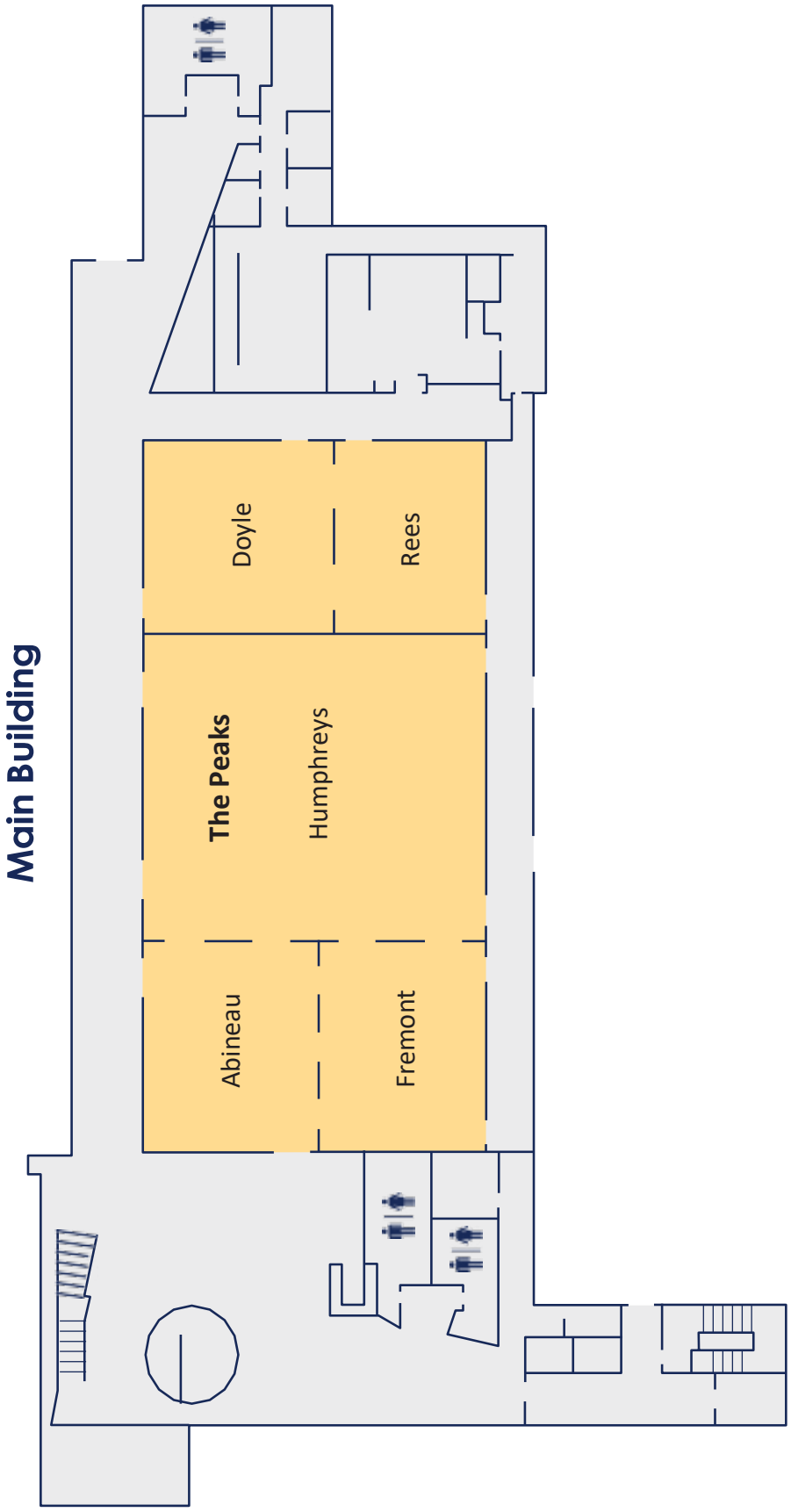
15TH BIENNIAL DEER & ELK WORKSHOP




May 15-18, 2023 | High Country Conference Center | Flagstaff, Arizona

Conference Center Floor Plan



15TH BIENNIAL DEER & ELK WORKSHOP

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Photos by George Andrejko, AZGFD

2023 WAFWA DEW PLANNING TEAM

Jim Heffelfinger, Chair
Kirby Bristow
Erin Butler
Debbie Carter
Dustin Darveau
Jeff Gagnon
Larisa Harding
Callie Cavalcant
Andrew Jones
Jackson Miller
Amber Munig
Rob Nelson
Brianna Russo
Scott Sprague
Allen Zufelt

Andrew Jones and Jim Heffelfinger, Proceedings Editors

Schedule-at-a-Glance

MONDAY, MAY 15TH		
1:00 PM - 5:00 PM	**Mule Deer Working Group Meeting**	*Doyle*
1:00 PM - 6:00 PM	**Registration Open**	*Prefunction*
1:00 PM - 6:00 PM	**Exhibitor Set Up**	*Prefunction*
6:00 PM - 9:00 PM	**Welcome Social** *Sponsored by Rocky Mountain Elk Foundation and MeatEater Inc.*	*Offsite: 1899 Bar and Grill*
TUESDAY, MAY 16TH		
7:00 AM - 8:00 AM	**Breakfast** *Sponsored by Whitetails Unlimited*	*Humphreys*
7:00 AM - 5:00 PM	**Registration Open**	*Prefunction*
8:00 AM - 10:00 AM	**Welcome and Plenary**	*Humphreys*
10:00 AM - 10:30 AM	**Break with Sponsors & Exhibitors** *Sponsored by the Southwest Section of The Wildlife Society*	*Prefunction*
10:30 AM - 12:00 PM	**Deer Concurrent Sessions: Deer Management**	*Humphreys*
10:30 AM - 12:00 PM	**Elk Concurrent Sessions: Predator-Prey Dynamics**	*Abineau/Fremont*
12:00 PM - 1:00 PM	**Lunch**	*Humphreys*
12:00 PM - 1:00 PM	**Business Meeting**	*Ponderosa*
1:00 PM - 3:00 PM	**Deer Concurrent Sessions: Movement and Migration**	*Humphreys*
1:00 PM - 3:00 PM	**Elk Concurrent Sessions: Movement and Migration**	*Abineau/Fremont*
3:00 PM - 3:30 PM	**Break with Sponsors & Exhibitors**	*Prefunction*
3:30 PM - 4:50 PM	**Deer Concurrent Sessions: Habitat Changes**	*Humphreys*
3:30 PM - 4:50 PM	**Elk Concurrent Sessions: Elk and Deer Management**	*Abineau/Fremont*
6:00 PM - 8:00 PM	**Evening Event at Orpheum Theater** *Sponsored by Matson's Laboratory*	*Offsite: Orpheum Theater*
WEDNESDAY, MAY 17TH		
7:00 AM - 8:00 AM	**Breakfast**	*Humphreys*
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8:00 AM - 9:40 AM	**Field Trip Plenary**	*Humphreys*
9:45 AM - 10:15 AM	**Grab & Go Lunch**	*Humphreys*
10:15 AM - 5:00 PM	**Field Trip**	*Offsite: Grand Canyon*
6:00 PM - 7:00 PM	**Poster Social & Visit with Sponsors and Exhibitors**	*Prefunction*
7:00 PM - 9:00 PM	**Closing Banquet & Awards** *Sponsored by Leupold & Stevens*	*Humphreys*
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8:00 AM - 10:00 AM	**Elk Concurrent Sessions: Management Challenges**	*Abineau/Fremont*
10:00 AM - 10:20 AM	**Break & Exhibitor Breakdown**	*Prefunction*
10:20 AM - 12:00 PM	**Final Session: Management**	*Humphreys*
12:00 PM	**Adjournment**	

Detailed Schedule

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7:00 AM - 5:00 PM	**Registration Open**	*Prefunction*
8:00 AM - 10:00 AM	**Welcome and Plenary** *Session Facilitator: Jim Heffelfinger, DEW Chair, Arizona Game and Fish Department*	*Humphreys*
8:00 - 8:10 AM	Opening Comments and Housekeeping *Jim Heffelfinger, DEW Chair, Arizona Game and Fish Department*	
8:10 - 8:20 AM	Welcome Remarks *Ty Gray, Director, Arizona Game and Fish Department*	
8:20 - 8:40 AM	Collaborative Conservation in West-wide Elk Management *Zach Lowe, WAFWA*	
8:40 - 9:20 AM	Overview of Deer and Elk Status in North America *Kyle Garrison, Washington Department of Fish and Wildlife*	
9:20 - 9:40 AM	How Habitat Use Impacts Mule Deer Survival in South-Central British Columbia, Canada *Chloe Wright, University of British Columbia - Okanagan*	
9:40 - 10:00 AM	Analysis of Six Years of Native Seedling Monitoring from Post-fire Restoration Efforts in Southwest Idaho *Michael Young, Idaho Department of Fish and Game*	
10:00 AM - 10:30 AM	**Break with Sponsors & Exhibitors** *Sponsored by the Southwest Section of The Wildlife Society*	*Prefunction*
10:30 AM - 12:00 PM	**Deer Concurrent Sessions: Deer Management** *Session Facilitator: Todd Black, Eagle Mountain City*	*Humphreys*
10:30 - 10:50 AM	Evaluating an Experimental Mule Deer Antler Restriction in the Texas Panhandle *Shawn Gray, Texas Parks and Wildlife Department*	
10:50 -11:10 AM	Tablet-Based Data Collection for Aerial Surveys: Experiences from Nevada and Washington *Cody McKee, Nevada Department of Wildlife; Brendan Oates, Washington Department of Wildlife*	
11:10 - 11:30 AM	A Comparison of Camera Based and Aerial Survey Methods for Collecting Herd Composition Data *Eric Freeman, Idaho Department of Fish and Game*	
11:30 - 11:50 AM	17.49: A Community-based Conservation Effort Managing for Wildlife in Eagle Mountain City, Utah *Todd Black, Eagle Mountain City*	

Detailed Schedule

TUESDAY, MAY 16TH (CONTINUED)		
10:30 AM - 12:00 PM	**Elk Concurrent Sessions: Predator-Prey Dynamics** *Session Facilitator: Jesse Alston, University of Arizona*	*Abineau/Fremont*
10:30 - 10:50 AM	Kill Rates and Prey Composition of Mexican Gray Wolves and Cougars in New Mexico and Arizona *Samuel Martinez, New Mexico State University*	
10:50 -11:10 AM	Quantifying Elk Foraging Strategies on a Multi-Predator Landscape *Julia Olson, New Mexico State University*	
11:10 - 11:30 AM	Elk Survival, Mortality Risk, and Mexican Wolf Recovery *James Cain, New Mexico Cooperative Fish and Wildlife Research Unit*	
11:30 - 11:50 AM	Predation Risk from Recovering Mexican Gray Wolf Populations Influences Resource Selection and Behavior of Elk in the Southwestern United States *James Cain, New Mexico Cooperative Fish and Wildlife Research Unit*	
12:00 PM - 1:00 PM	**Lunch**	*Humphreys*
12:00 PM - 1:00 PM	**Business Meeting**	*Ponderosa*
1:00 PM - 3:00 PM	**Deer Concurrent Sessions: Movement and Migration** *Session Facilitator: Orrin Duvuvuei, New Mexico Department of Game and Fish*	*Humphreys*
1:00 - 1:20 PM	Crossing Designs That Save Money and Time: A 2-year Summary on New Highway Escape Gates *Jessie Shallow, Mule Deer Foundation and Idaho Department of Fish and Game*	
1:20 - 1:40 PM	Using Mule Deer Movement Data to Determine Fawning, Peak Rut, and Mate Search Strategy *Levi Heffelfinger, Caesar Kleberg Wildlife Research Institute*	
1:40 - 2:00 PM	Migration Corridor Estimation: Current Best Practices and Future Directions *Jesse Alston, University of Arizona*	
2:00 - 2:20 PM	Stopover Ecology: How to Parsimoniously Decrease Type-1 and Type-2 Errors for Migrating Ungulates in Idaho *Scott Bergen, Idaho Department of Fish and Game*	
2:20 - 2:40 PM	Resource Selection Response of Mule Deer to Changing Densities of an Interspecific Competitor *Nathan Jackson, University of Nevada, Reno*	
2:40 - 3:00 PM	Temporal Variation in Resources Influences Offspring Quality of White-tailed Deer in a Semi-arid Environment *Miranda Hopper, TAMUK-CKWRI*	

Detailed Schedule

TUESDAY, MAY 16TH (CONTINUED)		
1:00 PM - 3:00 PM	**Elk Concurrent Sessions: Movement and Migration** *Session Facilitator: Scott Sprague, Arizona Game and Fish Dept.*	*Abineau/Fremont*
1:00 - 1:20 pm	Modeling Elk Parturition Habitat in Idaho Using Movement Patterns of Adult Females *Jon Horne, Idaho Department of Fish and Game*	
1:20 - 1:40 pm	Crossing Designs That Save Money and Time: A 2-year Summary on Woven-wire Fence Gaps for Big Game *Jessie Shallow, Mule Deer Foundation and Idaho Department of Fish and Game*	
1:40 - 2:00 pm	Survey Design Implications for Camera Trap Density Estimates on Trail and Road Networks *Guen Grosklos, Speedgoat*	
2:00 - 2:20 pm	Summer Elk Calf Survival in a Partially Migratory Population *Evelyn Merrill, University of Alberta*	
2:20 - 2:40 pm	Male Elk Survival, Vulnerability and Antler Size in a Transboundary Partially Migratory Elk Population *Evelyn Merrill, University of Alberta*	
2:40 - 3:00 pm	OPEN	
3:00 PM - 3:30 PM	**Break with Sponsors & Exhibitors**	*Prefunction*
3:30 PM - 4:50 PM	**Deer Concurrent Sessions: Habitat Changes** *Session Facilitator: Jackson Miller, Mule Deer Foundation*	*Humphreys*
3:30 - 3:50 PM	Novel Modeling Approach Connects Habitat Quality to Mule Deer Population Performance *Anna Moeller, University of Montana and Oklahoma State University*	
3:50 - 4:10 PM	Plant and Mule Deer Responses to Pinyon-Juniper Removal by Three Mechanical Methods *Chuck Anderson, Colorado Parks and Wildlife*	
4:10 - 4:30 PM	Restoring Cheatgrass Invaded Rangeland Decreases Wildfire Risk and Improves Wildlife Browse and Habitat *Jake Courkamp, Colorado State University*	
4:30 - 4:50 PM	Age-specific Survival of Female and Male Mule Deer in Utah, USA *Randy Larsen, Brigham Young University*	
3:30 PM - 4:50 PM	**Elk Concurrent Sessions: Elk and Deer Management** *Session Facilitator: Callie Hartson Cavalcant, Arizona Game and Fish Dept.*	*Abineau/Fremont*
3:30 - 3:50 PM	Estimating Ungulate Density with Camera Traps: An Overview of IDFG's Efforts to Date *Sarah Thompson, Idaho Department of Fish and Game*	
3:50 - 4:10 PM	Residual Costs of Reproduction in Elk *(Cervus canadensis)* *Brock McMillan, Brigham Young University*	
4:10 - 4:30 PM	Mapping Big Game Migrations Across the Western States: Science Support for Management and Conservation *Blake Lowrey, University of Wyoming*	
4:30 - 4:50 PM	OPEN	
6:00 PM - 8:00 PM	**Evening Event at Orpheum Theater** *Sponsored by Matson's Laboratory*	*Offsite: Orpheum Theater*

Detailed Schedule

WEDNESDAY, MAY 17TH		
7:00 AM - 8:00 AM	**Breakfast**	*Humphreys*
7:00 AM - 10:30 AM	**Registration Open**	*Prefunction*
8:00 AM - 9:40 AM	**Field Trip Plenary** *Session Facilitator: Casey Stemler, U.S. Fish and Wildlife Service*	*Humphreys*
8:00 - 8:20 AM	Migration Mapping Focuses Conservation Planning *Lucas Olson, University of Wyoming/Wyoming Game and Fish Department*	
8:20 - 8:40 AM	Efforts to Mitigate Habitat Fragmentation and Wildlife-Vehicle Collisions Along Two Interstates in Northern Arizona *Jeff Gagnon, Arizona Game and Fish Department*	
8:40 - 9:00 AM	Addressing the Potential Movement Implications of a Novel Interstate Highway *Scott Sprague, Arizona Game & Fish Department*	
9:00 - 9:20 AM	Migration Mapper Integration into Future Planning: Case Study CO Bar Ranch Renewable Energy Projects *Rob Nelson, Arizona Game and Fish Department*	
9:20 - 9:40 AM	How a Landscape-scale Conservation Program Includes: Renewable Energy, Fire, Drought, Migration and Movement, and Recreational Impacts *Billy Cordasco, Babbitt Ranches*	
9:45 AM - 10:15 AM	**Grab & Go Lunch**	*Humphreys*
10:15 AM - 5:00 PM	**Field Trip**	*Offsite: Grand Canyon*
	The Grand Canyon to Prescott Corridor is an S.O. 3362 priority movement area for elk, deer, and other wildlife. This field trip will include a stop at a future wildlife overpass site. Another stop will occur at a proposed solar and wind energy location that overlaps one of Arizona's longest mule deer migration corridors. Project partners are using GPS movement data to help inform placement and design of that renewable energy infrastructure. A visit to Grand Canyon National Park will be included during this field trip.	
6:00 PM - 7:00 PM	**Poster Social & Visit with Sponsors and Exhibitors**	*Prefunction*
	Recent Advances in Statistical Tools for Estimating Resource Selection *Jesse Alston, University of Arizona*	
	Female Elk (Cervus canadensis) Home Range Sizes in Elk Island National Park, Alberta *Payton Baltzer, Red Deer Polytechnic*	
	Building Collaborations to Assess and Manage CWD Risk Across the West *Gavin Cotterill, U.S. Geological Survey*	
	Trade-offs Between Selecting Habitat and Avoiding Human Disturbance for a Widespread Ungulate *Brianna Russo, Arizona State University*	
7:00 PM - 9:00 PM	**Closing Banquet & Awards** *Sponsored by: Leupold & Stevens* *Facilitator: Jim Heffelfinger, DEW Chair, Arizona Game and Fish Department; Wallmo Award Presenter: Orrin Duvuvuei, New Mexico Department of Game and Fish; RMEF Excellence in Elk Country Award, Presenter: Karie Decker, Rocky Mountain Elk Foundation*	*Humphreys*

Detailed Schedule

THURSDAY, MAY 18TH		
7:00 AM - 8:00 AM	**Breakfast**	*Humphreys*
7:00 AM - 12:00 PM	**Registration Open**	*Prefunction*
8:00 AM - 10:00 AM	**Deer Concurrent Sessions: Movement and Migration** *Session Facilitator: Levi Heffelfinger, Caesar Kleberg Wildlife Research Institute*	*Humphreys*
8:00 - 8:20 AM	Natal Range Dispersal and Exploratory Movements of Juvenile Mule Deer: Informing Chronic Wasting Disease Management *Calvin Ellis, Caesar Kleberg Wildlife Research Institute, Texas A&M University - Kingsville*	
8:20 - 8:40 AM	Wyoming's Comprehensive Management Strategy for the Sublette Mule Deer Migration Corridor *Ian Tator, Wyoming Game and Fish Department*	
8:40 - 9:00 AM	Factors Influencing Temporal Shifts of Space Use in Mule Deer *Calvin Ellis, Caesar Kleberg Wildlife Research Institute, Texas A&M University - Kingsville*	
9:00 - 9:20 AM	Mapping Oregon Mule Deer Migrations Using Brownian Bridge Movement Modeling *Valerie Hinojoza-Rood, Oregon State University*	
9:20 - 9:40 AM	The Impact of Predation and Other Mortality Sources on White-tailed Deer *(Odocoileus virginianus)* Population Dynamics in North Idaho *Elizabeth Painter, University of Montana*	
9:40 - 10:00 AM	Estimating Age of Mule Deer in the Field: Can We Move Beyond Broad Age Categories? *Morgan Hinton, Utah Division of Wildlife Resources*	
8:00 AM - 10:00 AM	**Elk Concurrent Sessions: Management Challenges** *Session Facilitator: Justin Shannon, Utah Division of Wildlife Resources*	*Abineau/Fremont*
8:00 - 8:20 AM	How Much Is Enough? Using Game Cameras to Estimate Herd Composition In Elk *Charles Henderson, Idaho Department of Fish and Game*	
8:20 - 8:40 AM	An Evaluation of Aerial Survey Design and an Attempt to Do More with Less *Josh Nowak, SpeedGoat*	
8:40 - 9:00 AM	The Utah Wildlife Migration Initiative: What We Have Learned After Five Years *Covy Jones, Utah Division of Wildlife Resources*	
9:00 - 9:20 AM	Simulation Tools for Private Lands Management, Data Deficient Management Units, and Public Communication *Hans Martin, Speed Goat, Wildlife Solutions*	
9:20 - 9:40 AM	Cause-Specific Mortality in Mule Deer: Influence of Nutritional Condition and Age *Kent Hersey, Utah Division of Wildlife Resources*	
9:40 - 10:00 AM	Mixed-Severity Wildfire Shapes Habitat Use of Deer, Elk, and Large Carnivores *Jesse Lewis, Arizona State University*	
10:00 AM - 10:20 AM	**Break & Exhibitor Breakdown**	*Prefunction*

Detailed Schedule

THURSDAY, MAY 18TH (CONTINUED)		
10:20 AM - 12:00 PM	**Final Session: Management** *Session Facilitator: Jim Heffelfinger, DEW Chair, Arizona Game and Fish Department*	*Humphreys*
10:20 - 10:40 AM	Resident/Non-resident Hunter Perceptions of Mule Deer Hunting and Management in Montana *Sonja Andersen, Montana Fish, Wildlife & Parks*	
10:40 - 11:00 AM	Effects of Energy Development, Landcover, Climate, and Restoration on Mule Deer Age Ratios *Tabitha Graves, U.S. Geological Survey*	
11:00 - 11:20 AM	From Conception to Recruitment: Maternal Condition Dictates Likelihood of Success in Mule Deer *Sydney Lamb, Utah Division of Wildlife Resources*	
11:20 - 11:40 AM	Identifying and Disrupting Top-Down Regulation of a Declining Mule Deer Population *Rusty Robinson, Utah Department of Natural Resources*	
11:40 - 12:00 AM	Kinds of Black-tailed and Mule Deer *Jim Heffelfinger, DEW Chair, Arizona Game and Fish Department*	
12:00 PM	**Adjournment**	

AWARDS

O.C. WALLMO AWARD

Presented by Orrin Duvuvuei

O. C. “Charlie” Wallmo was born in Iowa in 1919 and studied forestry and wildlife at the University of Wisconsin and University of Montana before completing his Bachelor’s degree at Utah State University in 1947. He returned to the UW for his Masters Degree and then to Texas A&M University for a Ph.D. Through his work in Texas, Arizona, Alaska and the Rocky Mountains, Dr. Wallmo pioneered research that resulted in many of the fundamental and foundational concepts in wildlife management. He conducted the first comprehensive study of the ecology of scaled quail early in his career. He was also one of the first to use free-ranging tame deer as research tools to elucidate diet, behavior, and metabolism of mule deer. Charlie was sought-after for his knowledge of mule deer nutrition and the effects of habitat manipulations on deer population dynamics. His work in the central Rockies showed the benefits of small forest clearcuts to deer nutrition and early work on deer survey methodology formed the basis for improved management of deer populations. His efforts in Southeast Alaska demonstrated the value of overstory cover for black-tailed deer during winter. Charlie published more than 50 significant publications and his edited tome “Mule and Black-tailed Deer of North America” that served as the primary source of basic information about that species for 40 years. Even though he was known for his dedication to science and the scientific process, his legacy is not volumes of esoteric scientific publications or reams of data analysis, but important contributions to the body of knowledge wildlife managers used for decades as the foundation for improved management. In addition, many of his former graduate students have become known for their work with cervids across North America.

