11.0%)	6 (5.5%)	0	5 (4.6%)	0
	2020	266	-	-	25 (9.4%)	22 (8.3%)	6 (1.5%)	4 (1.5%)
	2021	57	-	-	-	6 (10.5%)	3 (3.5%)	3 (3.5%)
	2022	186	-	-	-	-	45 (16.7%)	8 (4.3%)
	2023	140	-	-	-	-	-	19 (13.6%)
HY female	2018	131	13 (9.9%)	5 (3.8%)	0	0	0	0
	2019	73	-	3 (4.1%)	1 (1.4%)	0	1 (1.4%)	0
	2020	200	-	-	23 (11.5%)	5 (2.5%)	6 (3.0%)	1 (0.5%)
	2021	38	-	-	-	1 (2.6%)	2 (5.3%)	0
	2022	95	-	-	-	-	11 (11.6%)	0
	2023	93	-	-	-	-	-	1 (1.1%)
L male	2018	12	1 (8.3%)	0	0	0	0	0
	2019	7	-	1 (14.3%)	0	0	0	0

Banded cohort	Band year	Number banded	Number harvested (% of banded sample)					
			2018-2019	2019-2020	2020-2021	2021-2022	2022-2023	2023-2024
	2020	25	-	-	5 (20.0%)	0	1 (4.0%)	1 (4.0%)
	2021	0	-	-	-	0	0	0
	2022	10	-	-	-	-	1 (10.0%)	0
	2023	11	-	-	-	-	-	0
L female	2018	14	2 (14.3%)	0	0	0	0	0
	2019	11	-	1 (9.1)	0	0	0	0
	2020	28	-	-	3 (10.7%)	0	0	0
	2021	0	-	-	-	0	0	0
	2022	6	-	-	-	-	0	0
	2023	4	-	-	-	-	-	0
Total	2018	615	56 (9.1%)	30 (4.9%)	7 (0.7%)	5 (0.8%)	5 (0.8%)	3 (0.5%)
	2019	538	-	44 (8.2%)	16 (%)	10 (1.9%)	14 (0.7%)	1 (0.2%)
	2020	873	-	-	82 (9.4%)	43 (4.9%)	26 (3.0%)	13 (1.5%)
	2021	496	-	-	-	31 (6.3%)	15 (3.0%)	9 (1.8%)
	2022	604	-	-	-	-	87 (14.4%)	16 (2.6%)
	2023	321	-	-	-	-	-	26 (8.1%)

Table 3. Distribution by U.S. states and counties, and Canadian provinces, of the number (% of total) of direct (harvested during the hunting season immediately following banding) and indirect (harvested during hunting seasons one or more years after banding) recoveries of mallards banded in North Park, 2018-2023, reported by hunters to the USGS Bird Banding Lab through December 31, 2023.