Recipients
2023 - Hall Sawyer
2021 – Kevin Monteith
2019 – Gary White
2017 – Mark Hurley
2015 – R. Terry Bowyer
2013 – Dave Pac
2011 – Jim Heffelfinger
2009 – Dale McCullough
2007 – Len Carpenter

RMEF EXCELLENCE IN ELK COUNTRY

Presented by Karie Decker, RMEF

This award is to honor an individual scientist or wildlife biologist whose career has demonstrated desire and dedication to benefit the scientific management of elk or elk habitat. The accomplishments and actions of the individual must have shown a desire and dedication to go above and beyond the normal course of duty, as demonstrated by publications, participation in professional organizations and symposiums, recognitions and awards and other activities. The recipient has earned respect and credibility among his/her peers in the wildlife and conservation profession. The recipient has shown a sincere commitment and devotion to the conservation of wild free-ranging elk, other wildlife and their habitat.

Past Recipients
2023 - Mary Rowland
2021 – Ian Tator
2019 – Josh Millspaugh

OFFSITE EVENTS

WELCOME SOCIAL | 1899 BAR AND GRILL

Monday, May 15 | 6:00 PM - 9:00 PM

This upscale restaurant is named after Northern Arizona University's founding year and is testament both to the university's modernization and also a nod to its history and roots. It retains features from the historic building, such as its original copper fireplace, but adds dynamic lighting and an elegant, open design to produce a kind of dining experience never seen before on this campus.

Join us for our Monday evening welcome social outside on Potter's Square at the 1899 Bar and Grill for drinks, hors d'oeuvres and socializing! 1899 Bar and Grill is located on NAU campus right next to the High Country Conference Center, at 307 W Dupont Ave. We will be outside - please bring appropriate clothing for the weather.

TUESDAY DINNER | ORPHEUM THEATER

Tuesday, May 16 | 6:00 PM - 8:00 PM

Flagstaff has had its share of opera houses, movie theaters, dance halls and other entertainment venues through the years, but only one has stood the test of time and endures as an icon of Flagstaff 's vibrant downtown landscape. Located on the site of a former chicken yard, the Orpheum Theatre's presence—one might say its personality—is one that triggers even the casual visitor to utter, "If only these walls could talk." For a century, it has been a center for the performing and cinematic arts in Flagstaff. It is a cozy and funky venue.

Join us for our Tuesday evening dinner outside at the Stagewest outdoor venue at the Orpheum Theater for drinks, made-to-order wood-fired pizza from Fat Olives, and fun! Gluten free, vegetarian and vegan pizza options are available. Meet in the High Country Conference Center lobby to walk over to the Orpheum Theater at 5:40 pm, or meet us there! The venue address is 15 W Aspen Ave, and it is a .5 mile/11 minute walk. We will be outside - please bring appropriate clothing for the weather.

POSTER ABSTRACTS

Posters
May 17, 2023 / 6:00 - 7:00 pm

Building Collaborations to Assess and Manage CWD Risk Across the West

Gavin Cotterill, U.S. Geological Survey, Northern Rocky Mountain Science Center, 38 Mather Drive, PO Box 169, West Glacier, MT 59936, USA

Will Janousek, U.S. Geological Survey, Northern Rocky Mountain Science Center, 38 Mather Drive, PO Box 169, West Glacier, MT 59936, USA

Tabitha Graves, U.S. Geological Survey, Northern Rocky Mountain Science Center, 38 Mather Drive, PO Box 169, West Glacier, MT 59936, USA

Correspondence: Gavin Cotterill, U.S. Geological Survey, Northern Rocky Mountain Science Center, 38 Mather Drive, PO Box 169, West Glacier, MT 59936, USA. Email: gcotterill@usgs.gov

ABSTRACT Chronic wasting disease (CWD) has spread across much of North America over the last decade leading to declining populations of deer, elk, and moose. Managers may be able to reduce disease risk through adaptive management of population density or focal concentrations, but the relationship between ungulate distributions and CWD transmission is unknown. We are seeking collaborators interested in ranking relative disease risk across the Western U.S., quantifying the connection of local density to CWD prevalence and survival and evaluating the success of adaptive management efforts in areas with appropriate data. This project builds on work conducted at the National Elk Refuge, WY in 2017-2019 evaluating the drivers of elk aggregation and developing a decision support tool assessing methods for quantifying elk densities to aid in mitigating CWD transmission risk. The open- source R package WildAgg allows biologists to input standardized GPS collar or other location data and derive spatially and temporally explicit information to facilitate adaptive management and research across the country. The relative importance of direct versus indirect transmission across the CWD host range is unknown, yet aggregation patterns influence both: in terms of contact rates and time spent in areas where prions are shed. Our goal is to co-design, with our collaborators, a multi-population study to better understand the relationship between ungulate distributions and disease transmission. We envision providing support to partners with GPS or imagery data who are interested in characterizing deer and elk aggregation patterns (whether CWD is currently present in their populations or not), quantifying the impacts of adaptive management practices and helping to answer specific questions that meet our collaborators' needs.

Female Elk (Cervus canadensis) Home Range Sizes in Elk Island National Park, Alberta

Payton Baltzer, Red Deer Polytechnic, 100 College Blvd, Red Deer, AB T4N 5H5, Canada

Chelsea Beach, Red Deer Polytechnic, 100 College Blvd, Red Deer, AB T4N 5H5, Canada

Sandra MacDougall, Red Deer Polytechnic, 100 College Blvd, Red Deer, AB T4N 5H5, Canada

Ramona Maraj, Parks Canada, 30 Rue Victoria, Gatineau, QC J8X 0B3, Canada
Hanna Schoenberg, Parks Canada, 30 Rue Victoria, Gatineau, QC J8X 0B3, Canada

Erin Henderson, Parks Canada, 30 Rue Victoria, Gatineau, QC J8X 0B3, Canada

Correspondence: Payton Baltzer, Red Deer Polytechnic, 100 College Blvd, Red Deer, AB T4N 5H5, Canada. Email: payton.baltzer@rdpolytech.ca

ABSTRACT The objective of this study was to determine annual and season home range characteristics of the two female elk *(Cervus canadensis)* populations within a high density and low predation environment. Elk Island National Park (EINP) is a 194 km2 protected area that is part of the UNESCO Beaver Hills Biosphere Reserve. Comprised of aspen parkland, EINP is separated into two completely fenced blocks of differing sizes due to the presence of a major four lane divided highway. We compared annual and seasonal home ranges and the social group distributions for female elk using 154,517 GPS locations taken in 2-hour intervals from 34 radio- collared individuals (19 in the North block and 15 in the South block) between 2020-2022. Seasonal home range intervals were delineated as winter, spring, calving, summer and rut. Minimum convex polygons (MCP) and kernel density estimates were calculated using RStudio. The female elk population in the larger north block population was partitioned into 5 social groups and had a significantly smaller mean annual home ranges (18.73 km2 ± 7.05 SD) than those of the two social groups in the South block population (27.97 km2 ± 10.12 SD). For the entire park annual home range size was largest in the winter (19.44 km2 ± 8.83 SD) and smallest during the summer (8.39 km2 ± 3.57 SD). This data will be used to model the relationship between habitat availability and herd home range dynamics.

Recent Advances in Statistical Tools for Estimating Resource Selection

Jesse M. Alston, School of Natural Resources and the Environment, University of Arizona, 1064 E. Lowell St., Tucson, AZ 85721, USA

Christen H. Fleming, Smithsonian Conservation Biology Institute, 1500 Remount Rd., Front Royal, VA, 22630 USA

Justin M. Calabrese, Center for Advanced Systems Understanding (CASUS), Helmholtz- Zentrum Dresden-Rossendorf, Untermarkt 20, D-02826 Görlitz, Germany

Correspondence: Jesse M. Alston, School of Natural Resources and the Environment, University of Arizona, 1064 E. Lowell St., Tucson, AZ 85721, USA. Email: jmalston@arizona.edu

ABSTRACT The study of habitat selection is a foundational component of wildlife management. Today, habitat selection is primarily studied using resource selection functions, a class of models that uses logistic regression to compare “used” to “available” habitat. However, these models have several statistical problems, including rampant pseudoreplication from failing to account for autocorrelation in modern animal movement data, no clear guidelines for sampling available habitat, and large amounts of numerical error from sampling too few available points. These problems are widely acknowledged but have no generally accepted solutions. We discuss several recent advances in statistical techniques for studying resource selection: likelihood weighting, integrated availability sampling, and numerical convergence checks. We demonstrate the practical advantages of these methods over conventional approaches using simulations and describe how to apply these new methods to animal tracking data using the ‘ctmm’ R package. Broad uptake of these methods could substantially improve our estimates of habitat selection for animals including deer and elk.

Trade-offs Between Selecting Habitat and Avoiding Human Disturbance for a Widespread Ungulate

Brianna M. Russo, Arizona State University, College of Integrative Sciences and Arts, 6073 South Backus Mall, Mesa, AZ 85212, USA

Scott C. Sprague, Arizona Game and Fish Department, 5000 W. Carefree Hwy, Phoenix, AZ 85086, USA

Scott Hamilton, City of Scottsdale, 3939 N. Drinkwater Blvd., Scottsdale, AZ 85251, USA

Tiffany A. Sprague, Arizona Game and Fish Department, 5000 W. Carefree Hwy, Phoenix, AZ 85086, USA

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ABSTRACT Through habitat selection, animals select for habitat characteristics that maximize their survival and reproduction while minimizing the negative effects of predation, competition, and disturbance. As the human population continues to grow, understanding how habitat selection changes in response to human disturbance is becoming increasingly important. Mule deer *(Odocoileus hemionus)* are a particularly important focal species for conservation due to their wide-ranging movements, habitat requirements, and economic value. However, little is known how mule deer will shift their habitat selection across broad and fine scales to access limited resources, especially in arid environments where food and water may be especially limited during the hot and dry summer season. Our objectives were to evaluate habitat selection of mule deer in relation to landscape characteristics (i.e., plant productivity, water, and topography) and disturbance factors (urbanization and recreation) across multiple temporal (i.e., seasonal and daily time periods) and spatial scales. We used data from 31 GPS collared mule deer in the McDowell Mountains, near Scottsdale, Arizona to estimate resource selection functions across second and third orders of selection. Consistent with predictions, mule deer were less likely to avoid urbanization and trails at night and during the hot-dry season. Mule deer also selected for areas of high plant productivity regardless of season, but most strongly during the day. The results from this research suggest that mule deer can alter their habitat use in space and time to access resources, while also aiming to avoid human disturbance. This research can be applied by wildlife and landscape managers to conserve mule deer habitat throughout arid regions in the southwest.

ORAL PRESENTATION ABSTRACTS

Plenary
May 16, 2023 / 8:00 – 10:00 am

Session Facilitator: Jim Heffelfinger, DEW Chair, Arizona Game and Fish Department

Collaborative Conservation in West-wide Elk Management

Zach Lowe, Western Association of Fish and Wildlife Agencies, P.O. Box 190150, Boise, ID 83719, USA

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ABSTRACT This presentation will highlight the discussions and conclusions that took place at the 2023 Western Elk Summit in Missoula, Montana February 21-23, 2023. This event was an invitation-only summit to allow for Western Association of Fish and Wildlife Agencies' (WAFWA) leadership and leading elk managers to share challenges and triumphs that are uniquely relevant to managing western elk. As a species, elk have taken on new management needs and challenges in recent years for many states. Elk ecology still forms the foundation of our management programs and human wildlife conflicts, disease, and a diversity of human values relevant to elk pose new questions to be considered. WAFWA has worked very closely with leadership, deer and elk biologists, and Rocky Mountain Elk Foundation to identify topics that are most pressing towards wildlife agencies' needs and interests.

Overview of Deer and Elk Status in North America

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ABSTRACT The purpose of this presentation is to provide a general overview of the current deer and elk population status and general abundance trends throughout their range in North America. This overview will provide a snapshot of the status of these species throughout their range, which can be used by managers to help inform stakeholders, along as a tool for management and conservation. To do this, we collected information from over 20 states and providences regarding species population status and harvest information for their respective jurisdiction. Each state and providence collect information regarding the aforementioned topics uniquely, based on their resources and management needs. The data collected for the 2023 Deer and Elk Workshop will be added to a database that holds decades of similar information.

How Habitat Use Impacts Mule Deer Survival in South-Central British Columbia, Canada

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ABSTRACT Mule deer *(Odocoileus hemionus)* populations across much of southern British Columbia, Canada are declining. The causes of these declines are not clear due to multiple stressors from urbanization, resource extraction, changing weather patterns, and more large, high intensity wildfires. To help disentangle the mechanisms driving deer populations in southern BC, we fit GPS collars on 252 adult (≥ 1.5 year-old) female, 195 juvenile (6-month-old), and 135 neonate mule deer during 2018-2021. We were interested in determining how habitat use and weather at different temporal scales affected survival. We quantified time spent in cutblocks and burns, and weather variables, within 30-day, 7-day, and 2-day time scales during summer (June – November) and winter (December – May). We used Cox Proportional Hazards models to determine which covariates were important for each temporal scale and age class. Kaplan-Meier (KM) estimates of winter survival were 0.93 (95% CI = 0.91 – 0.95) for adults and 0.64 (0.55 – 0.69) for juveniles. KM estimates for summer survival were 0.89 (0.86 – 0.92) for adults and 0.27 (0.20 – 0.36) for neonates. Survival modeling results differed based on the time scale and age. For example, for adults in the summer at a 2-day time scale, mortality risk decreased by 30% for deer that spent 100% of their time in a recent cutblock (0 – 16 years since harvest) compared to deer that spent no time in a recent cutblock (β = -0.36, 95% CI = -0.69 – -0.03). For juveniles in the winter at a 30-day time scale, survival decreased as the number of cold days (max temp ≤ 0oC) increased (β = 1.34, 95% CI = 0.91– 1.78). These results give insight into some of the drivers of mule deer survival in southern BC and in some cases, provide habitat management recommendations that could increase survival rates amidst a changing landscape and climate.

Analysis of Six Years of Native Seedling Monitoring from Post-fire Restoration Efforts in Southwest Idaho

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ABSTRACT It is widely acknowledged that locally adapted and source-identified native plant materials are necessary for restoration of functional sagebrush steppe ecosystems and associated Greater Sage-Grouse habitat. Monitoring of post-fire restoration treatments is critical to gathering insight on how best to improve restoration success. Our program fills both of these needs by collecting locally adapted native seed for use in restoration plantings and by monitoring seedling growth, establishment, and survival. This research tracks short-term growth and survival of a random subset of out-planted seedlings across 30 sites in southwest Idaho occurring from 2016-present. 2,680 seedlings were monitored including 250 low sagebrush, 1,276 big sagebrush, 1,104 bitterbrush, and 50 saltbush during the spring and fall of these years. Preliminary results indicate that nursery seedling quality, season of planting, and soil type have a combined effect on survival of bitterbrush and sagebrush seedlings. Higher quality seedling stock has a higher probability of survival to the establishment phase at year two. Bitterbrush survives better when planted in the spring and sagebrush when planted in the fall. Bitterbrush survival and height are greater on clayey/loamy sites. Big sagebrush survival and height are greater on sandy/granitic sites. Future analysis will delve into microsite climatic factors.

Deer Concurrent Sessions: Movement and Migration
May 16, 2023 / 10:30 - 11:50 am

Session Facilitator: Todd Black, Eagle Mountain City

Evaluating an Experimental Mule Deer Antler Restriction in the Texas Panhandle

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ABSTRACT Texas Parks and Wildlife Department (TPWD) has received many requests from landowners, managers, and hunters to improve the buck age structure within the southeast Texas Panhandle in recent years. TPWD data indicated that annual, intensive mule deer buck harvest created a skewed sex ratio and an age structure inordinately weighted towards young deer in the buck segment of the population. Therefore, TPWD initiated an experimental antler restriction in six counties in the southeast Texas Panhandle from 2018-2021. The restriction prohibited the harvest of mule deer bucks with an outside

spread of the main beams less than 20 inches. The logic behind selecting the outside spread criteria (20”) was that the measurement in mature bucks is very close to the distance between ear tips when a buck is standing in the alert position. Additionally, the criteria allows accurate field judging by hunters and was predicted to protect the majority of young bucks. The primary objectives of the experimental antler restriction were to reduce excessive hunting pressure on young bucks and improve skewed sex ratios. By doing so the antler restriction also helped to improve hunter and manager satisfaction. Voluntary hunter check stations, post-season helicopter and ground surveys, and hunter and landowner opinion surveys were used by TPWD to determine if the antler restriction met the objectives of the experiment. Harvest data prior to the antler restriction (1994–2017) showed that only 33% of the mule deer bucks aged and measured by TPWD biologists were ≥5.5 years old in the southeast Texas Panhandle. During the four years of the experiment, 50% of the bucks brought to the check stations were ≥5.5 years old. From winter helicopter surveys conducted from 2005–2018 (prior to the experiment), TPWD estimated an average sex ratio of 4.7 does per buck. During the next 4 years of the experimental antler restriction, the average sex ratio was 2.9 does per buck. Harvest data collected during the experiment indicated that about 80% of bucks within young age classes (1.5–3.5-year-olds) were protected. Eighty one percent of mature bucks (≥4.5 years old) checked during the experiment met the antler restriction. Only 8% (17/212) of all mature bucks had an outside spread of the beams of 18 7/8” or less. Obviously, the antler restriction is not flawless, but all data collected during the experiment point to a marked improvement in mule deer sex ratios and buck age structure. These results demonstrate that the experiment’s objectives of managing for a more natural mule deer sex ratio and buck age structure were met using an outside spread of the main beams antler restriction set at 20”. In addition, public support for the antler restriction has been very favorable.

Tablet-Based Data Collection for Aerial Surveys: Experiences from Nevada and Washington

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ABSTRACT Composition data of ungulate populations collected during aerial surveys are highly valuable for state wildlife agencies to understand demographic trends and make effective management decisions. Although recording aerial survey data on paper has its benefits, the added step of entering it into a database may be time consuming and increases the possibility of error propagation. Data collection on mobile devices can expedite and improve data standardization, integration with databases, and inferences resulting from aerial surveys of ungulates. Nevada Department of Wildlife (NDOW) and Washington Department of Fish and Wildlife (WDFW) have adopted customized, off-the-shelf software developed by Environmental Systems Research Institute (ESRI) to improve the integrity and efficiency of data collection during surveys of mule deer, elk, and other big game species. Both agencies will provide an overview of how the software integrates with their data collection protocol for aerial surveys, including survey development, adoption by staff, learning curves, benefits, and future enhancements.

A Comparison of Camera Based and Aerial Survey Methods for Collecting Herd Composition Data

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ABSTRACT Herd composition surveys are used by wildlife managers to estimate demographic ratios, which provide insight into juvenile survival and the proportion of adult males in a population. These data are valuable for informing population management and contributing to annual population estimates. Wildlife managers have traditionally used several methods to collect these data (e.g., aerial survey, ground counts, spotlight surveys) but these methods can be expensive, come with an unacceptable level of risk, or can be inefficient for producing unbiased ratio estimates due to uneven spatial distribution of sex and age classes. We utilized three different methods of remote camera deployment to compile age and sex ratio data for mule deer in southeastern Idaho. These included cameras on migration routes, cameras placed randomly across an identified winter range, and cameras placed pseudo-randomly across an identified winter range. We compared camera-based ratios to ratio data collected from aerial surveys to compare results and effort. Our objectives were to: 1) determine the utility of different methods of camera deployment for collecting herd composition data, 2) develop a protocol for placing cameras and analyzing images, and 3) estimate the number of images, events, or cameras needed to provide an acceptable level of confidence in resulting herd composition data. Using remote cameras, we classified >10,000 individuals across three populations and six years. Comparisons between camera-based estimates and aerial survey estimates suggest that cameras are a viable means of collecting herd composition data, even when a migration corridor is not present, and may address several of the concerns with traditional methodologies.

17.49: A Community-based Conservation Effort Managing for Wildlife in Eagle Mountain City, Utah

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ABSTRACT Utah is currently one of the fastest growing states in the country, and Eagle Mountain City (EMC) is one of the fastest growing cities in Utah. Population growth results in changes to the landscape as roads are built and expanded and developments constructed to accommodate this growth. These changes have resulted in the deterioration and loss of wildlife habitat. In 1996 EMC was officially codified as a city by the State of Utah. Currently it is Utah's fourth largest city from a geographic footprint but ranks only 17th in total population. As such, over 66% of the land within the EMC boundary is currently considered open space and is either zoned as agriculture (~1% in conservation easements), public lands (Bureau of Land Management) or has an existing approved MDAs tied to it, that are yet to be developed. Since its conception the value and importance of wildlife has been a part of various planning documents, but it wasn't until recently that these were established in code. Since the passage of SO 3362, Utah has collected thousands of data points from deer and elk equipped with GPS radio transmitters. Since 2018, 46 mule deer *(Odocoileus, hemionous)* doe have been fitted with GPS radio transmitters at the south end of Lake Mountain (~6 miles south of EMC). Movements over the past few years showed several of these deer moving through EMC and to have established a well-defined route through EMC migrating from their winter range south of EMC to their summer range on the Oquirrh mountains and Camp Williams (Utah National Guard training grounds) north of EMC. Subsequently, in 2020, the UDWR approached EMC and asked for help in mitigating the further loss of habitat and migration route, in mitigating deer vehicle collisions, and to consider management actions to maintain the functional integrity of the migration route through the city. Subsequently in 2020, language for a special wildlife chapter, 17.49 "Wildlife Corridor Overlay Zone" (https://www.codepublishing.com/UT/EagleMountain/#!/html/EagleMountain17/EagleMountain174 9.html) in EMC code was drafted and passed by Council in February 2021. This chapter of code now offers a means for continued protection of wildlife and a way to implement certain conservation measures within the city. EMC continues to value wildlife as part of their life and with the hiring of their own wildlife biologist/ environmental planner will continue to look for ways to partner, to conserve, and protect wildlife and wildlife habitat into the future within its boundary.

Elk Concurrent Sessions: Predator-Prey Dynamics
May 16, 2023 / 10:30 - 11:50 am

Session Facilitator: Jesse Alston, University of Arizona

Kill Rates and Prey Composition of Mexican Gray Wolves and Cougars in New Mexico and Arizona

Samuel I. Martinez, New Mexico State University, Department of Fish Wildlife and Conservation Ecology, Las Cruces, NM 88003, USA

James W. Cain III, U.S. Geological Survey New Mexico Cooperative Fish and Wildlife Research Unit, New Mexico State University, Department of Fish Wildlife and Conservation Ecology, Las Cruces, NM 88033, USA

Nicole M. Tatman, New Mexico Department of Game and Fish, Santa Fe, NM 87507, USA

Stewart G. Liley, New Mexico Department of Game and Fish, Santa Fe, NM 87507, USA

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ABSTRACT Reintroduction of apex predators into systems where they have been absent for decades can results in strong interspecific interactions. For example, reintroduction of the gray wolves into the greater Yellowstone ecosystem resulted in increased predation on prey populations and increased competition with sympatric carnivores. Although it has been almost 25 years since the reintroduction of Mexican gray wolves *(Canis lupus baileyi)* into Arizona and New Mexico, there remains a lack of data on their influence on prey and other sympatric carnivores. Our objectives were to quantify seasonal kill and scavenging rates and prey composition of Mexican wolves and cougars (*Puma concolor)*. We used GPS cluster analysis to identify potential kill sites for Mexican wolves and cougars. We investigated 2,936 wolf clusters and 621 cougar clusters. We found prey at 668 Mexican wolf clusters and 456 carcasses were confirmed as kills with elk *(Cervus canadensis)* comprising 85%, mule deer *(Odocoileus hemionus)* 8%, and 7% other species. We located prey at 303 of the 621 cougar clusters in areas of overlapping Mexican wolf home ranges. Cougar kills were primarily classified as kills (n = 293) and consisted of 80% elk, 11% mule deer with 9% other species. The remaining 10 carcasses were scavenged by cougars. Additionally, we documented scavenging by Mexican wolves year-round, with 63% of the 212 scavenged carcasses being found during hunting seasons. Weekly kill rates will be calculated for wolves and cougars on a seasonal basis. We hope to establish accurate baseline kill rates and prey composition for recovering Mexican wolves and sympatric cougars to inform future management.

Quantifying Elk Foraging Strategies on a Multi-Predator Landscape

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ABSTRACT Predators influence prey directly by consumption and indirectly when prey alter their behavior to reduce risk. Mexican gray wolves *(Canis lupus baileyi)* have been an important component of ecosystems in New Mexico and Arizona since their reintroduction in 1998. Elk *(Cervus canadensis)* are their primary prey, but little is known about how predation risk from Mexican wolves affects behavior of elk in the region. Mountain lions *(Puma concolor)* are also a major predator of elk and there is little information on how elk balance mitigating risk of predation from both mountain lions and Mexican wolves. We observed elk across a predation risk gradient to measure the proportion of time individual elk spend foraging, their step rate while foraging, and overall herd behavior. We used GLMMs to model activity budgets and foraging behavior as functions of predation risk and habitat characteristics, biological, or temporal covariates. Preliminary models indicate that wolf risk is a major factor influencing elk behavior, but this effect varies with temporal variation in risk, forage conditions, and competition. In times and places

with high forage availability or quality, elk decrease foraging time and increase their step rate, but they decrease step rate and foraging when risk is highest. Elk may resolve this disparity in foraging time under higher risk by increasing their time spent multi-tasking with vigilance while continuing to chew food. Further modeling that includes mountain lion risk and additional observations will help to build a more complete understanding of elk foraging behavior.

Quantifying Elk Foraging Strategies on a Multi-Predator Landscape

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Elk Survival, Mortality Risk, and Mexican Wolf Recovery

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ABSTRACT Since the reintroduction of the Mexican gray wolf *(Canis lupus baileyi)* in 1998, there has been limited research estimating demographic rates of elk *(Cervus canadensis)* herds in west-central New Mexico and east-central Arizona. Within the last 4 years, there has been continued expansion and growth of the Mexican wolf population with the minimum count increasing from 131 in 2018 to 196 individuals in 2021. As the Mexican wolf population continues to recover it becomes critical to understand how elk demographic rates are responding. From 2019 to 2022, we captured and collared 897 adult female elk with Iridium-GPS collars. In addition, we captured 801 elk neonates during May and June each year. Capture locations for adult females and neonates were stratified across a risk gradient determined by home range and pack size of Mexican wolves. Using a Bayesian framework, preliminary survival probabilities for adult female elk outside of hunting season range from 0.935 to 0.948 and during hunting season range from 0.821 to 0.886. Across all years, hunter harvest was the leading mortality risk for adult elk with other common sources of mortality including mountain lion predation, wolf predation, and vehicle collisions. Survival probabilities of neonates from May to December range from 0.107 to 0.376. Neonates are predisposed to a larger diversity of mortality risks with leading causes including coyote, wolf, mountain lion, and malnutrition. Additional pending analyses will model differences in survival and cause-specific mortality rates to account for differences in spatial and temporal patterns in predation risk associated with wolf distribution on the landscape. At the conclusion of the study, our goal is to provide data that will assist in making management decisions for elk and Mexican wolves in the Southwest and contribute to our understanding of how prey species respond to a recovering apex predator.

Predation Risk from Recovering Mexican Gray Wolf Populations Influences Resource Selection and Behavior of Elk in the Southwestern United States

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ABSTRACT Non-consumptive effects of predation risk including increased vigilance and changes in habitat selection can decrease the fitness of prey through reduced foraging time, increased stress levels, and use of lower quality habitat contributing to reduced birth rates and decreased neonate survival. Our objectives were to quantify the effects of the Mexican gray wolf *(Canis lupus baileyi)* reintroduction on elk *(Cervus canadensis)* behavior and habitat selection. We fitted 866 adult female elk with GPS collars and conducted behavioral observations across areas of varying wolf densities in Arizona and New Mexico. We developed spatio-temporal predation risk indices using GPS locations of collared wolves and elk killed by wolves. We used GLMMs and step-selection functions to examine elk behavior-multitasking and relative intensity of elk habitat use, respectively, and in relation to habitat attributes, predator/prey activity, and multiple measures of predation risk. Probability of vigilance and foraging increased while the probability of resting decreased with increases in predation risk. Herd size was inversely related to the probability of vigilance by adult females. Multitasking was predominately explained by predation risk which increased the probability of multitasking. The effect of risk on elk habitat selection was variable, but across all seasons, relative use by elk was best explained by incorporating an interaction between diel period and predicted risky places. We also observed a functional response in elk habitat selection with differential responses in elk across the landscape-scale wolf density gradient. Mexican wolves were reintroduced to the wild in 1998, and are currently limited to a relatively small portion of the Southwest. Current estimated minimum population size is 241 individuals as of 2022. Future expansion of Mexican wolf population is likely to increase non-consumptive effects on elk populations. Consideration of non-consumptive effects of Mexican wolves should lead to more informed management plans for elk in the Southwest.

Deer Concurrent Sessions: Movement and Migration
May 16, 2023 / 1:00 - 3:00 pm

Session Facilitator: Orrin Duvuvuei, New Mexico Department of Game and Fish

Crossing Designs That Save Money and Time; A 2-year Summary on New Highway Escape Gates

Jessie R. T. Shallow, Idaho Fish and Game & Mule Deer Foundation, 99 HWY 93 N, Salmon, ID 83467, USA

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ABSTRACT Implementation of Idaho's State Action Plan spurred by Secretarial Order 3362 has resulted in leveraged funding opportunities to complete large-scale habitat and migration projects focused on mule deer, elk, and pronghorn while simultaneously benefiting many other wildlife species. This presentation will summarize 2-years of data from 8 camera monitoring sites documenting success of the newly designed 1-way gates which allow big game to escape the highway right-of-way when funnel fencing is present. The intent is to share the positive results and cost savings of this project for implementation on highway wildlife projects in other states. New gate design, comparison to past designs, and placement recommendations will be reviewed during the presentation. The success of these newly designed gates may lead to an alternative to jump-out ramps in highway funnel fence sections. Species in Idaho that have benefited from the innovative highway-escape-gates include white-tailed deer, mule deer, and mountain lions. The design and installation of these gates were made possible by funding from NFWF's Western Big Game Seasonal Habitat and Migration Corridors Fund.

Using Mule Deer Movement Data to Determine Fawning, Peak Rut, and Mate Search Strategy

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ABSTRACT Cervid species are highly social, with both sexes occupying the same areas, leading to male competition and varying search strategies for females. For example, white-tailed deer (*Odocoileus virginianus)* use single female tending where males frequently check female receptiveness; however, elk

(Cervus canadensis) employ a harem strategy where a male defends a female group until they reach estrus. Little is known about mule deer *(Odocoileus hemionus)* reproductive behavior and anecdotal information suggests a wide array of mate search strategies. Our objectives were to assess mule deer reproductive behavior and search strategy using location data. We collared 77 adult (>1 year old) female and 69 adult male mule deer across three sites in the Texas Panhandle. We used female step length to identify fawning dates and back dated by gestation length (203 days) to determine conception date. We delineated 14-day periods of pre- rut, early-rut, peak-rut, late-rut, and post-rut. We created assessment corridors to determine the proportion of a male's home range searched. Depending on site, peak fawning date ranged June 25th –July 22nd and average conception dates December 3rd – December 30th. Male space use was greatest during peak-rut with ≥2-year-old males occupying 9.9km2 (SD ± 6.1) whereas yearlings occupied a lesser 3.8km2 (SD ± 5.9). Search intensity was greatest during early and peak-rut and did not differ by age class where males searched 46% of their home range. Our study is the first to use location data to explicitly investigate the reproductive strategy of mule deer. Wildlife managers can use location data to evaluate site-specific timing of fawning and rut, which we found to vary, and evaluate the scale of harvest management by quantifying male movement during the rut. Understanding movement characteristics during the reproductive cycle will aid in future management planning and mitigation with stakeholders during harvest seasons.

Migration Corridor Estimation: Current Best Practices and Future Directions

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ABSTRACT Many deer and elk populations across the western United States are migratory, and improved animal tracking and remote sensing technology has greatly enhanced managers' knowledge of these migrations and their ability to manage the animals that undertake them. Identifying and mapping migration corridors has thus become an important tool for management of deer and elk. In order to best manage migratory animals, it is vital for managers to understand the conceptual foundations of the statistical techniques we use to map migration corridors. In this talk, we describe how occurrence estimators like Brownian bridge movement models work, outline their strengths and weaknesses, and discuss potential pathways toward improved corridor estimation, such as incorporating information on resource selection and more realistic movement models, as well as using different classes of estimators that enable prediction. We hope that this presentation helps managers to better understand current best practices while also encouraging them to think bigger about the potential for better statistical methods to assist them in solving ongoing management challenges related to elk and deer migration.

Stopover Ecology: How to Parsimoniously Decrease Type-1 and Type-2 Errors for Migrating Ungulates in Idaho

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ABSTRACT Ungulate migrations in the western United States have seen a greater conservation interest since DOI SO 3362 implemented and sustained across executive administrations. Although, stopovers are recognized as a critical structure apparent in functional ungulate migrations, the methodology to identify these important areas has not received proportional interest. We develop a more parsimonious methodology to identify stopovers using individual ungulate's rate of movement (lowest 10%), and duration of this slow movement (>12 hrs) to identify these areas of migration. Using the lower rate of movement, spatial variance of these locations is used to identify stopover area's utilized distribution within an individual's migratory path. The stopover locations are combined across a winter herd where comparisons are made at the individual and population level in Idaho for elk *(Cervus canadensis)* and mule deer *(Odocoileus hemionus)* to established stopover methodology. We compare results of the time-duration methodology to prevalent ungulate stopover identification methods at individual and population levels (winter herd). For mule deer at an individual level, type-1 errors in established techniques occur 7% (i.e. false positive) and type-2 errors (false negatives) did not identify 71% of stopovers. At a winter herd level, type-1 errors occurred at a rate of 48% and type-2 errors missed 40% of stopover. For elk at the individual level, type-1 errors occurred at a rate of 2% but type-2 errors resulted in missing 91% of the stopovers used by single elk. At a winter herd level, type-1 errors increased to 4% and type-2 errors did not identify 58% of the stopovers used. We explore the roots of the differences that occurred between the two methodologies, levels of analysis (individual vs winter herd), and species. Prevalent causes for these errors in identification come from, spatial variance calculations, distance of the stopover from the initial wintering range, and calculation within population level analyses.

Resource Selection Response of Mule Deer to Changing Densities of an Interspecific Competitor

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ABSTRACT Periodic declines in mule deer *(Odocoileus hemionus)* populations across much of their range in recent decades garnered much interest from federal and state wildlife agencies. Interactions with interspecific competitors rank among competing hypotheses formulated to explain these declines. We evaluated resource selection of sympatric mule deer and elk *(Cervus canadensis)* populations from 2016-2021 on the Starkey Experimental Forest and Range in northeastern Oregon. Our objective was to assess the degree to which mule deer compete with elk for resources when elk are at high and low densities. We experimentally reduced the density of elk to assess the effects of varied levels of interspecific competition with mule deer. We evaluated resource selection by mule deer and elk using a Random Forest machine-learning approach. We used these models to map the probability of use by each species before and after the reduction. We then performed a moving window correlation analysis of mule deer and elk predictive maps to assess the degree of overlap or separation of the species at varied elk densities. We observed a shift from strong spatial separation at high elk densities to an increased degree of overlap following the experimental elk reduction. Our results suggest that at high densities, elk outcompete mule deer and exclude them from resources. Further, increased overlap of predicted space use at low elk densities suggests that decreased interspecific competition may allow mule deer to access higher quality resources.

Temporal Variation in Resources Influences Offspring Quality of White-tailed Deer in a Semi-arid Environment

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ABSTRACT Timing of resource availability has important implications for population performance. Resource availability relative to consumer requirement influences the consumer's ability to acquire nutrients as energetic demands fluctuate. Temporal variation matters for wildlife; however, the period when it matters most remains unknown. Therefore, we determined the biological period at which rainfall was most predictive of offspring quality. We used rainfall as our environmental variable because it varies greatly and directly affects plant growth. We used white-tailed deer *(Odocoileus virginianus)* as a model species and offspring body mass as a proxy for quality, as mass is correlated with survival and time to primiparity. We captured 480 fawns and 571 1.5-year-olds in the fall at four sites in South Texas from 2011 to 2021. We assigned precipitation data from seven biological seasons we hypothesized would affect mass to each deer record. We used linear mixed-effects models to identify the period when rainfall was most predictive of mass. Rainfall in the early growing season (April), approximately three months prior to birth of fawns, had the greatest effect on deer mass. For every ten cm increase in rainfall, fawn body mass increased by 2.17 kg (P=0.01) and yearling body mass increased by 2.88 kg (P = 0.04). Our results demonstrate that offspring quality is most affected by rainfall in seasons relevant to plant phenology rather than rainfall in seasons relevant to reproductive chronology. Therefore, when assessing how temporal variation in resources influences population performance, managers should consider multiple trophic levels to fully capture this process.

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Elk Concurrent Sessions: Movement and Migration
May 16, 2023 / 1:00 - 3:00 pm

Session Facilitator: Scott Sprague, Arizona Game and Fish Department

Modeling Elk Parturition Habitat in Idaho Using Movement Patterns of Adult Females

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ABSTRACT Understanding where and when elk give birth is important to reduce anthropogenic impacts during calving periods and for managing habitat to meet population objectives. A common approach to develop this understanding is via resource selection functions (RSFs) built from observed calving locations and vaginal implant transmitters (VITs) is a proven technology for obtaining these locations. However, this approach is logistically difficult, costly, and involves a substantial time commitment from field personnel. We used an alternative approach based on the movement patterns of adult females to infer calving locations. We used GPS location data of 1,091 female elk from 2007-2020 and associated movement patterns to identify putative parturition locations. We estimated parameters of RSFs for 6 populations at 2 scales: a broad-scale analysis to determine the characteristics within the general area that elk chose and a local-scale analysis that considered habitat characteristics in the immediate vicinity of the parturition site. We identified 314 partition events with most (64%) occurring during the last week of May through the first week of June (mean parturition date was 2 June). Most of the best models for predicting calving habitat at the broad scale contained covariates related to cover type, elevation, distance to snow, and slope. At the local scale, there were few covariates that were consistently in the top model across populations beyond the cover type and distance to developed areas. Our models performed well based on measures of sensitivity (i.e., model predicted habitat where parturition sites occurred) and specificity (i.e., model predicted non-habitat where parturition sites did not occur). By utilizing an extensive dataset on female elk locations not originally intended for this purpose, we were able to predict calving habitat across the state with comparable far fewer resources than it would have taken based on traditional approaches.