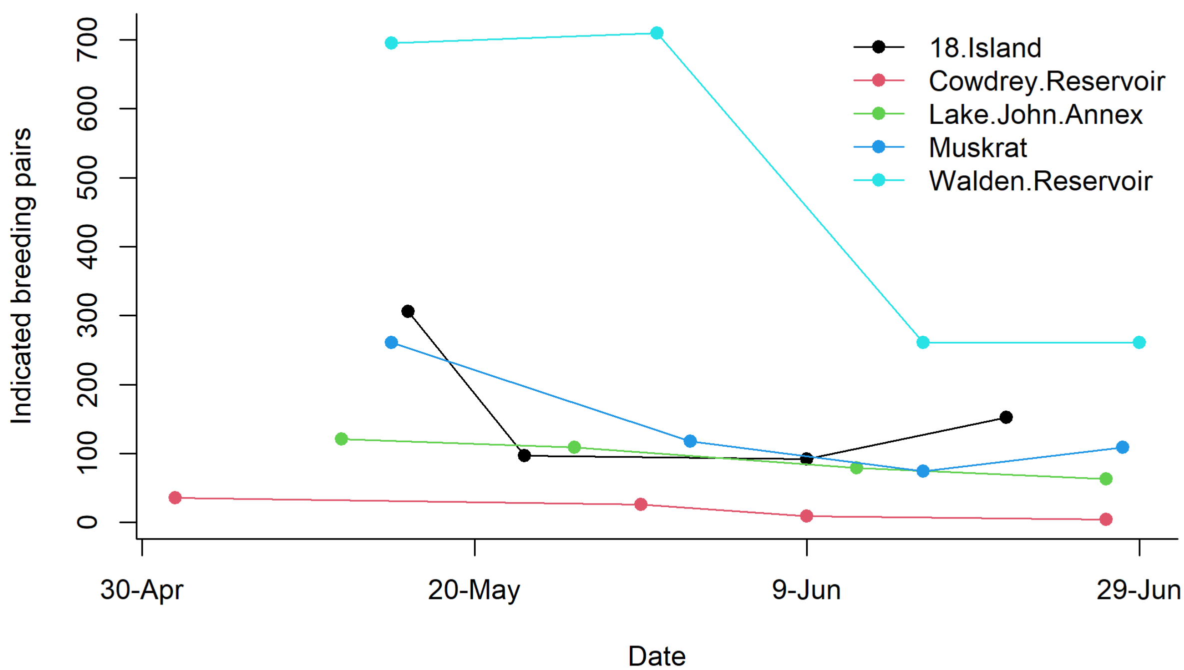
State	County	Direct recoveries	Indirect recoveries
Colorado	Total	260 (79.6)	121 (58.5)
	Adams	4 (1.2)	4 (2.0)
	Alamosa	6 (1.9)	5 (2.4)
	Bent	2 (0.6)	1 (0.5)
	Boulder	7 (2.2)	4 (2.0)
	Chaffee	1 (0.3)	0
	Conejos	1 (0.3)	1 (0.5)
	Costilla	2 (0.6)	2 (1.0)
	Crowley	1 (0.3)	1 (0.5)
	Delta	1 (0.3)	4 (2.0)
	Dolores	0	1 (0.5)
	Douglas	1 (0.3)	0
	Eagle	7 (2.2)	0
	El Paso	1 (0.3)	0
	Fremont	0	1 (0.5)
	Garfield	5 (1.5)	0
	Grand	15 (4.6)	5 (2.4)
	Gunnison	2 (0.6)	1 (0.5)
	Jackson	91 (28.0)	16 (7.8)
	Kiowa	0	1 (0.5)
	La Plata	1 (0.3)	1 (0.5)
	Larimer	6 (1.9)	4 (2.0)
	Las Animas	3 (0.9)	1 (0.5)
	Logan	4 (1.2)	6 (2.9)
	Mesa	3 (0.9)	1 (0.5)
	Montrose	1 (0.3)	4 (2.0)
	Morgan	7 (2.2)	4 (2.0)
	Otero	7 (2.2)	3 (1.5)
	Park	8 (2.5)	4 (2.0)
	Pitkin	1 (0.3)	0
	Prowers	1 (0.3)	0
	Pueblo	12 (3.7)	2 (1.0)
	Rio Grande	5 (1.5)	6 (2.9)
	Routt	6 (1.9)	1 (0.5)
	Saguache	9 (2.8)	3 (1.5)
	Summit	2 (0.6)	0
	Weld	35 (10.8)	34 (16.6)
	Unknown	2 (0.6)	0
Arizona	Total	2 (0.6)	0
	Coconino	1 (0.3)	0
	Maricopa	1 (0.3)	0
California	Total	0	1 (0.5)

State	County	Direct recoveries	Indirect recoveries
	Tehama	0	1 (0.5)
Idaho	Total	0	3 (1.5)
	Franklin	0	1 (0.5)
	Payette	0	1 (0.5)
	Power	0	1 (0.5)
Kansas	Total	3 (0.9)	5 (2.4)
	Barton	1 (0.3)	0
	Crawford	0	1 (0.5)
	Marion	0	1 (0.5)
	Mitchell	1 (0.3)	0
	Pottawatomie	0	1 (0.5)
	Sumner	0	1 (0.5)
	Trego	1 (0.3)	1 (0.5)
Kentucky	Total	0	1 (0.5)
	Ballard	0	1 (0.5)
Missouri	Total	0	1 (0.5)
	Holt	0	1 (0.5)
Montana	Total	1 (0.3)	2 (1.0)
	Beaverhead	0	1 (0.5)
	Big Horn	0	1 (0.5)
	Yellowstone	1 (0.3)	0
Nebraska	Total	4 (1.2)	9 (3.9)
	Garden	1 (0.3)	0
	Keith	2 (0.6)	1 (0.5)
	Lincoln	1 (0.3)	2 (1.0)
	Loup	0	1 (0.5)
	Morrill	0	1 (0.5)
	Scotts Bluff	0	4 (2.0)
New Mexico	Total	40 (12.3)	27 (13.2)
	Bernalillo	1 (0.3)	2 (1.0)
	Catron	1 (0.3)	0
	Chaves	4 ()	0
	Dona Ana	1 (0.3)	3 (1.5)
	Eddy	1 (0.3)	0
	Mora	0	1 (0.5)
	Otero	1 (0.3)	0
	Quay	1 (0.3)	1 (0.5)
	Rio Arriba	2 (0.6)	1 (0.5)
	Roosevelt	1 (0.3)	0
	San Juan	4 (1.2)	4 (2.0)
	Sandoval	0	1 (0.5)
	Santa Fe	1 (0.3)	0