Crossing Designs That Save Money and Time: A 2-year Summary on Woven-wire Fence Gaps for Big Game

Jessie R. T. Shallow, Idaho Fish and Game & Mule Deer Foundation, 99 HWY 93 N, Salmon, ID 83467, USA

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ABSTRACT The Idaho Department of Fish and Game (IDFG) developed its first State Action Plan in 2018. The Idaho State Action Plan brought more partners and funding to the table with better collective focus on actions to enhance habitat for big game. Implementation of the State Action Plan has resulted in several voluntary large-scale habitat and migration route projects focused on mule deer, elk, and pronghorn while simultaneously benefiting many other wildlife species in Idaho. This presentation will summarize the

results of an innovative fence gap project in Idaho made possible by Secretarial Order3362. The intent is to share the positive results, design specifications, and cost savings of these projects for implementation on woven-wire fence conversion projects aimed at maintaining big game migrations. The summary will include 2- years of data from 23 camera monitoring sites on woven-wire fence conversions. The location of the project was prioritized based on documented elk and pronghorn migrations in the Lemhi Priority Area. Partners involved in the project are Mule Deer Foundation, Partners for Fish and Wildlife, and Idaho Department of Fish and Game. Big game species that have benefited from the innovative crossings include elk, moose, pronghorn, white-tailed deer, and mule deer.

Survey Design Implications for Camera Trap Density Estimates on Trail and Road Networks

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ABSTRACT There is ongoing debate surrounding appropriate camera trap survey designs when estimating densities of a species that travel along game trails or other linear features (e.g., roads, railways). This is especially of interest when conducting surveys of a rare species where most, if not all, camera captures occur along trails. Random survey designs are typically used as camera trap placement strategies; however, random sampling may not provide sufficient camera captures for accurate density estimates. In this talk, we investigate a variety of survey designs using individual-based models that simulate animal movement with selective bias towards game trails to understand the implications for different camera placements on density estimates. Simulated camera trap data is collected to inform three camera trap models that use encounter, count, and staying time information of unmarked individuals to estimate population densities. We find that random sample designs and camera placements proportional to available landscape types produce non-biased density estimates whereas increasing the number of cameras on game trails creates biases that reflect animal space use. Additionally, these biased estimates remain when rare species captures only occur on game trails, implying that density estimates of non-random survey designs are biased according to animal space use. In other words, survey designs biased towards game trails will overestimate densities when animals spend more time on trails than off trails and underestimate densities when animals spend less time on trails than off trails. This work begins to understand the relationship between animal space use, survey designs, and camera trap models, and provides support for random sampling as a reliable strategy for unbiased density estimates.

Summer Elk Calf Survival in a Partially Migratory Population

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ABSTRACT Decomposing variation in juvenile recruitment is a key component of understanding population dynamics for partially migratory ungulates. We investigated reproductive parameters of adult elk (Cervus canadensis) with calves at heel, and survivorship, cause-specific mortality, and intrinsic and extrinsic factors affecting risk of mortality for calves in a partially migratory elk population from 2013–2016 in Alberta, Canada. Elk calves born to resident mothers had 45% lower survivorship on average compared to migrant calves (0.24 vs. 0.69) and nearly twice the mortality rate (0.37 vs. 0.19) from bears (Ursus spp.), the dominant source of mortality. Contrary to our predictions, we found that increasing levels of maternal ingesta-free body fat were associated with increasing risk of calf mortality, indicating predation may have overwhelmed nutritional effects. We found no evidence that timing of calf birth or birth weight differed between migratory tactics or influenced mortality risk. We found that as percentage of cut forest increased, risk of calf mortality marginally decreased, which benefited migrant elk that were exposed to more clearcuts compared to residents. Exposure to bear predation risk was unimportant during the hiding phase (≤10 days after birth) for either migratory tactic, presumably because neonatal hiding behavior reduced vulnerability. In contrast, the risk of mortality from bears increased after 10 days in age, especially for resident elk calves, which were exposed to higher bear predation risk compared to migrants. We conclude that relative differences in bear predation between migratory tactics are contributing to the dynamics of partial migration in this population through additive effects on calf mortality. Thus, wildlife managers should anticipate that recovering grizzly bear (U. arctos) populations may substantially lower elk recruitment through effects on summer calf survival, especially in areas with diverse carnivore assemblages.

Male Elk Survival, Vulnerability and Antler Size in a Transboundary Partially Migratory Elk Population

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ABSTRACT Migration is a behavioral strategy used to access resources and/or avoid predation to

attain higher fitness. Although migration can expose animals to differential harvest, few studies have addressed the costs and benefits of migration for males especially where large carnivores are present. We investigated how male elk survival and antler size were influenced by age and forage quality in a transboundary, partially migratory population in a multi-carnivore system in the Ya Ha Tinda elk population in Alberta, Canada. Recreational harvest was managed through a 6-point Antler Point Restriction (APR) harvest, and year-round treaty First Nation harvest. We captured and tracked 82 adult male elk aged > 2 years of age that followed 3 migratory tactics (resident, east-, west-migrant) for cause-specific mortality 2018 – 2020 and measured antler size. Male elk mortality was primarily due to hunter harvest with a third of it being First Nation harvest, whereas non-harvest mortality was low. Six-point antler-point-restrictions resulted in low yearly survival rates for male elk over 4 years of age with 6 or more antler points. Risk of harvest was higher closer to roads increasing by 20% for every 1-km. Antler size was largely a non-linear function of age, though migratory male elk had larger antlers with the biological effect similar to the difference in size predicted between 5- and 6-year-old animals. This difference could perhaps be due to exposure to higher quality forage afforded by migration. Despite being exposed to multiple large carnivores, harvest by both licensed hunters under a 6- point APR and First Nations drove male elk survival and mortality hazard similar to populations with no large carnivores. These results show harvest drives male elk age structure, and hence antler size, even in carnivore-rich, transboundary systems.

Deer Concurrent Sessions: Habitat Changes
May 16, 2023 / 3:30 - 4:50 pm

Session Facilitator: Jackson Miller, Arizona Game and Fish Department

Novel Modeling Approach Connects Habitat Quality to Mule Deer Population Performance

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ABSTRACT Habitat quality may be an underlying factor driving or exacerbating mule deer *(Odocoileus hemionus)* population declines across their range and concurrent white-tailed deer *(Odocoileus virginianus)* population increases. However, understanding what constitutes high quality habitat for mule deer and white-tailed deer is challenging, due to limitations of technology, sample size, and analytical frameworks. We developed a Bayesian hierarchical model that uses observed GPS locations and survival state (alive/dead), to model the unobservable probability of survival as it changes with habitat use. Our cumulative autoregressive model quantifies the effect of different resource quantities and qualities on an individual's survival probability over time. Leveraging one of the largest existing long-term datasets of GPS collared

mule deer and white-tailed deer, we applied the newly developed model to measure habitat quality through different resources' effects on survival. Over three years, we estimated survival and habitat quality for adult females and juveniles of both species. Juvenile deer had more variation than adults in their responses to elevation, slope, drought, perennial forbs and grasses, annual forbs and grasses, and shrubs. Juvenile mule deer had the strongest responses to habitat variables of any group, showing increased survival in areas of higher elevation, lower slope, more shrubs, and less production of annual forbs and grasses. The new model gave inference into long-term effects of habitat on individual survival, thereby connecting habitat quality to an important metric of population performance. Predictive maps of habitat quality will help managers highlight areas of conservation priority for mule deer.

Plant and Mule Deer Responses to Pinyon-Juniper Removal by Three Mechanical Methods

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ABSTRACT Land managers in western North America often reverse succession by removing pinyon *(Pinus sp.)* and juniper *(Juniperus sp.)* trees to reduce fire risk and increase forage for wildlife and livestock. Because prescribed fire carries inherent risks, mechanical methods such as chaining, roller-chopping, and mastication are often used. Mechanical methods differ in cost and the size of woody debris produced and may also differ in plant and animal responses. We implemented a randomized, complete-block, split-plot experiment in December 2011 in the Piceance Basin, northwestern Colorado, USA, to compare mechanical methods and to explore seeding (subplot) interactions. We assessed plants 1-, 2-, 5-, and 6-years post-treatment, and mule deer *(Odocoileus hemionus)* response via GPS locations 3–8 years post-treatment. By 2016, treated plots had 3-5 times higher perennial grass cover and ~10 times higher cheatgrass *(Bromus tectorum)* cover than untreated control plots. Roller-chopped plots had both the highest non-native annual forb cover, and when seeded, the highest density of bitterbrush *(Purshia tridentata)*, a nutritious shrub used by mule deer. Masticated plots had higher bitterbrush use during summer/fall, leaving less forage available for winter. Days of winter mule deer use from GPS point detections in chained and roller-chopped plots was ~70% higher than in control plots, while winter use in masticated plots was similar to control plots. Mule deer use appears related to a combination of relative hiding cover, resulting from residual woody debris, and winter forage availability. Roller-chopped plots provide the best combination of hiding cover and winter forage, but mastication or chaining, applied leaving dispersed security cover, may be better options at large scales when invasive species concerns exist.

Restoring Cheatgrass Invaded Rangeland Decreases Wildfire Risk and Improves Wildlife Browse and Habitat

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ABSTRACT Invasive winter annual grasses such as cheatgrass, medusahead, and ventenata continue to spread at an alarming rate. These invasive species are one of the largest threats to western rangeland, and the wildlife that depend on these shrubland communities for survival. The fine-fuels that accumulate from annual grasses significantly alter the fire regime by increasing wildfire frequency, and facilitating the conversion to invasive annual grass monocultures. Hundreds of wildlife species across 14 states are dependent on intact shrub communities such as sage-grouse, mule deer, pronghorn, and elk; however, once these sites convert to invasive grass monocultures, it is nearly impossible to restore these critical shrub-dominated plant communities. The objectives of this study were to 1) evaluate a new tool, Rejuvra, for long-term invasive annual grass control, 2) determine the impact of cheatgrass on critical winter range shrub species, and 3) evaluate the decrease in fine-fuels associated with wildfire and response of the native plant communities after cheatgrass control. Sites for this study were selected in Boulder County, CO and Sublette County, WY. These sites include lowland, foothills and mountains of Colorado and Wyoming that provide critical overwintering habitat for mule deer, elk, and other wildlife. A major concern of ecologists and wildlife biologists in these areas is the loss of critical wildlife habitat areas due to cheatgrass-fueled wildfires. In winter 2017 and 2018, six sites were treated with Rejuvra plus glyphosate, while desirable shrub species were in dormancy and no leaves were present. These sites were 2 to 20 acres in size with dense stands of mountain mahogany, four-lobed sumac, antelope bitterbrush, winterfat, rubber rabbitbrush, four-winged saltbush, and fringed sage. Permanent random transects (3 X 200') were created inside cheatgrass-treated, and immediately adjacent, non-treated plots. Data collection included line intercept canopy cover for cheatgrass and all desirable perennial vegetation. In addition, biomass was collected for all species including cheatgrass litter to determine fine-fuel weights in treated vs. non-treated plots. This provided an indication of how quickly cheatgrass fine-fuel litter degrades after Rejuvra treatments. Shrub measurements including longest leader growth were collected along the entirety of the transect.
Data were collected over two consecutive summers, at approximately 8 and 20 months after treatment. The first summer after application, cheatgrass litter biomass averaged 935 lb/A in non- treated areas compared to 82 lb/A in treated areas, a 92% degradation of cheatgrass litter in areas treated with Rejuvra. By the second summer after application, cheatgrass litter had completely degraded on Rejuvra treated sites. Perennial grass at the sites responded positively to the treatments, with an average 5x increase in biomass by 20 MAT. New growth measurements on shrubs spanning the transect lines revealed increased leader growth and shrub canopy volume in the treated areas for all seven shrub species evaluated. New leader growth was 1.5x to 2.8x longer on shrubs in areas treated for cheatgrass compared to non-treated areas, while shrub canopy volume increased 120% to 400% with cheatgrass treatments. This research suggests that Rejuvra could be a useful tool in wildlife habitat improvement projects on invasive winter annual grass dominated sites.

Age-specific Survival of Female and Male Mule Deer in Utah, USA

Randy T. Larsen, Brigham Young University, Provo UT 84602, USA

Madelon van de Kerk, Western Colorado University, Gunnison CO 81231, USA

Kent R. Hersey, Utah Division of Wildlife Resources, Salt Lake City UT 84114, USA

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ABSTRACT Accurate estimates of demographic rates such as survival are needed to understand population dynamics. Our objective was to estimate age- and sex-specific survival of mule deer in Utah, USA. We captured 2977 mule deer between 2014 and 2019 and fitted them with GPS collars. Using Cox proportional hazard regression and model selection, we then estimated survival rates for these marked deer. We examined the effects of age and sex on survival, while accounting for the influence of a variety of other covariates. Fawn survival averaged 0.52 (95% CI: 0.45 – 0.60) for females and 0.66 (95% CI 0.55–0.79) for males. For adults, annual survival averaged 0.76 (95% CI 0.75 – 0.78) for females and 0.73 (95% CI 0.70 – 0.77) for males. Survival rates for both sexes varied by age, with survival highest (0.83; 95% CI 0.81-0.84) for prime-aged females (2.5-7.5 years old), and lower for younger and older individuals as well as males. Surprisingly, survival of yearling (the year from 1.5 to 2.5 years of age) females was nearly as low (0.59; 95% CI 0.56 to 0.63) as that of fawns. For yearling males, annual survival excluding harvest was estimated at only 0.48 (95% CI 0.39 to 0.57). Both sexes experienced a negative effect of latitude on survival, and female survival was positively affected by chest girth and ingesta-free body fat (IFBF). Such low survival of yearlings has not been previously reported with this species and has implications for population models (yearlings are typically simply grouped with other adults) and harvest strategies. Additional research is needed to identify causes of mortalities and the underlying drivers of variation in survival rates.

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on survival, and female survival was positively affected by chest girth and ingesta-free body fat (IFBF). Such low survival of yearlings has not been previously reported with this species and has implications for population models (yearlings are typically simply grouped with other adults) and harvest strategies. Additional research is needed to identify causes of mortalities and the underlying drivers of variation in survival rates.

Elk Concurrent Sessions: Elk and Deer Management
May 16, 2023 / 3:30 - 4:50 pm

Session Facilitator: Callie Cavalcant, Arizona Game and Fish Department

Estimating Ungulate Density with Camera Traps: An Overview of IDFG's Efforts to Date

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Jon Horne, Idaho Department of Fish and Game, 600 S Walnut Street, Boise, ID 83712, USA

Mark Hurley, Idaho Department of Fish and Game, 600 S Walnut Street, Boise, ID 83712, USA

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ABSTRACT Since 2018, Idaho Department of Fish and Game has implemented several large- scale camera trap deployments with the goal of estimating abundance of unmarked wildlife populations. To date, we have primarily focused on testing the applicability of the space-to-event (STE) and instantaneous sampling (IS) models described by Moeller et al. (2018). In early trials, we deployed unique camera arrays to estimate abundance of a single ungulate species on winter range, often using a resource selection function developed from winter GPS-collar data to inform camera distribution. Across one winter camera deployment for mule deer, two for elk, and one for moose, we had mixed results suggesting the method had potential, but logistics associated with winter estimation were limiting its potential (e.g., misalignment between camera array and animal distribution due to changes in winter severity, lack of moose detections due to restricted winter movement). We also wanted to increase efficiency by looking toward multispecies estimation with a single camera array. Given there were obvious limitations for multispecies estimation during winter, we continued our testing with camera arrays designed to produce concurrent multispecies estimates by deploying cameras during summer across entire IDFG Game Management Units (GMU). Most of our multispecies estimation efforts have been focused in GMUs 1, 6, and 10A in north Idaho, areas dominated by coniferous forest that make aerial surveys difficult. In 2021, estimates of summer (July–August) density ranged from 7–9 deer/km2 (17–23 deer/mi2), 2–6 elk/km2 (4–15 elk/mi2), and 0.1–0.6 moose/km2 (0.2–1.5 moose/mi2) depending on GMU and model used. The STE and IS summer density estimates were similar in most GMU/species combinations, with IS point estimates usually being slightly higher than STE point estimates. Both models seem capable of producing reasonable ungulate density estimates from a summer camera array designed for multispecies estimation.

Residual Costs of Reproduction in Elk *(Cervus canadensis)*

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ABSTRACT Residual costs of reproduction are predicted by life-history theories of aging. More specifically, energy that is allocated to current reproduction should have a “cost” to the energy available for physiological maintenance or reproduction later in life. Empirical support for the idea of residual costs of reproduction in ungulates is limited. Examinations of the relationship between previous reproductive effort and future reproductive output are uncommon and often limited to successive years only. We examined the potential effects of pregnancy status, lactation duration, and age of elk *(Cervus canadensis)* in Utah, USA from 2019-2022 to better understand the relationship between previous reproductive effort and future reproductive output, particularly in non-successive years. Pregnancy status 1 year prior, pregnancy status 2 years prior, and age had no effect on the likelihood of pregnancy in elk. However, lactation duration in prior years had a negative effect on the likelihood of pregnancy, and the best-fitting model to explain the relationship between pregnancy status and previous lactation was the interaction between lactation duration 1 year prior and lactation duration 2 years prior. The results of our study suggest long-lasting (i.e., multiple year), residual costs of reproduction can influence reproductive output in female elk.

Mapping Big Game Migrations Across the Western States: Science Support for Management and Conservation

Blake Lowrey, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071, USA

Jerod A. Merkle, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071, USA

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Matthew J. Kauffman, U.S. Geological Survey, Wyoming Cooperative Fish and Wildlife Research Unit, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071, USA

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ABSTRACT Ungulates play an important role in ecosystem function while providing economic benefits to regional communities through tourism and hunting. Across the western U.S., many ungulate populations undertake seasonal migrations to exploit spatially and temporally variable resources and to avoid deep snow, predation, or other threats. Wildlife management agencies across the western U.S. have worked to identify, protect, or enhance ungulate migration corridors and seasonal ranges. These efforts garnered additional support through the U.S. Department of the Interior Secretarial Order (SO) 3362, which provides federal support for enhancing habitat quality of big-game winter ranges and migration corridors across the western states. Additionally, SO 3362 prompted the U.S. Geological Survey (USGS) to establish the Corridor Mapping Team (CMT): a collaboration between USGS and participating state, tribal, and federal wildlife management agencies. To date, the CMT has analyzed and mapped the migrations of 152 ungulate herds across the western U.S. Migration maps are published in the Ungulate Migrations of the Western United States report series and many of the map layers are also made available through the ScienceBase data archive of USGS and a public web map viewer. Collectively these mapping products serve as a regional map-based inventory of documented ungulate migrations. To help standardize migration mapping across the western U.S., the CMT additionally develops novel tools to aid in mapping migrations. In addition to summarizing successes of the CMT, our presentation will detail two recent tools, the release of Migration Mapper 3.0 and the line-buffer approach to defining migration corridors, which both provide flexibility to states and tribes in their analysis and mapping of diverse migration data sets. Through strong collaboration among states, tribes and federal partners, best science and management approaches are emerging that have advanced how migrations in the changing American West are mapped, managed, and conserved.

Field Trip Plenary - Panel
May 17, 2023 / 8:00 - 9:40 am

Session Facilitator: Casey Stemler, U.S. Fish and Wildlife Service

Migration Mapping Focuses Conservation Planning

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Jeff Gagnon, Arizona Game and Fish Department, 5000 W. Carefree Hwy, Phoenix, AZ 85086, USA

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ABSTRACT: Ungulate migrations are important for ecosystems but are at risk. In the western United States, the function of ungulate migrations is of concern among rapid expansion of transportation infrastructure, canals, fences, pipelines, energy development, and housing development. These anthropogenic features often overlap with ungulate habitat, causing loss and fragmentation of migration corridors and seasonal range. The importance of migrations for ungulate populations has stressed urgency for widespread migration mapping for conservation planning. In 2018 the US Secretary of the Interior signed SO3362 prioritizing migration conservation in the west. Following this, the U.S. Geological Survey assembled a Corridor Mapping Team (CMT) to provide technical assistance to western states working

to map bison, elk, moose, mule deer, and pronghorn migrations using Global Positioning System (GPS) tracking data. Led by the Wyoming Cooperative Fish and Wildlife Research Unit, the CMT has developed standardized analytical and computational methods and allow for population-level migration corridors and stopovers to be mapped using ungulate GPS data. Since 2020, the team has released 3 volumes of a report titled 'Ungulate migrations of the western United States' which has included maps of corridors, stopovers, routes and winter ranges throughout western states. Using mapped migration habitats, state and federal transportation officials, land and wildlife managers, planners, and other conservationists can consider conservation opportunities using a focused approach. For example, the Arizona Game and Fish Department (AZGFD) and partners have been using mapped migration corridors for elk and mule deer throughout Arizona to aid in the planning process of transportation infrastructure and renewable energy development. Such planning will allow corridors to remain functional and keep seasonal ranges connected. Linking GPS tracking data to migration maps is a key step in conservation planning. An emphasis on migration mapping will help ensure that migratory ungulate populations continue to be taken into consideration.

Efforts to Mitigate Habitat Fragmentation and Wildlife-Vehicle Collisions Along Two Interstates in Northern Arizona

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ABSTRACT Roads are a significant source of mortality and habitat fragmentation for most wildlife species and interstates are especially problematic because of vehicle speeds and large vehicles. Arizona Game and Fish Department (AZGFD) and Arizona Department of Transportation (ADOT) identified northern Arizona's Interstate-17 (I-17) and Interstate-40 (I-40) as priority roadways for wildlife-vehicle collision (WVC) and habitat fragmentation mitigation. From 2007 through 2012, an AZGFD and ADOT collaborated on studies along I-17 from mileposts 306-340 and I-40 from mileposts 165-220. These studies used WVC data, telemetry data, topography, spacing, and land ownership to identify WVC mitigation options. During these studies AZGFD documented a combined 200 elk and deer-vehicle collisions per year and an elk passage rate of 0.09 crossings/approach for elk that approached within 250 meters of I-17 and I-40. Ultimately, 70% of all collared elk that approached I-17 or I-40 did not cross. Although data from the I-17 and I-40 studies were used to prioritize wildlife crossing locations, the projects were delayed due to unavailability of funding. During the delay, AZGFD collected additional telemetry data (partially funded by SO3362) and ADOT conducted a WVC hotspot study that further supported the need for safe wildlife movements across I-17 and I-40. In June of 2022, with the incorporation of this additional information and lessons learned from other successful mitigation projects (e.g. State Route 260), AZGFD and ADOT, with USDA Forest Service support, initiated the design of three wildlife overpasses (two on I-17 and one on I-40). The goal of this design effort is to produce 30% complete design plans and estimate construction costs. These 30% plans and estimated costs will strengthen ADOT applications when applying for highly competitive future funding opportunities, such as the Infrastructure Investment and Jobs Act's Wildlife Crossing Pilot Program. As design ensues, AZGFD is working with the Rocky Mountain Elk Foundation, Kaibab National Forest, and The Nature Conservancy to prepare the I-40 overpass site through habitat restoration efforts. The I-40 overpass site will be on the 2023 Deer and Elk Workshop field trip itinerary.

Addressing the Potential Movement Implications of a Novel Interstate Highway

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ABSTRACT The North American Free Trade Agreement designated the CANAMEX Corridor – a network of transportation improvements to promote connectivity. Over the last 3 decades legislators and reports have refined the vision, including identification of Future Interstate-11 (I- 11). The I-11 & Intermountain West Corridor Study recommended upgrading existing roadways to interstate specifications and constructing novel segments to address infrastructure gaps. Without wildlife accommodations, habitat fragmentation from expansive upgrades and new roadway would undermine wildlife persistence. Overlap with mule deer *(Odocoileus hemionus)* habitat suggested expansive areas of conflict best addressed using unavailable mule deer movement datasets to focus accommodations. Arizona Game and Fish Department (AZGFD) participated in the development of the 2021 I-11 Corridor Tier 1 Environmental Impact Statement (EIS). That EIS included a commitment to address wildlife movement knowledge gaps to inform Tier 2 analysis and design. Concurrent with the Tier 1 process, the 2018 Arizona State Action Plan (AZSAP) for Secretarial Order 3362 (SO3362) listed the Proposed Path of a New Interstate 11 as Arizona's top research need. Resulting funding allowed AZGFD to deploy 60 GPS collars on mule deer across three new-roadway areas of interest. The 2019 AZSAP identified the need to evaluate and refine mule deer linkage models across two potential segments of I-11 likely to manifest as existing infrastructure upgrades. AZGFD deployed 40 GPS collars on mule deer across those areas. Using Brownian Bridge movement models, AZGFD identified important movement patterns that inform landscape needs to maintain permeability of mule deer and other wildlife. As the recently funded Tier 2 EIS process begins for I-11, we are working to build out the AZGFD movement dataset into a more robust and even coverage of the target area so that designs can incorporate the most valuable and effective accommodation extents.

Migration Mapper Integration into Future Planning: Case Study CO Bar Ranch Renewable Energy Projects

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ABSTRACT Migration mapper and previous telemetry research have illustrated an important seasonal wildlife corridor that deer use between the San Francisco Peaks in Flagstaff and the Grand Canyon. The CO Bar Ranch is in the heart of this wildlife corridor and has a long history of conservation stewardship and enhancing wildlife habitat, while simultaneously using these same lands for diverse economic and recreational multi-use benefits. The most current example of CO Bar's multi-use land ethic is maintaining this important wildlife corridor while also providing the Flagstaff community with local renewable energy options (wind and solar energy). CO Bar's upcoming solar energy development project provides an excellent case study of how wildlife migration data is being used in the planning and site placement of renewable energy infrastructure. This project has the potential to develop portions of up to 22 land sections with solar panels and associated fencing that will be implemented over three phases. Early in the development of this project, CO Bar and the solar energy contractor reached out to the Arizona Game

and Fish Department (AZGFD) for strategies to minimize wildlife impacts from this project. This early partnering and coordination over several years has ultimately led to improving the placement of fencing and incorporating ¼ and ½ mile gaps between land sections of high conservation value to maintain this important wildlife corridor. CO Bar and the solar energy contractor have voluntarily implemented these recommendations and continue to partner with AZGFD as this project moves into the implementation phases in 2023. Continued telemetry studies in this location will allow an evaluation of the success of these wildlife mitigation components and will further assist adaptive management strategies to fine tune the site placement of critical solar infrastructure in each successive phase of development of this project and inform future renewable energy projects.

How a Landscape-Scale Conservation Program Includes: Renewable Energy, Fire, Drought, Migration and Movement, and Recreational Impacts

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ABSTRACT From the Pioneer Age to the Space Age, Babbitt Ranches has forged a land-use ethic that has guided the land company for 137 years. With a philosophy of participation and an understanding that land management is both art and science, Babbitt Ranches has held tight to its values of responsibility and accountability, emphasizing that relationships are key in all endeavors, with family business, community, and the land itself. Decisions are grounded in a multiple bottom line principle that considers what's best for the organization, ecological processes, regional economy, and community, which includes the nation and planet for generations to come. This visionary philosophy explains why Babbitt Ranches installed anemometers 20 years ago to test the strength and consistency of wind as a potential source of renewable energy, while studying migration corridors of deer and pronghorn antelope. It's why the benefits and destruction of wildfire were discussed on a hillside with Forest Service officials as the 2021 Slate Fire burned toward Cedar Ranch's historic buildings. It's why Babbitt Ranches filled a water tanker daily, dispersing millions of gallons of water for two years across the 750,000-acre ranch for livestock and wildlife during the most extreme drought in documented history. It's why Babbitt Ranches has been a champion for deer and pronghorn, working with the Arizona Game and Fish Department since the 1990s to study their migration and movement; and, why hundreds of acres were cleared of encroaching piñon and juniper trees for these grassland species. It's also why the SP Crater Golden Eagle Conservation Complex is hailed as a national model, the result of years of research, demonstrating how to protect a struggling species as recreational demands soar on public and private lands. Babbitt Ranches proposes this plenary abstract as a participant and witness to Changing Landscapes since 1886.

Deer Concurrent Sessions: Movement and Migration
May 18, 2023 / 8:00 - 10:00 am

Session Facilitator: Levi Heffelfinger, Caesar Kleberg Wildlife Research Institute

Natal Range Dispersal and Exploratory Movements of Juvenile Mule Deer: Informing Chronic Wasting Disease Management

Calvin C. Ellis, Caesar Kleberg Wildlife Research Institute, Texas A&M University–Kingsville, Kingsville, TX 78363, USA

Michael J. Cherry, Caesar Kleberg Wildlife Research Institute, Texas A&M University– Kingsville, Kingsville, TX 78363, USA

Shawn S. Gray, Texas Parks and Wildlife Department, Alpine, TX 79830, USA

David G. Hewitt - Caesar Kleberg Wildlife Research Institute, Texas A&M University– Kingsville, Kingsville, TX 78363, USA

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ABSTRACT Dispersal lies at the heart of many ecological and evolutionary processes including metapopulation dynamics, gene flow, and disease epidemiology yet is poorly understood for many systems. Animal movement in unfamiliar landscapes may differ from movement within the home range and understanding how movement changes during excursions outside of the home range is important to parameterize dispersal mechanisms in epidemiological models. We GPS-collared 30 juvenile mule deer *(Odocoileus hemionus)* in a Chronic Wasting Disease (CWD) zone in the Texas Panhandle and developed resource selection models to test the hypothesis that habitat selection and movement change during excursions outside the home range. We identified excursions from the natal range as any movement outside of the buffered natal range for ≥ 24 hours. Excursions included dispersal (one-way) and exploratory (two-way) movements. We observed 121 excursions, of which 94% were exploratory behavior (114 individual movements); however, 7 dispersals were also observed. Dispersals were male-biased and occurred mainly during parturition and rut, while exploratory movements were not seasonal or sex-biased. Mean cumulative distance of dispersal and exploratory tracks were 381.93 ± 109.85 km ($\bar{x}$ ± SE) and 26.34 ± 7.92 km, respectively. Speed increased during excursions 121.95 ± 0.12 meters/hour ($\bar{x}$ ± SE) compared to 117.43 ± 0.28 meters/hour inside the natal range. Resource selection varied between sexes and with familiarity of the landscape. Males increased selection of high elevation, steep slopes, and areas closer to water in familiar areas compared to unfamiliar areas. Females increased selection for high elevation and steep slopes in unfamiliar areas while decreasing selection for areas close to water. Our results demonstrate excursions are a complex process that vary between sexes and seasons, and resource selection changes when in unfamiliar areas. Moving forward, CWD epidemiological modeling should account for variations in excursive behavior and resource selection.

Wyoming's Comprehensive Management Strategy for the Sublette Mule Deer Migration Corridor

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ABSTRACT The State of Wyoming is fortunate to have intact landscapes that provide necessary forage and connectivity for big game across the state. The Wyoming Game and Fish Department works with partners to maintain connectivity that will be accessible well into the future by finding sustainable and collaborative solutions to migration corridor management. We will highlight a variety of strategies employed to conserve and manage vital habitat including the Wyoming Governor's Mule Deer and Antelope Migration Corridor Protection Executive Order and policies established by the Wyoming Game and Fish Commission. These governmental policies have proven to be important components of land management decisions and outline the public process for future corridor designations. Conservation actions have been extensively implemented in priority habitats and we will present an in-depth analysis of work occurring within the Sublette (Red Desert to Hoback) mule deer migration corridor. This work has included a wide variety of conservation actions including conservation easements, land acquisition, fence modification and removal, invasive annual grass management, a variety of vegetation treatments, wet meadow enhancements, spring developments and various wildlife crossing strategies spanning across all landownerships. The USDA-Wyoming Big Game Partnership Pilot is a recent example of increased emphasis on the role of private lands in migratory habitat management. Work within the corridor has occurred over many years and across all land ownerships. This presentation will provide a framework to evaluate previous actions while simultaneously looking forward through a strategic approach lens to ensure the Sublette mule deer migration corridor remains functional for centuries to come.

Factors Influencing Temporal Shifts of Space Use in Mule Deer

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ABSTRACT Site fidelity is an important aspect of animal ecology and is crucial for understanding animal movement, resource selection, and disease dynamics. To improve our understanding of this vital life-history mechanism, we examined site fidelity of 125 GPS- collared adult mule deer *(Odocoileus hemionus)* across four sites in the Texas Panhandle from 2015-2019. We compared space use and spatiotemporal overlap for 1,115 unique combinations of biologically relevant seasons and years. Seasons for 59 males were pre-rut, rut, post-rut, and antler growth; seasons for 66 females were fawn-rearing, recovery and ovulation, early gestation, and late gestation. In males, mean space use varied throughout the year, ranging from 15 ± 0.9 ($\bar{x}$ ± SE) km2 during the rut to 17 ± 1.2 km2 post-rut. Mean male site fidelity between years peaked during antler growth at 34% overlap and was lowest during the rut at 25%. Mean female space use ranged from 5 ± 0.3 km2 during recovery and ovulation to 5 ± 0.3 km2 during late gestation. Female site fidelity between years peaked during late gestation at 42%, followed by recovery and ovulation and early gestation at 40%, and 39% during fawn-rearing. Seasonal variation in space use and site fidelity was common, where mule deer exhibited low overlap in space use (< 42%) during the same biological season across years. This shifting of space use across seasons and years has important implications for harvest management and informing the spatial scale of management for Chronic Wasting Disease.

Mapping Oregon Mule Deer Migrations Using Brownian Bridge Movement Modeling

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ABSTRACT Anthropogenic development alters environmental landscapes and disrupts terrestrial migration patterns. Mule deer *(Odocoileus hemionus)* migrate in response to seasonal changes in weather and forage quality with migrations typically comprised of movement corridors and stopovers. Development impedes these long-distance migrations, and the Oregon Department of Transportation (ODOT) annually removes an average of 6,000 deer and elk carcasses from roadways. Our objective of identifying high use corridors and stopovers is vital for managing and preserving mule deer migratory connectivity. Using herd range boundaries developed from winter range centroids and migration direction, GPS telemetry data from 1,585 adult female mule deer recorded from 2015 to 2022 were separated into 22 eastern Oregon herd ranges. High herd use corridors and stopovers were then determined by overlaying individual utilization distributions (UDs) calculated through Brownian bridge movement modeling (BBMM). Herds varied from 22 percent to 86 percent migratory with an average migration length of 40.2 km (SD 23 km) and a maximum length of 134 km. On average, spring migrations began on April 15th (SD 22 days) and

ended on April 26th (SD 23 days) while fall migrations began on November 4th (SD 34 days) and ended on November 14th (SD 35 days). We delineated distinct areas of high use for each herd range, distinguishing multiple ecologically important corridors, stopovers, and seasonal ranges which traversed major highways or intersected potential development locations. Since mule deer exhibit high fidelity to migratory routes, identifying these high use areas can inform management decisions regarding migratory connectivity by indicating conservation priorities.

The Impact of Predation and Other Mortality Sources on White-Tailed Deer (Odocoileus virginianus) Population Dynamics in North Idaho

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ABSTRACT In North Idaho, ungulate and predator populations are fluctuating, and determining the population growth of white-tailed deer *(Odocoileus virginianus)* will allow us to assess their role in the complex predator-prey systems, where they have never been studied. We wanted to identify how white-tailed deer fawn and adult survival influence population growth rates, and how predation on different age groups contributes to changes in population growth rates. We used vital rates estimated from 430 female deer collared between 2019 and 2022 to build a stage-based matrix model. We then tested eight management scenarios of hypothetical reductions in cause-specific mortality proportional to each stage to determine their impacts on population growth. We estimated a current declining population growth rate. The scenarios that produced a population growth rate above 1, were a 50% reduction in mountain lion predation, and two scenarios of combined reductions in mortality due to mountain lions and bears, as well as a reduction in antler-less harvest. Our findings demonstrated that this population can withstand low fawn survival rates, and is more sensitive to changes in adult survival rates. Additionally, mountain lion predation impacts all stages and would require drastic changes to alter the trajectory of this population. We produced the first estimates of population parameters and vital rates in North Idaho of white-tailed deer, highlighting low recruitment rates and high mortality due to mountain lions. The management scenarios illustrate the potential effects, or ineffectiveness, of predator removal to improve the white-tailed deer population outlook in the region.

Estimating Age of Mule Deer in the Field: Can We Move Beyond Broad Age Categories?

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ABSTRACT Age of individuals is an intrinsic demographic parameter used in the modeling and management of wildlife. Although analysis of cementum annuli from incisors is currently the most accurate method used to age ungulates ≥2.5 years old, the age of live ungulates in the field can be estimated by examining tooth wear and tooth eruption patterns. However, there may be limitations to aging based on tooth wear as the rate of tooth wear likely varies among individuals due to factors such as age, environment, and sex. Current tooth wear aging methods often place ungulates into age categories including fawn, 1-2 years old, 3-4 years old, and 4+ years old. Our objective was to determine the reliability of estimating age for mule deer based on tooth wear and tooth eruption patterns for deer 1.5-15.5 years old. We compared ages estimated by tooth wear (collected at time of capture for a statewide monitoring effort) to ages determined from cementum analysis (from teeth collected after mortalities of GPS-tracked animals from the monitoring effort). Ages estimated from tooth wear were within one year of cementum ages >75% of the time when aged by experienced observers. Bias in accuracy for estimates of age was low but slightly biased toward underestimation (i.e., 0.6 years on average)—especially as cementum age increased. Our results indicate that aging mule deer using patterns in tooth wear can be reliable if observers estimating age have experience using this method. Additionally, results indicated that estimates of age for older can be reliable, suggesting that broad age categories may not always be necessary.

Elk Concurrent Sessions: Management Challenges
May 18, 2023 / 8:00 – 10:00 am

Session Facilitator: Justin Shannon, Utah Division of Wild Resources

How Much Is Enough? Using Game Cameras to Estimate Herd Composition in Elk

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ABSTRACT The use of game cameras to collect data about populations of wildlife species has increased over the last two decades. This is especially true for game species such as deer and elk. However, research on the most effective and efficient ways to deploy cameras on scales that are useful for wildlife management is still ongoing. The focus of this analysis was to compare different camera deployment protocols and quantify the amount of effort necessary to collect herd composition data for elk precise

enough to inform management decisions. We utilized data gathered by Idaho Department of Fish and Game from cameras deployed across 4 different Game Management Units (GMU) in Idaho. The initial analysis used data from 20 game cameras deployed on elk migrations routes to compare age ratio estimates from photos to ratios estimated from aerial surveys. In the winter of 2021-22, the estimate of the age ratio from photos was 27.5 (21.4-33.5) calves:100 cows similar to the estimate of 29.3 calves:100 cows from an aerial survey conducted on the same elk population. A camera-based, sex ratio estimate of 12.3 (8.5-16.2) bulls:100 cows was similar to estimates from previous aerial surveys in this area. The second portion of the analysis compared age and sex ratio estimates using photos collected from 161 cameras deployed using 2 different protocols. The first protocol placed cameras on existing roads and trails while the second protocol distributed cameras randomly across a GMU. Age ratios estimates in each GMU were similar across protocols. For example, the age ratio estimate in one GMU from the cameras deployed using the first protocol was 46.8 (41.0-52.7) calves:100 cows compared to 48.3 (33.3-63.2) calves:100 cows estimated from cameras using the second protocol. Sex ratio estimates varied widely between camera deployment protocols and work is still ongoing to understand why.

An Evaluation of Aerial Survey Design and an Attempt to Do More with Less

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ABSTRACT Aerial surveys can be an efficient way to count wildlife. However, many efforts still attempt to census populations. Given safety concerns, increasing survey costs, and a desire to better inform management decisions we looked back through past aerial surveys to quantify the consequences of sampling. Subsampling and bootstrapping were used to quantify the potential impacts on point estimates and measures of uncertainty. We assessed whether stratifying the study area by expected animal density based on previous surveys or expert opinion was an effective way to maximize the precision of estimates given fixed survey costs. We then leveraged the power of simulation to evaluate the effect of grouping

behavior. Social species that can be found in large groups can challenge the ability of a random sample to accurately estimate quantities such as abundance. By simulating populations exhibiting different levels of grouping we were able to quantify when pure random surveys fail to be efficient and provide alternative approaches. The results of this work have been used to inform survey design in several states, provided the impetus for the development of survey design and storage tools, and started several meaningful conversations about the use of random sampling in wildlife surveys.

The Utah Wildlife Migration Initiative: What We Have Learned After Five Years

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ABSTRACT Utah's human population is projected to double within the next 50 years, resulting in significant changes to the landscape as roads and housing developments are constructed, and water is diverted to accommodate the growing population. In light of these current and future complications, the Utah Division of Wildlife Resources began a statewide Wildlife Migration Initiative (WMI) in 2017 to document, preserve, and enhance movement pathways and migration corridors for fish and wildlife throughout the state. To date, tracking data has been collected on 26 different species and amassed more than 40 million data points — offering great opportunities to incorporate data crossing broad spatial scales and long time frames into the decision-making process. However, this also presents a staggering amount of new and ever-changing information to digest. In this presentation, we will describe the evolution of the WMI in Utah, explain how we overcame hurdles in managing data, and discuss how we developed a database to store and use the data in management and planning processes. We will also provide an in-depth overview of each tool we have created and how they are used to provide better management of wildlife in Utah.