State	County	Direct recoveries	Indirect recoveries
	Sierra	3 (0.9)	3 (1.5)
	Socorro	10 (3.1)	7 ()
	Valencia	9 (2.8)	4 (2.0)
Nevada	Total	1 (0.3)	1 (0.5)
	Lyon	0	1 (0.5)
	Nye	1 (0.3)	0
Oklahoma	Total	4 (1.2)	6 (2.9)
	Caddo	0	2 (1.0)
	Carnegie	0	1 (0.5)
	Carter	1 (0.3)	0
	Garfield	1 (0.3)	0
	Logan	0	1 (1.1)
	Oklahoma	0	2 (1.0)
	Pottawatamie	1 (0.3)	0
	Stephens	1 (0.3)	0
Oregon	Total	0	1 (0.5)
	Lane	0	1 (0.5)
South Dakota	Total	0	1 (0.5)
	Fall River	0	1 (0.5)
Texas	Total	7 (2.2)	12 (5.9)
	Carson	1 (0.3)	0
	Crosby	0	1 (0.5)
	Dallam	0	1 (0.5)
	El Paso	0	1 (0.5)
	Haskell	1 (0.3)	1 (0.5)
	Hockley	0	1 (1.1)
	Hudspeth	1 (0.3)	1 (0.5)
	Irion	0	1 (0.5)
	Lamb	0	2 (1.0)
	McCulloch	1 (0.3)	0
	Oldham	2 (0.6)	1 (0.5)
	Reeves	0	1 (0.5)
	Terry	1 (0.3)	0
Utah	Total	3 (0.9)	8 (3.9)
	Boxelder	0	2 (1.0)
	Cache	0	1 (0.5)
	Davis	0	1 (0.5)
	Duchesne	2 (0.6)	0
	Piute	0	1 (0.5)
	Salt Lake	0	2 (1.0)
	Uintah	1 (0.3)	0
	Weber	0	1 (0.5)

State	County	Direct recoveries	Indirect recoveries
Wyoming	Total	2 (0.6)	9 (2.9)
	Albany	1 (0.3)	3 (2.4)
	Carbon	1 (0.3)	0
	Converse	0	1 (0.5)
	Fremont	0	1 (0.5)
	Goshen	0	1 (0.5)
	Lincoln	0	2 (1.0)
	Sublette	0	1 (0.5)
Canada	Total	0	3 (1.5)
	Alberta	0	1 (0.5)
	Saskatchewan	0	2 (1.0)
Total recoveries		327	211

Figure 1. Total duck pair counts at five large reservoirs in North Park, Colorado during spring and summer 2024.



Publications, presentations, workshops and committee involvement by Avian Research staff
January – December 2024

PUBLICATIONS

Donnelly, J. P., D. E. Naugle, J. M. Knetter, **J. H. Gammonley**, B. A. Grisham, N. C. Nowak, and D. P. Collins. 2024. Wetland scarcity and flood-irrigated agriculture structures summering sandhill crane distribution in western North America. Ecology and Evolution DOI: 10.1002/ece3.10998

Gammonley, J. H. 2024. Duck walk: a birder's improbable path to hunting as conservation (book review). Ornithological Applications 126, DOI: 10.1093/ornithapp/duad063

Hobbs, N. T., **D. B. Johnston, K. N.** Marshall, E. C. Wolf, and D.J. Cooper. 2024. Does restoring apex predators to food webs restore ecosystems? Large carnivores in Yellowstone as a model system. Ecological Monographs DOI: 10.1002/ecm.1588

Johnston, D. B. and R. K. Mann. 2024. Rangeland pitting for revegetation and annual weed control. Rangelands, DOI: 10.1016/j.rala.2023.11.002

Setash, C. M., **A. C. Behney**, **J. H. Gammonley**, and D. N. Koons. 2024. Riding the wetland wave: Can ducks locate macroinvertebrate resources across the breeding season? Ecology and Evolution 14(6):e11568.