Simulation Tools for Private Lands Management, Data Deficient Management Units, and Public Communication

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ABSTRACT Managers are often faced with the challenge of setting harvest goals with limited data. This is particularly true for private lands managers who don't have the budgets of state or federal agencies to fly surveys and collar animals but still desire to manage animal populations sustainably. Without data, typical statistical models are of little use and managers must rely on simulation to help make decisions. However,

there are very few user-friendly simulation tools available. We present a publicly available simulation tool that allows managers to play what-if games under different harvest scenarios and demographic conditions. The tool takes user defined means and standard errors of demographic rates and total number of animals harvested each year for any number of age and sexes classes to simulate the population over n number of years. We developed this tool to assist private lands managers with limited data to predict the effects of harvest on the local elk herd and to communicate the effects of harvest to adjacent landowners. Using the Rangeland Analysis Platform database, we estimated the carrying capacity of elk on the ranch and were able to use the simulation tool to assess different harvest scenarios that would maintain a population that could be sustained by the available forage. This simulation tool will be easily accessible for managers, and we hope it will help communicate the effects of the proposed harvest to the public.

Cause-Specific Mortality in Mule Deer: Influence of Nutritional Condition and Age

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ABSTRACT Determination of compensatory and additive mortality has considerable implications for understanding limiting factors of a population. Although the influence of these processes is conceptually straightforward, a quantitative approach to characterize compensatory and additive mortality for large ungulates is lacking. For this study, we examined the relationship between nutritional condition entering winter, age, and cause-specific mortality for populations of mule deer *(Odocoileus hemionus)* in habitats ranging from high alpine to Mojave Desert. From December 2014 to December 2021, we captured 2602 adult female mule deer using helicopter net-gunning. For each captured deer, we estimated age and ingesta free body fat (IFBF) and fitted all deer with satellite GPS collars equipped with an 8-hour mortality sensor. Once notified, we investigated all mortalities as quickly as possible to assign the most probable cause of death. From 2014 to 2022, we investigated 577 adult female mule deer mortality events during winter (December – April). IFBF of adult mule deer killed by coyotes *(Canis latrans)* was lower than average and not different from those dying of malnutrition. In contrast, mountain lions *(Puma concolor)* killed deer that had IFBF estimates representative of what was available in the population. Additionally, coyotes primarily killed older adults (> 8 years old), whereas mountain lions killed deer across all age classes in proportion to availability. Because coyotes tended to kill adult deer that were older and in poorer condition than adult deer killed by mountain lions, we suggest that mortalities associated with coyote predation were more likely to be compensatory (i.e. animals were likely to die from malnutrition or old age if they were not killed by coyotes). Conversely, mortalities associated with mountain lion predation were more likely to be additive since mountain lions have the potential to kill prime-aged individuals in good condition.

Mixed-Severity Wildfire Shapes Habitat Use of Deer, Elk, and Large Carnivores

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ABSTRACT Wildfire is a widespread form of ecological disturbance and can have both positive and negative effects on animals. Further work is necessary to understand how large mammalian herbivore and carnivore populations respond to the gradient of fire severity. The overall objective of this research was to understand the relative roles of bottom-up and top-down factors across the gradient of fire severity on populations of ungulates (i.e., elk and mule deer) and large carnivores (i.e., black bear, mountain lion, and gray wolf) seven years post fire. Remote wildlife (RW) cameras sampled the gradient of fire severity seven years post a large mixed-severity wildfire (Wallow Fire, year 2011, 2,177 km2) in the White Mountains of Arizona, USA. We evaluated RW camera data using single-species occupancy and Royle-Nichols (relative habitat use) models. As predicted, large mammals (black bear, elk, mountain lion, mule deer, and wolves) exhibited high occupancy and/or habitat use in relation to higher levels of fire severity and/or fire heterogeneity, which was likely related to increased food resources, 7 years post fire, and cover. Some species (black bear and elk) also exhibited relatively high use of unburned forest. If high occupancy and/or habitat use by wildlife in areas experiencing higher fire severity and heterogeneity translates into increased populations of animals, wildfire might be beneficial to humans, focal wildlife populations, and fire-adapted ecosystems.

Effects of Energy Development, Landcover, Climate, and Restoration on Mule Deer Age Ratios

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ABSTRACT Multiple, large-scale changes with long-term effects on population dynamics increasingly complicate decisions on optimal management for wildlife species and their habitats. As site-specific proposals for energy development and long-term planning for habitat restoration arise, decision theory suggests that broadening the questions and range of management options considered could improve conservation actions. For many species, understanding constraints on the decision space, including shifts in climate and landcover that drive demographics, may alter decisions. We used long-term, spatially explicit datasets to quantify the relative influence of multiple landscape- scale changes within winter use areas on mule deer *(Odocoileus hemionus)* recruitment in Wyoming, USA from 1985-2019. Age ratios declined with wind and traditional energy development, cumulative drought, and wildfire but increased with higher mean winter temperatures and summer precipitation. Agriculture and shrubland had positive effects more than twice the magnitude of any other factor we investigated. Variation across herd units (with minimal change over time) suggests accessibility of these habitat components may constrain recruitment in some parts of the state. Expected increases in drought and decreases in summer precipitation further constrain options to sustain mule deer populations. Although mule deer recruitment can sometimes be altered through habitat restoration, effects varied with treatment type, habitat type, and time since treatment. Maintenance of resources through mechanical treatments in aspen and conifer forest in winter use areas may provide a short-term buffer for recruitment against unpredictable forage and changing environmental conditions. Whether wind, oil, or gas, age ratios decreased with placement of energy developments in winter use areas. Our results can be used to weigh the strength of threats and restoration actions, interpret historic demographic change, prioritize populations for conservation, and optimize wildlife habitat. Understanding the relationship between recruitment and landscape-scale change can inform conservation that accounts for changing conditions and research on adaptive capacity.

From Conception to Recruitment: Maternal Condition Dictates Likelihood of Success in Mule Deer

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ABSTRACT Maternal effects are the influence of maternal phenotype and the maternally- provided environment on the phenotype of offspring. Frequently, maternal effects are manifest both before and after parturition. Pre-parturition effects are primarily direct allocation of energy to the offspring that is in utero. Post-parturition effects can include direct (e.g., nursing and defending offspring) and indirect (e.g., selection of habitat that is relatively safe or has high nutritional value) influences. Although both direct and indirect effects are often discussed, there is a paucity of information on the relative importance of each type on offspring due to the difficulty in monitoring mothers prior to parturition and mother-offspring relationships after parturition in free-ranging animals. Our objective was to determine the importance of direct maternal effects on birth weight, growth rates, and survival of mule deer *(Odocoileus hemionus)* fawns from birth through the first 18 months of life. During 2018-2020 we captured and marked 89 female mule deer and 98 neonatal fawns (fawns collected were offspring of marked females), and recaptured 27 of those fawns at six months of age. We used generalized linear models to determine the effect of maternal condition on birth weight (pre-parturition direct effect), growth rate and survival of fawns (post-parturition direct effects). Direct maternal effects were evident both before and after parturition; dams in better condition produced offspring with greater mass at birth, higher rates of growth, and increased survival. Our findings demonstrate that maternal condition influences fawn health from gestation through recruitment. These links highlight the importance of considering direct maternal effects when examining population dynamics and reproductive success in long-lived mammals. Management plans for ungulates should include assessment of nutritional condition of adult females to maximize likelihood of effective conservation.

Identifying and Disrupting Top-Down Regulation of a Declining Mule Deer Population

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ABSTRACT Understanding predator-prey dynamics is critical for making decisions about whether predator control is necessary to meet management goals. We evaluated different harvest strategies of cougars *(Puma concolor)* and the coinciding survival and predation rates of sympatric mule deer *(Odocoileus hemionus)*. Our study was conducted on the South Manti in Central Utah. From December 2017 to December 2022, we captured 96 mule deer using helicopter net-gunning. We measured ingesta-free body fat (IFBF) of adult mule deer to assess body condition. We then fitted all deer with satellite GPS collars with a 12-hr mortality sensor. We attempted to locate all mortalities within 48 hours of being notified of a mortality to assign the most probable cause of death. IFBF of mule deer was above average when compared to other mule deer populations in Utah. From 2017 to 2020, malnutrition related mortality of adults or fawns was never observed. Cougar predation, however, accounted for a 17% loss of collared adults per year and was the leading cause of mortality. Annual survival averaged 74.5%. Healthy deer, coupled with high cougar predation indicated probable top-down regulation. In 2021, the harvest strategy of cougars changed from a limited entry system (an average of 49 cougars harvested per year) to an unlimited over-the-counter system. In 2021, cougar harvest increased to 77 individuals, and mule deer survival increased from 68% to 92%, while annual cougar predation rates decreased from 23% in 2020 to 3% in 2021. Overall, the deer population changed from a declining trend (λ =0.95) to an increasing trend (λ =1.09). We deduce that when mule deer are limited by top-down regulation as indicated by cause-specific mortality and body condition data, that sustained predator control may be successful at disrupting top-down regulation and could be a useful management tool to increase survival and promote population growth.

Kinds of Black-tailed and Mule Deer

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ABSTRACT The species scientists call *Odocoileus hemionus* includes the kinds of deer we know as black-tailed and mule deer. Infraspecific taxonomy has been a challenge in mule deer, in part because the species is geographically widespread and continuously distributed. This species has been divided into as many as 11 subspecies, typically based on minor physical variations. Contemporary investigations of genetic, physical, and ecological differences, however, have shown that most subspecies designations were not well supported. Subspecies and other infraspecific groupings, however, can be given legal definitions enshrined in conservation law. If subspecies, or any other groupings, are not based on phylogeny reflected by concordant phenotypic and genetic characteristics, they are more appropriately called ecotypes. There is phenotypic and nuclear and mitochondrial genetic support for 2 subspecies in the Pacific Northwest referred to as Sitka and Columbian black-tailed deer. Additionally, there are 2 subspecies confined to Tiburón and Cedros islands in Mexico that are supported by genetic data and some morphological differentiation. None of the remaining mainland types of mule deer that have been referred to as subspecies are geographically separated from other adjacent types. In fact, they are genetically indistinguishable at a broad scale and freely interbreed as an interconnected metapopulation with no pronounced phylogenetic pattern. Given the totality of all the evidence, we find support for 5 subspecies of black-tailed and mule deer: Sitka black-tailed deer, Columbian black-tailed deer, Cedros Island mule deer, Tiburón Island mule deer, and mule deer on the mainland. The formerly recognized mule deer subspecies names (California, Rocky Mountain, desert, burro, southern, Inyo, peninsula) are good examples of ecotypes and should not be recognized as subspecies. Still, there is no reason to discontinue the use of these local references, even if they do not represent well-defined scientific divisions of a species.

Resident–nonresident hunter perceptions of mule deer hunting and management in Montana

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ABSTRACT Setting hunting seasons is among the primary roles of fish and wildlife agencies charged with managing game populations. In addition to using sound science on the population(s) in question, data regarding human dimensions play a vital part in decision-making. However, incorporating public opinions in wildlife management is challenging. In Montana for example, various stakeholder groups represent a range of values from preservation to utilitarianism. Additionally, hunters as a stakeholder group are also diverse in their perceptions of wildlife population objectives, current statuses, and priorities. While these circumstances apply to all managed species, mule deer and elk receive a high amount of attention. In 2011, Montana Fish, Wildlife, and Parks (MFWP) conducted a hunter preference survey of residents and nonresidents to gauge hunter satisfaction and opinions on the direction of mule deer hunting in the state. Results from that study confirmed that mule deer hunting was very important to Montanans and overall, hunters reported mule deer hunting opportunities and management to be satisfactory. Because perceptions of stakeholders change over time, we repeated this preference survey in 2023 to determine if there has been a shift in hunter perceptions related to mule deer hunting and management. We also conducted a similar survey related to elk management in Montana. Results from these 2023 mule deer and elk hunter preference surveys will be used to inform governing bodies, such as commissioners and legislators, as they make decisions that influence elk and mule deer management in Montana. Our Montana survey results are consistent with surveys from other states that suggest most hunters prefer opportunity over 'trophy' quality, although there is substantial interest in alternative management strategies that includes management for older age class harvests. Vocal minorities in public settings may provide misleading indications of the preponderance of public opinion.

KEYWORDS human dimensions, hunter opportunity, hunter preference, Montana, elk, mule deer, trophy management

Wildlife conservation agencies for states and provinces in North America manage wildlife, including game species, for the citizens who are beneficiaries of the trust (The Wildlife Society 2010, Smith 2011). Management agency staff work with elected and appointed officials to set hunting seasons and harvest quotas to conserve and regulate game populations, and monitoring social perspectives to determine changes over time is also important. Agency personnel develop season setting recommendations using biological data (e.g., population trends, recruitment, weather conditions, past harvest rates) to inform decision makers such as commissions and legislators. Yet, social desires play a critical role because those desires establish the objectives agencies try to achieve with their management recommendations as well as the range of

publicly acceptable management approaches. Incorporating human dimensions into wildlife management is challenging because different stakeholders may have competing preferences for specific goals, objectives, and strategies to manage wildlife, and their approach and access to decision makers may differ (Decker et al. 2015). Although hunters may represent a single user group, individual hunters have different values and interests when it comes to game management (Wakeling and Watkins 2010).

Mule deer (Odocoileus hemionus) and elk (Cervus elaphus) receive much public attention in western states and provinces, including Montana. When it comes to mule deer management, Montana's primary goal is to manage for the long-term welfare of mule deer populations and provide recreational opportunities that reflect the dynamic nature of deer populations (MFWP 2001, 2021). Montana has designated 11 of 136 hunting districts as special management districts where higher male:female ratios or older age class harvests are the management objective. Yet most hunting districts, including some special management districts, are managed to provide hunting opportunity that may include female harvest (MFWP 2021), with a total harvest limit of 8 deer/resident hunter in 2023. In Montana's Elk Management Plan (MFWP 2023), 31 hunting districts are designated as special management districts and resident hunters may harvest up to 3 elk annually. Consequently, hunters often consider Montana an "opportunity" state when compared with other states because there are fewer limitations on hunter numbers and hunters can obtain hunting licenses over-the-counter annually.

To guide mule deer management, Montana Fish, Wildlife, and Parks (MFWP) uses an adaptive harvest management plan (MFWP 2001, 2021) that uses biological data to identify season type and quota adjustments based on objective ranges for population size and recruitment. For instance, when populations are abundant, liberal female harvest may be used to regulate population trajectory. In special management districts managed for older age class male harvest, permits may be adjusted to maintain a higher mean age at harvest. Similarly, the Elk Management Plan includes goals and strategies specific to each hunting district (MFWP 2023). Montana uses information from hunters and other stakeholders to develop each plan (including citizen's advisory committees, public meetings, virtual forums, and written public comment) and continues to use input during the development of season structures and annual quotas (including public meetings and virtual forums for discussion during development, written public comment, and public comment at commission meetings). Information from hunters and other stakeholders is essential to periodically assess hunter demographics, perceptions, and satisfaction (Messmer et al. 2023).

Generally, biological conditions allow for a variety of possible season types. For instance, most populations may be managed for relatively high male to female ratios (e.g., 40:100) or low male to female ratios (10:100) without measurable changes in recruitment (White et al. 2001). Public input is essential in determining appropriate management scenarios because management objectives are appropriately influenced by social acceptability within biological sideboards (Manfredo et al. 2004). In 2011, MFWP conducted a resident–nonresident mule deer hunter preference survey to gauge Montana hunters' perceptions on mule deer management in the state. Although the values of different stakeholder groups are likely to remain relatively consistent across time in areas with stable land use patterns and human demographics (D'Angelo and Grund 2015), periodic resampling of social perspectives remains prudent. As populations of western states and provinces grow, shifting demographics and other social changes may result in changing attitudes and perspectives concerning different facets of wildlife management. We repeated the resident–nonresident mule deer hunter survey and initiated an additional resident–non-resident elk hunter survey in 2023 to gather baseline data on hunter perspectives of elk management and determine if hunter perspectives about mule deer management changed over time.

METHODS

In 2023, we sent a cover letter and survey questionnaire to a sample of randomly selected Montana resident (n = 5,000) and nonresident (n = 800) deer license holders pulled from the pool of all deer license holders from 2022 hunting season. This survey was a virtually identical version to a survey conducted in 2011, which sampled the same number of resident and nonresident deer license holders from the 2010 season. The original survey was designed to measure attitudes about several aspects of deer management, including questions that assessed public desires for specific types of hunting opportunities such as the chance to hunt deer annually and the chance to harvest older age class deer. Because public sentiment may change over time, we wanted to determine if public hunting desires had changed over time for those that participate in Montana. Also in 2023, we sent a cover letter and survey questionnaire to resident (n = 5,000) and nonresident (n = 800) elk license holders from the pool of hunters who held an elk license during the 2022 hunting season to establish a baseline for Montana elk hunters and determine if their preferences differed from mule deer hunters. We sent replacement mailings to nonrespondents 4 to 5 weeks after the initial mailings to boost survey response rates. Because the surveys were largely returned and analyzed in 2011 and 2023, unless specifically referring to the 2010 or 2022 hunting seasons, we refer to the most mule deer and the elk surveys as either the “2011” or “2023” resident-nonresident surveys. Copies of all 3 surveys are provided in Appendix A (Questions asked for Resident-Nonresident Mule Deer Hunter Preference Survey, 2011), Appendix B (Questions asked for Resident-Nonresident Mule Deer Hunter Preference Survey, 2023), and Appendix C (Questions asked for Resident-Nonresident Mule Deer Hunter Preference Survey, 2023).

For the mule deer survey, most questions in 2023 were identical to questions posed in 2011 with a few minor differences; all surveys contained questions asking for a mix of multiple choice and forced-choice type answers. Most of the multiple-choice questions were framed on a Likert scale, asking respondents to rate their response from 1 (i.e., very negative) to 5 (i.e., very positive), such as “strongly agree,” “agree,” “neither agree nor disagree,” “disagree,” and “strongly disagree” (or similar terminology; Likert 1932).

Respondents were first asked if they had hunted mule deer (or elk) in Montana during the past 5 years. If they responded “no,” they could stop and return the survey. Otherwise, they were asked how important mule deer or elk hunting was to them, and in what region of Montana they spent the most time hunting mule deer or elk during the past 5 years (Figure 1). The next questions asked respondents to answer in consideration of the region they spent the most time hunting, including why they chose that region, their perceptions regarding opportunities to hunt mule deer or elk, access to hunt mule deer or elk, hunter crowding and behavior, satisfaction with current mule deer or elk hunting regulations, understandability of mule deer or elk hunting regulations, and how complex mule deer or elk hunting regulations should be.

We posed forced-choice questions about whether respondents would prefer the opportunity to hunt mule deer or elk every year or forgo that annual opportunity for a higher likelihood of harvesting a mature buck or bull elk when hunting once every several years. In a forced-choice question, respondents must select one choice over another and not simply respond that hunting every year AND harvesting a mature animal are both important; the respondent must indicate which is most preferable. Related to these questions, respondents were also asked to consider tradeoffs by rating the acceptability of restrictive regulations in some areas increasing mule deer or elk hunting pressure in less restrictive areas.

We asked respondents how important it is for them to be able to consistently hunt mule deer or elk in the same place in Montana each year, for their opinions regarding the timing of mule deer and elk seasons in Montana, and how strongly they support or oppose the current timing of the 5-week general season for mule deer and elk. Specific to the mule deer survey, respondents were asked to what extent do they sup-

port or oppose the hunting of mule deer bucks during the rut. Specific to the elk survey, respondents were asked how important is it that the timing of the general rifle season for elk aligns with the timing of the general rifle season for mule deer.

Other questions related to mule deer and elk season types gauged interest in archery and muzzleloader seasons, general (rifle) seasons, late seasons for elk, hunting antlerless mule deer and elk, and hunting bull elk. Additionally, for the mule deer survey, respondents were asked how acceptable they found the hunting of antlerless mule deer for management purposes. Respondents were also given a list of 10 motives for hunting mule deer and elk in Montana and asked to rate them.

Respondents were asked to rate how satisfied they were with Montana's current mule deer and elk management, and how much they trusted MFWP to manage mule deer and elk in Montana. The survey also asked respondents to check all the sources from which they get most of their information regarding mule deer, elk, and their management in Montana.

We asked for background characteristics of the respondents, such as (if it was the mule deer survey) whether they hunted elk or antelope (Antilocapra americana) in Montana during the past 5 years, or (if it was the elk survey) whether they hunted mule deer in Montana during the past 5 years. Respondents were also asked how many of the past 5 years they hunted mule deer or elk in Montana, and how many days per year they hunt mule deer or elk in Montana.

Finally, 2 questions specific to elk hunting were asked about a new statewide regulation change that occurred for the 2022 hunting season. Under a new Montana elk hunting regulation, individuals who successfully draw a limited either-sex elk permit are restricted to hunting bull elk in the hunting district for which their permit is valid. In Montana, a permit validates a license to hunt within a specific hunting district. A general license may be used to hunt in multiple hunting districts, and previously hunters could hunt in any general district as well as the hunting district for which their permit was valid. They were asked if this new regulation affected their approach in applying for permits, and specific to respondents who held an either-sex elk permit in 2022, if they found that the new regulation affected hunting pressure or elk harvest in that special permit area.

We summarized the data by frequency of response by category for each question. We looked for general differences in trends of response frequencies between mule deer hunter surveys and between the deer and elk hunter surveys. We also compared Montana's management objectives (e.g., proportion of special management districts) with response frequencies that indicate support for those management objectives (e.g., proportion of hunters that expressed preference for older age class management).

RESULTS

From the 2023 mule deer survey, we received responses from 2,005 resident and 350 non-resident deer license holders (41% and 44%, respectively). This closely resembles the response rate from the 2011 mule deer survey, in which MFWP received responses from 1,980 resident and 335 nonresident deer license holders (41% and 43%, respectively). For the elk survey, we received responses from 2,022 resident and 375 nonresident elk license holders (42% and 47%, respectively). Complete results, with survey questions and responses broken down by regions (where applicable) can be found on MFWP's website: https://fwp.mt.gov/conservation/wildlife-management.

Resident–nonresident mule deer hunter perceptions, 2011 and 2023

Nonresident respondents reported using their license to hunt mule deer in Montana more frequently than did resident respondents during both the 2011 and 2023 surveys. In 2011, 80% of residents and 87% of nonresidents reported hunting mule deer in the past 5 years, and 79% of residents and 85% of nonresidents reported hunting mule deer in the past 5 years in 2022.

Mule deer hunting was important (rated as either their most important or one of their most important hunting activities) for 62.0% of residents and 69.5% of nonresidents in 2011 (Table 1). In 2023, these percentages stayed the same for residents and increased for nonresidents, to 76.1%. In 2011, the majority of residents reported spending the most time hunting in Regions 4 (23.0%) and 3 (21.1%), whereas the majority of nonresidents reported spending the most time hunting in Regions 7 (36.8%) and 6 (17.9%). This also did not change in the 2023 survey; residents largely reported hunting in Regions 3 (25.7%) and 4 (20.9%), while nonresidents still spent the most time hunting in Regions 7 (34.1%) and 6 (19.9%; Table 1).

In 2023, resident respondents chose a particular region for the following reasons: to hunt a familiar location (76.4%), to be able to hunt mule deer and other game species at the same time (74.7%), and for access to hunt mule deer on publicly owned land (72.3%; Table 2). Nonresidents differed in their top priority for selecting a particular region, but otherwise had similar reasons: mule deer buck numbers (69.3%), access to hunt mule deer on publicly owned land (69.1%), and to be able to hunt mule deer and other game species at the same time (69.1%). Both resident and nonresident hunters' perceptions regarding the overall opportunities to hunt mule deer increased between 2011 and 2023 (Table 3). Additionally, both residents and nonresidents rated the opportunities to hunt "mature" mule deer bucks as better in 2023 than 2011. Residents' and nonresidents' perceptions of their experiences within specific Regions also differed somewhat (Table 3).

When forced to choose between more restrictive regulations (resulting in a higher likelihood of harvesting a larger buck) and the opportunity to hunt a mule deer buck every year, 61.4% of residents preferred annual opportunities both statewide and in the region they spent the most time hunting in 2023 (Table 4). Nonresidents also preferred the opportunity to hunt mule deer every year in the state and their selected region (56.9% and 60.5%, respectively). These responses were like those in 2011, although the percentages of respondents choosing "opportunity" is slightly lower in 2023 (Table 4). Overall, residents and nonresidents alike preferred access to hunting mule deer bucks during the rut (63.8% and 69.5%, respectively) but this percentage also decreased, more notably for residents, between 2011 and 2023 (Table 5).

Residents and nonresidents hunt mule deer in Montana for a variety of reasons (Table 6). For residents, "to enjoy nature and the outdoors" was the number one reason they hunted mule deer in Montana (92.7% and 90.7% said this was an important or very important reason in 2011 and 2023, respectively). "To get venison for eating" was the second most important motive in 2023 and moved up in importance between 2011 and 2023 (66.9% in 2011 and 76.4% in 2023). "To harvest a trophy buck" was the least important reason residents chose to go mule deer hunting in Montana in both 2011 and 2023. Nonresidents shared in some of these motives; "to enjoy nature and the outdoors" was an important or very important reason to go mule deer hunting in Montana (above other options at 95.8% and 94.2%, respectively, in 2011 and 2023). "To get venison for eating" was among the least important reasons nonresidents hunted mule deer in Montana in 2011 and 2023 (Table 6).

Satisfaction with Montana's mule deer management differed between residents and nonresidents in 2023. Nonresident respondents were generally more satisfied and more trusting in MFWP's ability to manage mule deer than residents: 41.5% of residents and 59.1% of nonresidents are satisfied with Montana's mule deer management, and 48.0% of residents and 68.7% of nonresidents place a high level of trust with

MFWP to manage mule deer. The majority of residents and nonresidents who hunted mule deer in 2010 and 2022 also hunted elk (Table 7).

Resident–nonresident elk hunter perceptions, 2023

Participation rates in elk hunting were greater for nonresident respondents than resident respondents; 96% of nonresidents reported they hunted elk in Montana during the past 5 years, while 88% of residents reported the same. Elk hunting was either the most important or one of the most important hunting activities for 81.0% of residents and 85.3% of nonresidents.

The majority of resident elk hunters spent the most time in Regions 3 (35.9%) and 4 (18.4%), and nonresidents were similar: 45.4% of nonresident respondents spent the most time hunting elk in Region 3, and 24.2% spend the most time hunting elk in Region 4 (Table 8). Residents selected a particular region for elk hunting because of or in order to: hunt a familiar location (80.1%), access to hunt bull elk on publicly owned land (72.9%), to be able to hunt elk and other game species at the same time (71.1%), and to hunt close to home (66.8%). On the other hand, nonresidents selected a particular region to hunt based on access to hunt bull elk on publicly owned land (66.1%), elk numbers (63.4%), to be able to hunt elk and other game species at the same time (61.6%), and bull elk numbers (61.5%; Table 8).

Resident and nonresident elk hunters also largely considered Montana's opportunities to hunt elk and mature elk as good or excellent (Table 9). Similar to the mule deer survey, residents and nonresidents alike preferred the opportunity to hunt bull elk every year over more restrictive seasons that would limit opportunity to once every several years (Table 10). Resident and nonresident elk hunters also considered increased hunting pressure in some hunting districts as a result of more restrictive season types in others to be unacceptable or very unacceptable. The majority of respondents believed it was important to be able to hunt elk in the same place each and every year (Table 11). "To enjoy nature and the outdoors" and "to get venison for eating" were the primary motivations for residents to hunt elk in Montana, whereas nonresidents were interested in enjoying nature and the outdoors and spending time with friends and family (Table 12).

For Montana, 34.8% of residents were satisfied or very satisfied with current elk management while 38.2% were neutral and 16.9% were dissatisfied or very dissatisfied. Of note, 59.5% of nonresidents were satisfied or very satisfied with Montana's elk management, while 33.7% were neutral and only 6.8% were dissatisfied or very dissatisfied. Comparably, 42.8% of Montana resident respondents placed high or very high trust in MFWP to manage elk in Montana, and 27.5% placed little to no trust in MFWP, whereas 67.7% of nonresidents placed high or very high trust and only 9.7% of nonresidents placed little or no trust in MFWP. Most resident and nonresident hunters hunted mule deer during the years they hunted elk (Table 14).

DISCUSSION

Both resident and nonresident hunters expressed a greater preference for hunting opportunity (a chance to hunt) over hunt quality (an opportunity to harvest and older age class animal) in all 3 surveys, but a substantial proportion expressed interest in management objectives that provide a diverse hunting experience. Although nearly 12 years had passed since the initial mule deer survey, results from the 2023 mule deer survey were extremely similar to results from 2011. Results from both the mule deer survey and elk survey also resemble similar hunter preference surveys conducted in other states (Manfredo et al. 2004, Sanyal and Krumpe 2012, IDFG 2017). Although public perspectives may not always change, societal shifts in wildlife values do occur (Manfredo et al. 2018) and monitoring the effect of those changes is incumbent upon management agencies.

“Opportunity” is a broad term and can refer to season structure (e.g., legal animal) or increased area or time afield via other means (e.g., access, season length). During 2022, there were 11 special management districts for mule deer and 31 special management districts for elk, representing roughly 8% and 23% of Montana, respectively. In special management districts, hunting opportunity is restricted to provide a limited opportunity for some individuals to harvest older-aged bucks or bulls. In 2010, there were 15 mule deer special management districts, so opportunity via season structure has increased between the 2 surveys. Additional limitations for mule deer hunting exist in Montana, but overall, most of the state still provided general license hunting opportunities for mule deer in 2022. Elk hunting opportunity in Montana is also relatively open, with many general license areas, liberal archery quotas across many of the special management districts, and liberal antlerless license allocations in areas with over-objective elk populations.

For elk hunting, residents and nonresidents alike found public land hunting opportunities as good or excellent. Conversely, most residents considered access to private lands to hunt both antlerless and bull elk as poor or very poor, and nonresidents’ perceptions regarding access to public and private lands for elk hunting were better than residents’ perceptions. Hunting access is an important and rising issue in Montana and the bulk of contention centers around access for elk hunting, particularly on private lands (Eliason 2016). Respondents’ perceptions and the differences between residents and nonresidents may highlight the different means in which residents and nonresidents pursue access opportunities in the state (i.e., fee access or guided hunts versus “do-it-yourself” hunting or otherwise pursuing free public access options).

Perceptions of hunter crowding improved between 2011 and 2023 for both resident and nonresident mule deer hunters. Similarly, fewer than half of resident and nonresident elk hunters believed they saw “too many” other hunters while afield. However, the majority of residents believed that the number of elk hunters in general was too great. Hunter crowding is a common complaint from Montana’s resident hunters in public season setting meetings, and Montana’s population increased by 11% between 2010 and 2022 (US Census Bureau 2022). The apparent lack of concern by elk survey respondents about hunter crowding was somewhat unexpected.

According to Montana’s hunting and harvest estimates, in 2022 there were 7,507 fewer deer hunters than in 2010. Additionally, the number of elk hunters did not increase substantially during this time (an increase of 2,415 between 2010 and 2022). However, in the few years prior to 2010, deer hunter numbers increased by almost 10,000 in 2008, and elk hunters increased by the same amount. Mule deer hunter perceptions of crowding in 2011 may have been related to the surge in hunter numbers just a few years prior to that survey. The unexpected ‘acceptance’ of hunters seen afield across resident and nonresident mule deer and elk hunters in 2023 may be an artifact of adaptation and normalization, as hunter numbers have been relatively unchanged or moderately declined since 2010. Access to hunting areas on public or private land in relation to hunter crowding were not addressed in this survey but merit further evaluation.

Resident and nonresident mule deer and elk hunters alike preferred the opportunity to hunt mule deer or elk every year, versus only having the opportunity to hunt mule deer or elk once every several years with a higher likelihood of harvesting a mature buck or bull. The results for mule deer are similar between 2011 and 2023, although there has been a slight shift towards a preference for more “restrictive” management. These results are like hunter perceptions surveys conducted by other states, including states known for more restricted, “trophy” management (Manfredo et al. 2004). For instance, Colorado conducted a hunter preference survey with elk hunters, finding that across all management alternatives offered, most hunters preferred rifle hunts that maximized their opportunity to hunt despite the fact that these types of opportunities would result in higher hunter densities and harvests of “smaller” male animals (Manfredo et al. 2004).

Hunter preference surveys in Idaho yielded similar results when opportunity was compared with more restricted management. Given multiple management scenarios (e.g., the opportunity to harvest a raghorn

bull every year vs. harvesting a mature bull once every 10 years, the opportunity to harvest a cow every year vs. harvesting a mature bull once every 3 years), the majority of Idaho elk hunters preferred to maintain opportunity over hunting for older age class or larger-sized bulls less frequently (Sanyal and Krumpe 2012). In a mule deer hunter preference survey, hunters were asked to choose between opportunity to hunt mule deer bucks every year vs. more restrictions for a higher likelihood of harvesting larger bucks, and 75% of Idaho hunters favored the opportunity to harvest specifically a small buck every year vs. a big buck once every three years (IDFG 2017). There were a lot of nuances to these responses, and from their results, they concluded that Idaho hunters were willing to accept additional restrictions to manage for larger or more mule deer bucks, provided there were still adequate general-season opportunities available (IDFG 2017). Controlled hunts (i.e., limiting the number of licenses or permits issued) was an acceptable restriction for some areas but giving up the ability to hunt every year was unacceptable (IDFG 2017).

The majority of resident and nonresident mule deer and elk hunters support the timing of Montana's deer and elk seasons, which includes the hunting of mule deer bucks during the rut. This support has decreased for residents between 2011 and 2023, however. For elk and mule deer hunters alike, it was important that the timing of the general rifle seasons for elk and mule deer matches up. While not asked in the mule deer survey, 75.5% of residents and 65.0% of nonresident respondents noted that the ability to hunt elk every year in the same place in Montana was important or very important.

Fewer than 50% of respondents are interested in hunting during the archery or muzzleloader seasons or harvesting antlerless mule deer; however, the majority of resident and nonresidents support antlerless mule deer hunting for management purposes. Residents and nonresidents were also largely disinterested in hunting elk during the muzzleloader season, and somewhat less interested in hunting elk during the late/shoulder seasons as opposed to the archery and rifle seasons. Nonresidents were more interested than residents in the elk archery seasons; this may be due to the relatively large permit quotas offered in Montana for special management districts as well as general elk license opportunities available. The lack of interest by nonresident hunters for muzzleloader seasons makes sense, as generally nonresidents come to Montana for a single trip (in the archery or general season) and return home prior to the beginning of muzzleloader seasons.

Motivations for hunting mule deer in Montana were largely similar in 2011 and 2022 with minor differences. Most notably, "to get venison for eating," "to experience solitude," and "to harvest a trophy buck" increased in importance between 2011 and 2023 for residents and nonresidents, but the overarching motivation for hunting Montana was still "to enjoy nature and the outdoors" for both survey groups across years. "To harvest a trophy buck" was the least important reason respondents chose to hunt mule deer in Montana in both 2011 and 2023. Notably, respondents who reported that harvesting a trophy buck is an important motivation for going mule deer hunting in Montana were more likely to select the more restrictive option for season types. Forty-six percent of the respondents who reported that harvesting a trophy buck is important to them selected the "opportunity to hunt mule deer bucks once every several years (with a higher likelihood of harvesting a mature buck)" for that survey question. Additionally, respondents who reported that mule deer hunting wasn't very important to them were also more likely to select the more restrictive option. Elk hunter motivations were similar to mule deer hunter motivations; the main reason hunters reported pursuing elk in Montana was "to enjoy nature and the outdoors." These results are also like results from hunter preference surveys in Idaho, where "being close to nature" was the most important motivation for mule deer hunting, and for elk hunting, "harvesting a mature bull" or "harvesting a large bull" were towards the lower end of the spectrum on importance (Sanyal and Krumpe, 2012, IDFG 2017).

Nonresidents are currently more satisfied with Montana's mule deer hunting regulations than residents; their satisfaction increased between 2011 and 2023, while resident satisfaction has declined. Satisfaction with Montana's elk management varied between residents and nonresidents. Nonresident respondents

were generally more satisfied and more trusting in MFWP's ability to manage elk than residents. Having stakeholders' trust and confidence is critical for effective wildlife management (Smith et al. 2013). Many resident elk hunters are concerned about a variety of elk hunting issues. Gaining access to hunt elk is a continuing concern, particularly on private lands. Also, there are concerns about the numbers of both antlerless and bull elk on Montana's public lands. However, roughly 50% of resident and 64% of nonresident elk hunters considered the opportunities to hunt bull elk in Montana as better than average.

Each year, MFWP hears from a segment of the hunting public that more emphasis needs to be placed on trophy hunting in the state. These comments are not new; the original Adaptive Harvest Management document noted that there is a "significant and presumably growing element that places a high value on age structure and the opportunity to harvest an older age buck" (AHM 2001). Roughly two-thirds or more of resident and nonresident elk and mule deer hunters however would still prefer less restrictive elk and mule deer regulations across the state compared to more restrictive regulations that would limit opportunity in favor of more trophy hunting. The importance of a sampling context cannot be overstated, as randomly selected members of the hunting public tend to respond differently than those who are more vocal, attend public meetings, and submit public comments (Wakeling and Watkins 2010). Listening to the desires of vocal and involved hunters is important, as is listening to the desires of the less vocal segment of the hunting population, because the greatest opportunity to maximize hunter recruitment, retention, and reactivation may lie among their ranks (Wakeling and Watkins 2010).

MANAGEMENT IMPLICATIONS

Human dimensions in fish and wildlife management remains important, and to effectively inform trustees of the resource, agencies need to incorporate human dimensions into their management (Decker and Enck 2008, Jacobson et al. 2010). Manfredo et al. (1995) mentions 2 components to incorporating human dimensions in wildlife management; the first to make use of social science to learn stakeholders' perspectives, the second to use that information in future decision making. These resident–nonresident surveys provide MFWP with valuable information about the perceptions and perspectives of Montana's mule deer and elk hunters. These results indicate that the majority of resident and non-resident mule deer and elk hunters prefer the opportunity to hunt mule deer and elk each year over more restricted opportunities for older age-class animals. Therefore, when developing season recommendations for consideration by the commission, the department should keep prioritizing opportunity over 'trophy' management as the resource allows.

Not all hunters prioritize the same types of experiences, so offering a variety of hunting opportunities may provide a wider range of benefits to the hunting public (Manfredo et al. 2004). Fulton and Manfredo (2010) suggest a threshold exists where season restrictions yield substantive impacts on hunter satisfaction. If Montana considered season changes for mule deer and elk to closer match the survey results, it would be important to provide all stakeholders with the tradeoffs associated with such possible changes prior to implementation (Cornicelli et al. 2011). For example, if Montana implemented more restrictive hunting regulations for mule deer in areas, there would be reduced opportunity in those areas and more hunter pressure from displaced hunters in other areas. Cornicelli et al. 2011 also noted that survey respondents were more likely to support more restrictive regulations if those regulations were perceived as necessary (e.g., during population lulls or to achieve certain objectives).

Effective wildlife management often means taking a hard look at challenges and benefits of different regulation types and these tradeoffs need to be carefully weighed to meet the desires of multiple stakeholders (Cornicelli et al. 2011). Every biennium, MFWP undergoes a season-setting process for the following 2 years' hunting seasons. During this period, MFWP takes public comments and develops proposals based

on biological and social issues. Results from this study will help guide season proposals going forward. The biological and social data are shared with the commission so that decisions may be made in a public forum. The similarities we observed in the results of our survey and results from surveys in other states suggests that there are striking similarities in hunter preferences among many states and provinces, and our data may help inform decisions in other jurisdictions as well.

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TABLES

Table 1. Resident/nonresident responses regarding the importance of mule deer hunting and the region respondents spent the most time hunting in Montana during the past 5 years prior to taking the hunter preference survey.

	Resident		Nonresident	
Survey Question	2011	2023	2011	2023
Importance of mule deer hunting in Montana[1]	62.0%	62.0%	69.5%	76.1%
Mule deer hunting by region of Montana[2]				
Region 1	10.2%	7.6%	2.5%	2.7%
Region 2	11.9%	10.6%	5.4%	3.4%
Region 3	21.1%	25.7%	15.4%	18.2%
Region 4	23.0%	20.9%	15.0%	17.9%
Region 5	10.3%	10.6%	7.1%	3.7%
Region 6	10.7%	12.0%	17.9%	19.9%
Region 7	12.8%	12.6%	36.8%	34.1%

[1] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("it is my least important hunting activity") to 5 ("it is my most important hunting activity").
[2] Respondents selected the region they spent the most time hunting mule deer in during the past 5 years.

Table 2. Reasons provided by resident and nonresident mule deer hunters for why they chose to spend the most time hunting a particular region of Montana in 2023. Responses were rated on a scale of 1 ("very unimportant") to 5 ("very important"). Percentages are the sums of 1/2 responses and 4/5 responses.

	Resident		Nonresident	
Survey Question	1 or 2	4 or 5	1 or 2	4 or 5
To hunt close to home	20.8%	63.7%	72.0%	16.9%
To hunt a familiar location	8.8%	76.4%	23.4%	55.0%
Mule deer numbers	16.9%	55.1%	11.1%	61.9%
Antlerless mule deer numbers	40.5%	30.8%	52.2%	23.3%
Mule deer buck numbers	16.3%	58.3%	11.2%	69.3%
Access to hunt mule deer on public land	12.8%	72.3%	17.4%	69.1%
Access to hunt antlerless mule deer on private land	56.5%	25.9%	64.9%	21.2%
Access to hunt mule deer bucks on private land	40.5%	40.9%	36.2%	49.3%
To be able to hunt mule deer and other game species at the same time	12.1%	74.7%	16.9%	69.1%

Table 3. Answers to scaled questions regarding resident and nonresident perceptions of mule deer hunting and management in Montana. Survey questions were framed in relation to the region that respondents spent the most time in during the 5 years prior to taking the survey (Table 1). "-" depicts that the question was not asked during that survey year.