Setash, C. M., **A. C. Behney**, **J. H. Gammonley**, C. T. Overton, M. L. Casazza, F. Letourneux, F. E. Buderman, M. L. Schummer, B. Z. Luukonen, N. R. Huck, K. E. Beatty, P. Legagneux, and D. N. Koons. 2024. Can waterfowl buffer the mortality risk induced by GPS tags? A cautionary tale for applied inference across species. Animal Biotelemetry, 12(1):26.

Setash, C. M., **A. C. Behney**, **J. H. Gammonley**, L. Pejchar, M. A. Reddy, and D. N. Koons. 2024. Agricultural mosaics offer nesting habitat to dabbling ducks in the arid Intermountain West of the United States. Ecosphere, 15(11):e70072.

Walker, B. L., A. A. Yappert, C. L. Brennan, C. M. Bossu, and A. W. Jones. 2024. Field research guided by citizen science and monitoring data reveal a novel alpine breeding distribution and vegetation associations of a declining, habitat-specialist songbird in Colorado, USA. Avian Conservation and Ecology 19(1):10. https://doi.org/10.5751/ACE-02595-190110

Walker, B. L. 2024. Applying citizen science data to quantify differences in song between controversial avian taxa, the sagebrush and timberline subspecies of the Brewer's Sparrow (*Spizella breweri*). Western North American Naturalist 83:10

PRESENTATIONS

Behney, A. C. Duck food availability in northeast Colorado wetlands. Colorado/Nebraska Platte River Knowledge Exchange, April 2024.

Behney, A. C. Wetland management and duck food sampling. CPW and partner habitat training, May 2024.

Schaller, S. (co-presenter) and **R. Y. Conrey** (co-presenter). Bald eagle update. Colorado Parks and Wildlife Commission meeting, Denver, CO, January 11, 2024.

Conrey, R. Y. (presenter), M. M. Middleton, J. H. Gammonley, M. Smith, B. D. Snyder, and J. Snyder. Front Range bald eagles: research update. Presented as part of Bird Conservancy of the Rockies Bald Eagle Watch, Annual Training, Statewide (virtual), January 20, 2024.

Rossi, L., **R. Y. Conrey** (presenter), and R. Sacco. Raptor monitoring update. Species Conservation Coordination Meeting, Statewide (virtual), January 31, 2024.

Albright, S. A. (presenter), W. Kendall, and **R. Y. Conrey**. Occupancy and density of burrowing owls nesting in eastern Colorado. Colorado Chapter of the Wildlife Society Annual Meeting, Pueblo, CO, February 9, 2024.

Middleton, M. (presenter), **R. Y. Conrey**, and L. Pejchar. Bald eagle home range size in an urban to rural gradient. Colorado Chapter of the Wildlife Society Annual Meeting, Pueblo, CO, February 9, 2024.

Albright, S. A. (presenter), W. Kendall, and **R. Y. Conrey**. Population assessment of burrowing owls nesting in eastern Colorado. Lois Webster Fund Annual Research Program, Denver, CO, April 16, 2024.

Albright, S. A. (presenter), W. Kendall, and **R. Y. Conrey**. Occupancy, abundance, and productivity of burrowing owls nesting in eastern Colorado. Colorado Field Ornithologists Annual Convention, Lamar, CO, May 4, 2024.

Conrey, R. Y. (presenter). How to help birds: conservation actions for you and your community. K/1 class, Denver Centennial Elementary, Denver, CO (virtual), May 15, 2024.

Conrey, R. Y. (presenter), M. M. Middleton, J. H. Gammonley, M. Smith, B. D. Snyder, and J. Snyder. Bald eagle numbers are growing despite development in Colorado's Front Range. Featured speaker at Denver Audubon Soaring Soiree, Denver, CO, June 13, 2024.

Bove, D. (presenter), **R. Y. Conrey**, and M. Middleton. Understanding territorial absences: insights into bald eagle hiatuses in the Northern Colorado Front Range. American Ornithological Society Annual Meeting, Estes Park, CO, October 3, 2024.

Conrey, R. Y. (presenter), M. Middleton, B. D. Snyder, J. Snyder, J. H. Gammonley, and M. Smith. Bald eagle population growth despite high mortality. American Ornithological Society Annual Meeting, Estes Park, CO, October 3, 2024.

Middleton, M. (presenter), **R. Y. Conrey**, and L. Pejchar. Bald eagle habitat selection in an urbanizing landscape. American Ornithological Society Annual Meeting, Estes Park, CO, October 4, 2024.

Conrey, R. Y. (presenter). Working for a state agency. Colorado State University Careers in Ecology Seminar, Fort Collins, CO, November 18, 2024.

Gammonley, J. H. Waterfowl populations and harvest management. CPW Hunter Education workshop, Timnath, CO, April 27, 2024.

Gammonley, J. H. Sandhill cranes in western Colorado. New Dimensions, Grand Junction, CO, March 18, 2024.

Brandell, E. E., and **D. B. Johnston** (presenter). Proposed studies on effects predator communities on Colorado aspen. Western Aspen Alliance Conference, Gothic, CO, August 28, 2024.

Johnston, D. B. (presenter) and D. Neumann. The Colorado seed tool. Society for Range Management Annual Meeting, Sparks, NV, January 30, 2024.

Johnston, D. B. (presenter) and R.K. Mann. Rangeland pitting for revegetation and annual weed control. Society for Range Management Annual Meeting, Sparks, NV, January 31, 2024.

Johnston, D. B. (presenter) and R.K. Mann. Rangeland pitting for revegetation and annual weed control. Restoration Ecology Class Lecture, Colorado Mesa University, Grand Junction, CO, February 21, 2024.

Johnston, D. B. (presenter) and D. Neumann. The Colorado seed tool: increase your seeding success. Partners in the Outdoors Conference. Breckenridge, CO, April 16, 2024.

Johnston, D. B. (presenter) and R.K. Mann. Rangeland pitting for revegetation and annual weed control. Cheatgrass subcommittee of the Gunnison sage-grouse working group (virtual), April 26, 2024.

Johnston, D. B. Habitat research update. CPW Northwest Region meeting, Yampa River State Park, CO, May 15, 2024.

Johnston, D. B. Colorado Parks and Wildlife habitat research. CPW Habitat training, Livermore, CO, May 22, 2024.

Johnston, D. B. Rangeland pot-holer. Utah Division of Wildlife Resources Equipment Showcase, Ephraim, UT, June 16, 2024.

Setash, C. M. (presenter), **A. C. Behney**, **J. H. Gammonley**, and D. N. Koons. Characterizing the population dynamics of waterfowl breeding in the Intermountain West. North American Duck Symposium, Portland, OR. February 2024.

Setash, C. M. Water and Waterfowl in the Intermountain West: Prioritizing a Finite Resource. Monte Vista Crane Festival, Monte Vista, CO. March 2024.

Setash, C. M. Land Sparing vs. Land Sharing. Guest Lecture, Conservation Biology (NR300), Colorado State University. April 2024.

Setash, C. M., and D. N. Koons. Waterfowl Life History Evolution. Guest Lecture, Waterfowl Ecology and Management (FW430), Colorado State University. April 2024.

Setash, C. M. CPW Solar Energy Research – Impacts on Birds. Colorado Solar and Storage Association (COSSA) Meeting, Pueblo, CO. July 2024.

Setash, C. M. Synthesizing the Impacts of On-Shore Renewable Energy on Birds and Summarizing Current Best Management Practices. American Ornithological Society Conference, Estes Park, CO. October 2024.

Setash, C. M. N-Mixture Models and Data Integration. Guest Lecture, Wildlife Ecology Modeling (FW680A4), Colorado State University. October 2024.

Walker, B. L. (presenter), A. Yappert, C. Bossu, and A. Jones. Monitoring, citizen science, and field data reveal a novel alpine breeding distribution and vegetation associations of a migratory, habitat-specialist songbird. Invited symposium speaker. American Ornithology Society annual meeting. October 2024. Estes Park, CO.

Walker, B. L. (presenter), T. Balzer, K. Pauling, and K. Stone. Greater sage-grouse response to pinyon-juniper and mountain shrub removal in western Colorado. Invited symposium speaker. American Ornithology Society annual meeting. October 2024. Estes Park, CO.

Wann, G. T. (presenter), A. L. Whipple, M. M. McLachlan, J. L. Beck, P. S. Coates, C. J. Conway, J. B. Dinkins, D. K. Dahlgren, T. S. Bowden, L. Waldner, A. N. Johnston, C. A. Hagen, P. D. Makela, D. E. Naugle, M. A. Schroeder, J. S. Sedinger, **B. L. Walker**, P. J. Williams, and C. L. Aldridge. Modeling range-wide annual changes in Greater Sage-Grouse seasonal habitats over time (1995 to 2020). American Ornithology Society annual meeting. October 2024. Estes Park, CO.

Ruzicka, R. E. (presenter), **B. L. Walker**, and W. L. Kendall. Uncertainty in male sage-grouse daily lek attendance and inter-lek movement. Western Association of Fish and Wildlife Agencies (WAFWA) Sage and Columbian Sharp-tailed Grouse Technical Committee Meeting. August 2024. Wenatchee, WA.

Wann, G. T. (presenter), A. L. Whipple, M. M. McLachlan, J. L. Beck, P. S. Coates, C. J. Conway, J. B. Dinkins, D. K. Dahlgren, T. S. Bowden, L. Waldner, A. N. Johnston, C. A. Hagen, P. D. Makela, D. E. Naugle, M. A. Schroeder, J. S. Sedinger, **B. L. Walker**, P. J. Williams, and C. L. Aldridge. Range-wide predictive seasonal habitat mapping for Greater Sage-Grouse. Western Association of Fish and Wildlife Agencies (WAFWA) Sage and Columbian Sharp-tailed Grouse Technical Committee Meeting. August 2024. Wenatchee, WA.

Walker, B. L. (presenter), A. Yappert, C. Bossu, and A. Jones. Monitoring, citizen science, and field data reveal a novel alpine breeding distribution and vegetation associations of a migratory, habitat-specialist songbird. Western Section of The Wildlife Society annual meeting. February 2024. Rohnert Park, CA.

WORKSHOPS, COMMITTEES, AND OTHER ASSIGNMENTS

Behney, A. C. Associate Editor, Wildlife Society Bulletin.

Behney, A. C. Treasurer, Colorado Chapter of The Wildlife Society.

Behney, A. C. Pacific Flyway Study Committee Work and Business meetings, February 2024.

Behney, A. C. North American Waterfowl Management Plan Human Dimensions and Public Engagement Team meeting, July 2024

Behney, A. C. Pacific Flyway Study Committee meeting, August 2023.

Conrey, R. Y. Faculty Committee member for M.S. candidate Sarah Albright, Colorado State University. Thesis completed: Albright, S. 2024. Population assessment of burrowing owls nesting on black-tailed prairie dog colonies in Colorado. (https://www.proquest.com/dissertations-theses/population-assessment-burrowing-owls-nesting-on/docview/3094278516/se-2?accountid=150414)

Conrey, R. Y. Faculty Committee member for M.S. candidate Miranda Middleton, Colorado State

University. Thesis completed: Middleton, M. 2024. Bald eagle space use in an urbanizing landscape. (https://www.proquest.com/dissertations-theses/bald-eagle-space-use-urbanizing-landscape/docview/3147745270/se-2?accountid=150414)

Conrey, R. Y. Review Committee, Lois Webster Fund grant program, Denver Audubon Society.

Gammonley, J. H. CPW Wetlands Program Application Review Team. February/March 2024.

Gammonley, J. H. Central Flyway Waterfowl, Webless Migratory Game Bird, and Central Management Unit Dove Technical Committee meetings, South Padre Island, TX, February 5-7, 2024.

Gammonley, J. H. Central Flyway Technical Committee and Council meetings, Winter Park, CO, August 26-30, 2024.

Jaffe, N. E. CPW Animal Care and Use Committee.

Johnston, D. B. Co-advisor for Nathan Nelson, Colorado State University M.S. Candidate. Participated in weekly meetings, helped collect field data, and consulted on methods for study titled 'Mountain Shrub Establishment in Colorado'.

Johnston, D. B. Seed Mix Working Group Co-Leader. Served on subcommittee for sagebrush planting. Helped write guidance on sagebrush seed collection and transfer.

Johnston, D. B. CPW Animal Care and Use Committee.

Johnston, D. B. Colorado Seed Tool Working Group co-leader. Oversaw development of Version 1 of the Colroado Seed Tool, incorporating feedback from Beta Version. Coordinated with third-party vendor for tool development.

Setash, C. M. Faculty Committee member for Ph.D. candidate Casey Weissburg, University of Colorado – Denver.

Setash, C. M. President-elect, Colorado Chapter of The Wildlife Society.

Walker, B. L. Core Team member, USGS rangewide seasonal habitat mapping analysis for greater sage-grouse.

Walker, B. L. (chair) CPW Animal Care and Use Committee.