	Resident		Nonresident	
Survey Question	2011	2023	2011	2023
Overall opportunities to hunt mule deer[1]	52.4%	55.0%	61.7%	64.8%
Opportunities to hunt antlerless mule deer[1]	53.5%	44.6%	67.9%	47.3%
Opportunities to hunt mule deer bucks[1]	-	53.5%	-	63.7%
Opportunities to hunt "big" (2011) or "mature" mule deer bucks (2022)[1]	22.5%	35.4%	31.5%	45.4%
Access to publicly owned land to hunt mule deer[1]	52.5%	57.5%	53.7%	58.2%
Access to privately owned land to hunt antlerless mule deer[1]	43.4%	24.8%	43.5%	34.5%
Access to privately owned land to hunt mule deer bucks[1]	55.0%	26.4%	39.0%	40.0%
The number of other hunters observed when hunting mule deer[2]	34.2%	31.7%	15.5%	53.3%
The behavior of other hunters typically observed when hunting mule deer[2]	-	55.3%	-	74.5%
Satisfaction with Montana's current mule deer hunting regulations[3]	43.2%	45.8%	55.7%	62.9%
The ease of understanding Montana's mule deer hunting regulations[4]	64.8%	60.0%	55.4%	66.8%

[1] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("poor") to 5 ("excellent").
[2] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question; from a scale of 1 ("very unacceptable") to 5 ("very acceptable").
[3] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question; from a scale of 1 ("very dissatisfied") to 5 ("very satisfied").
[4] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question; from a scale of 1 ("very difficult to understand") to 5 ("very easy to understand").

Table 4. Resident and nonresident perceptions regarding how complex and restrictive mule deer hunting regulations should be from surveys in 2011 and 2023.

Given only one choice, which of the following would be most favorable to you…	Resident		Non-resident	
	2011	2023	2011	2023
In Montana as a whole…				
With few exceptions, mule deer hunting regulations should be the same in most hunting districts across the state, OR	42.4%	40.2%	58.0%	43.4%
There should be a variety of different mule deer hunting regulations across the state to meet a wide range of mule deer hunter interests	57.6%	59.8%	42.0%	56.6%
The opportunity to hunt mule deer bucks every year somewhere in Montana (with a lower probability of harvesting a mature buck), OR	63.0%	61.4%	57.9%	56.9%
The opportunity to hunt mule deer bucks once every several years somewhere in Montana (with a higher probability of harvesting a mature buck)	37.0%	38.6%	42.1%	43.1%
In the region you spent the most time hunting in the past 5 years…				
With few exceptions, mule deer hunting regulations should be the same in most hunting districts in this region of the state, OR	55.6%	52.4%	66.7%	59.3%
There should be a variety of different mule deer hunting regulations across this region to meet a wide range of mule deer hunter interests	44.4%	47.6%	33.3%	40.7%
The opportunity to hunt mule deer bucks every year in this region of the state (with a lower probability of harvesting a mature buck), OR	63.8%	61.4%	58.1%	60.5%
The opportunity to hunt mule deer bucks once every several years in this region of the state (with a higher probability of harvesting a mature buck)	36.2%	38.6%	41.9%	39.5%

Table 5. Resident and nonresident perceptions regarding the timing of Montana's mule deer hunting seasons, other season structures, satisfaction with mule deer management in Montana, and trust in FWP to manage mule deer, in 2011 and 2023. "-" depicts that the question was not asked during that survey year.

	Resident		Nonresident	
Survey question	2011	2023	2011	2023
Acceptability of the tradeoff between increased mule deer hunting pressure in less restrictive hunting districts as a result of additional restrictions in other hunting districts[1]	31.6%	24.2%	31.5%	23.8
Importance of being able to consistently hunt mule deer in the same place in Montana each year[2]	57.1%	64.5	60.4%	65.1%
Support hunting mule deer bucks during the rut[3]	65.1%	63.8%	70.0%	69.5%
Importance of hunting mule deer in Montana during the week that includes the Thanksgiving holiday[2]	63.7%	67.3%	44.3%	44.4%
Support the current timing of the 5-week general rifle season for mule deer[4]	78.2%	70.6%	75.9%	70.3%
Importance of mule deer hunting season aligning with elk season[2]	63.9%	67.1%	53.9%	59.5%
Interest in hunting mule deer during the archery season[4]	-	33.6%	-	26.9%
Interest in hunting mule deer during the muzzleloader season[4]	-	20.7%	-	18.2%
Interest in harvesting antlerless mule deer in Montana[4]	51.3%	38.3%	34.9%	29.2%
Acceptability of hunting antlerless mule deer for management purposes[1]	-	68.6%	-	62.7%
Satisfaction with mule deer management in Montana[5]		41.5%		59.1%
Trust in FWP to manage mule deer in Montana[6]		48.0%		68.7%

[1] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("very unacceptable") to 5 ("very acceptable").
[2] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("very unimportant") to 5 ("very important").
[3] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("strongly oppose") to 5 ("strongly support").
[4] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("very disinterested") to 5 ("very interested").
[5] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("very unsatisfied") to 5 ("very satisfied").
[6] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("little or no trust") to 5 ("very high trust").

Table 6. Resident and nonresident motivations for hunting mule deer in Montana in 2011 and 2023. Responses were rated on a scale of 1 ("very unimportant") to 5 ("very important"). Percentages are the sums of the 4 and 5 responses.

Reason	Resident		Nonresident	
	2011	2023	2011	2023
To enjoy nature and the outdoors	90.7%	92.7%	95.8%	94.2%
To get venison for eating	66.9%	76.4%	51.1%	68.2%
To do something with my family	73.5%	74.8%	64.9%	68.6%
To be with friends with similar interests	76.3%	73.4%	87.4%	85.0%
To feel the exhilaration of the hunt	69.1%	64.6%	83.1%	80.7%
To develop my skills and abilities	64.0%	63.8%	63.7%	67.8%
To test my hunting skills	63.4%	61.0%	69.4%	70.1%
To harvest a trophy buck	47.3%	59.2%	62.7%	72.4%
To feel a sense of accomplishment	59.6%	60.7%	63.6%	68.1%
To experience solitude	67.2%	71.9%	67.8%	76.5%

Table 7. Background characteristics of survey respondents participating in resident–nonresident mule deer hunter perception surveys in 2011 and 2022. "-" depicts that the question was not asked during that survey year.

Survey Question	Possible Answer(s)	Resident		Nonresident	
		2011	2023	2011	2023
During the past 5 years, have you hunted elk in Montana?	Yes	-	88.1%	-	54.5%
	No		11.9%		45.5%
If yes, how often do you also hunt mule deer (or would harvest a mule deer) while primarily elk hunting?	Often/all the time	-	62.2%	-	66.1%
	Not often/never or rarely	-	20.9%	-	16.9%
During the past 5 years, have you hunted antelope in Montana?	Yes	-	51.4%	-	35.6%
	No		48.6%		51.1%
If yes, how often do you also hunt mule deer (or would harvest a mule deer) while primarily antelope hunting?	Often/all the time		32.9%		35.6%
	Not often/never or rarely	-	53.5%	-	51.1%
How many of the past 5 years have you hunted mule deer in Montana?	1 year	5.7%	7.3%	24.6%	28.9%
	2 years	9.7%	8.6%	26.0%	22.7%
	3 years	11.9%	12.4%	17.0%	20.3%
	4 years	9.2%	9.9%	14.0%	12.4%
	All 5 years	63.5%	61.8%	18.2%	15.8%
How many days per year do you hunt mule deer in Montana?	Median	10.0	10.0	6.0	6.0
	Mean	12.0	10.4	7.3	6.9
Age of respondents	Median	49	51.0	53	53.0
	Mean	47	49.5	52	51.8
Gender of respondents	Male	88%	-	99%	-
	Female	12%		1%	

Table 8. Resident–nonresident responses regarding the importance of elk hunting, the region respondents spent the most time hunting in Montana during the past 5 years prior to taking the hunter preference survey, and why hunters spent the most time in a particular region.

Survey Question	Resident	Nonresident
Importance of elk hunting in Montana[1]	81.0%	85.3%
Elk hunting by region of Montana[2]		
Region 1	11.2%	4.5%
Region 2	17.2%	9.2%
Region 3	35.9%	45.4%
Region 4	18.4%	24.2%
Region 5	8.3%	7.5%
Region 6	4.6%	3.1%
Region 7	5.2%	6.1%
Reasons why hunters spend most of their time elk hunting in this region of Montana[3]		
To hunt close to home	66.8%	19.2%
To hunt a familiar location	80.1%	54.9%
Elk numbers	60.0%	63.4%
Antlerless elk numbers	48.3%	35.8%
Bull elk numbers	51.3%	61.5%
Access to hunt antlerless elk on public land	62.5%	42.6%
Access to hunt antlerless elk on private land	38.7%	32.2%
Access to hunt bull elk on public land	72.9%	66.1%
Access to hunt bull elk on private land	36.6%	46.0%
To be able to hunt elk and other game species at the same time	71.1%	61.6%

[1] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 (“it is my least important hunting activity”) to 5 (“it is my most important hunting activity”).
[2] Respondents selected the region they spent the most time hunting mule deer in during the past 5 years.
[3] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 (“very unimportant”) to 5 (“very important”).

Table 9. Answers to scaled questions regarding resident and nonresident perceptions of elk hunting and management in Montana. Survey questions were framed in relation to the region that respondents spent the most time in during the 5 years prior to taking the survey (Table 8).

Survey Question	Resident	Non-resident
Overall opportunities to hunt elk[1]	57.0%	70.8%
Opportunities to hunt antlerless elk[1]	48.9%	62.5%
Opportunities to hunt bull elk[1]	49.6%	64.4%
Opportunities to hunt mature bull elk[1]	33.1%	48.5%
Access to publicly owned land to hunt antlerless elk[1]	52.9%	61.2%
Access to privately owned land to antlerless elk[1]	24.2%	39.9%
Access to publicly owned land to hunt bull elk[1]	56.1%	63.9%
Access to privately owned land to hunt bull elk[1]	19.5%	44.4%
Overall numbers of elk[2]	15.3%	18.0%
Overall numbers of antlerless elk[2]	24.8%	22.4%
Overall numbers of bull elk[2]	10.1%	13.9%
Overall numbers of mature bull elk[2]	8.5%	9.9%
Numbers of antlerless elk on publicly owned lands[2]	14.7%	15.2%
Numbers of antlerless elk on privately owned lands[2]	58.8%	46.8%
Numbers of bull elk on publicly owned lands[2]	7.5%	9.8%
Numbers of bull elk on privately owned lands[2]	52.1%	45.6%
Number of elk hunters[2]	60.3%	34.0%
Number of roads open to motorized access to elk[2]	24.6%	30.0%
Number of other hunters observed per day[2]	23.4%	44.3%
Behavior of other hunters typically observed[2]	48.8%	70.2%
Satisfaction with Montana's current elk hunting regulations[3]	37.2%	58.9%
The ease of understanding Montana's elk hunting regulations[4]	49.1%	51.8%

[1] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question from a scale of 1 ("poor") to 5 ("excellent").
[2] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question; from a scale of 1 ("too few") to 5 ("too many").
[3] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question; from a scale of 1 ("very dissatisfied") to 5 ("very satisfied").
[4] Percentages are the summed percentages of respondents who selected a 4 or 5 to this question; from a scale of 1 ("very difficult to understand") to 5 ("very easy to understand").

Table 10. Resident and nonresident elk hunter perceptions regarding restrictive elk hunting regulations should be.

Given only one choice, which of the following would be most favorable to you…	In Montana as a whole…		In the region of Montana you spent the most time hunting the past 5 years…	
	Resident	Nonresident	Resident	Nonresident
The opportunity to hunt bull elk every year (with a lower probability of harvesting a mature bull)	69.3%	63.9%	69.8%	66.1%
The opportunity to hunt bull elk once every several years (with a higher probability or harvesting a mature bull)	30.7%	36.1%	30.2%	33.9%

Table 11. Resident and nonresident perceptions regarding hunting pressure, the timing of Montana's elk hunting seasons and other season structures.

	Resident		Nonresident	
Survey Question	1 or 2	4 or 5	1 or 2	4 or 5
Acceptability of more restrictive season types implemented to reduce congestion and crowding in places where the number of elk hunters observed has become unacceptable…				
…to most elk hunters[1,2]	42.4%	26.5%	37.6%	27.8%
…to most private landowners[1,2]	45.7%	23.0%	41.0%	25.0%
Acceptability of more restrictive season types in some hunting districts leading to increased hunting pressure on less restrictive hunting districts[1]	47.5%	16.1%	38.9%	16.4%
Importance of being able to consistently hunt elk in the same place in Montana each and every year[3]	8.1%	75.5%	14.3%	65.0%
Support of the current timing of the 5-week general season for elk hunting which starts the third weekend in October and ends the Sunday after Thanksgiving[4]	8.8%	75.1%	6.5%	67.9%
Importance that the timing of elk season matches up with the timing of the mule deer hunting season[3]	20.3%	61.4%	14.1%	62.6%
Interest in…[5]				
…hunting elk during the archery season	33.7%	53.6%	25.7%	60.9%
…hunting elk during the general rifle season	3.7%	89.7%	11.7%	73.5%
…hunting elk during the muzzleloader season	60.7%	20.8%	58.9%	19.0%
…hunting elk during the winter/late shoulder season	29.7%	49.3%	52.1%	26.4%
…hunting antlerless elk	7.9%	79.1%	20.4%	63.7%
…hunting bull elk	5.2%	81.3%	1.6%	92.4%

[1] Percentages are the summed percentages of respondents who selected a 1 or 2, or 4 or 5 to this question from a scale of 1 ("very unacceptable") to 5 ("very acceptable").
[2] Under such a scenario, more restrictive elk season types might be considered even if elk population numbers support more liberal elk season types.
[3] Percentages are the summed percentages of respondents who selected a 1 or 2, or 4 or 5 to this question from a scale of 1 ("very unimportant") to 5 ("very important").
[4] Percentages are the summed percentages of respondents who selected a 1 or 2, or 4 or 5 to this question from a scale of 1 ("strongly oppose") to 5 ("strongly support").
[5] Percentages are the summed percentages of respondents who selected a 1 or 2, or 4 or 5 to this question from a scale of 1 ("very disinterested") to 5 ("very interested").

Table 12. Resident and nonresident motivations for elk hunting in Montana in 2022.

Reason[1]	Resident	Nonresident	Resident	Nonresident
	1 or 2		4 or 5	
To enjoy nature and the outdoors	2.6%	1.7%	91.3%	93.8%
To get venison for eating	7.2%	6.5%	79.5%	74.8%
To do something with my family	14.2%	18.9%	70.3%	64.4%
To be with friends with similar interests	9.7%	9.1%	73.3%	82.1%
To feel the exhilaration of the hunt	11.2%	5.6%	67.2%	81.9%
To develop my skills and abilities	13.6%	7.6%	62.5%	71.8%
To test my hunting skills	15.7%	7.6%	60.8%	73.5%
To harvest a mature bull	26.9%	9.9%	45.4%	64.0%
To feel a sense of accomplishment	14.4%	8.7%	64.3%	72.8%
To experience solitude	12.6%	8.7%	69.1%	74.3%

[1] Percentages are the summed percentages of respondents who selected a 1 or 2, or 4 or 5 to this question from a scale of 1 ("very unimportant") to 5 ("very important").

Table 13. Resident–nonresident Perceptions regarding a new Montana elk regulation in which applicants who successfully draw an either-sex elk permit in a given year are restricted to only hunting bull elk in that hunting district for which their permit is valid.

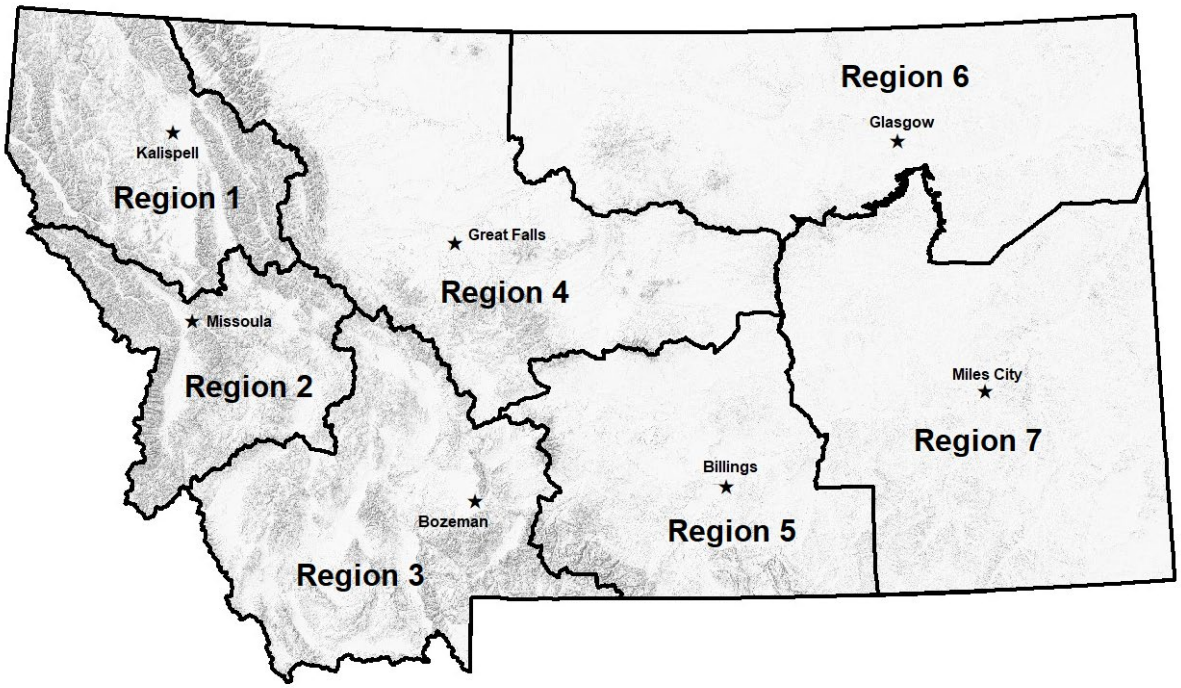
Survey Question		Resident	Nonresident
Prior to the 2022 hunting season, did you apply for any special elk hunting permits?	No	33.3%	64.1%
	Yes	66.7%	35.9%
If yes, did this new regulation affect how you approached applying for permits?	No	67.6%	70.3%
	Yes	32.4%	29.7%
This past hunting season (2022), do you hunt elk in any special permit elk hunting districts?	No	65.2%	80.8%
	Yes	34.8%	19.2%
If yes, do you think this new regulation results in any changes to…			
…hunting pressure in the special permit area(s) you hunted?	No	34.9%	26.5%
	Yes, it decreased pressure	10.2%	7.4%
	Yes, it increased pressure	14.3%	4.4%
	I don't know	40.6%	61.8%
…elk harvest in the special permit area(s) you hunted?	No	34.7%	20.6%
	Yes, it decreased pressure	9.4%	7.4%
	Yes, it increased pressure	5.9%	4.4%
	I don't know	49.9%	67.6%

Table 14. Background characteristics of survey respondents participating in a resident–nonresident elk hunter perception survey in 2023.

Survey Question	Possible Answer(s)	Resident	Nonresident
During the past 5 years, have you hunted mule deer in Montana?	Yes	74.0%	60.5%
	No	26.0%	39.5%
If yes, how often do you also hunt elk (or would harvest an elk) while primarily mule deer hunting?	Often/all the time	63.2%	64.7%
	Not often/never or rarely	23.1%	22.0%
How many of the past 5 years have you hunted elk in Montana?	1 year	7.2%	36.3%
	2 years	9.7%	17.7%
	3 years	11.2%	17.2%
	4 years	9.8%	12.7%
	All 5 years	62.1%	16.1%
How many days per year do you hunt elk in Montana?	Median	10.0	7.0
	Mean	13.3	8.8
Age of respondents	Median	54.0	54.0
	Mean	51.5	51.5

FIGURES

Figure 1. Map of Montana Fish, Wildlife & Parks' regional administrative boundaries.



APPENDIX A. Questions asked for Resident-Nonresident Mule Deer Hunter Preference Survey, 2011

1. During the past FIVE years, have you hunted MULE DEER in Montana?

   [ ] NO ..... **If no, you're done with the survey. Please return your survey using the enclosed postage-paid envelope.**
   [ ] YES

2. How important is mule deer hunting to you in Montana? **(check only one)**

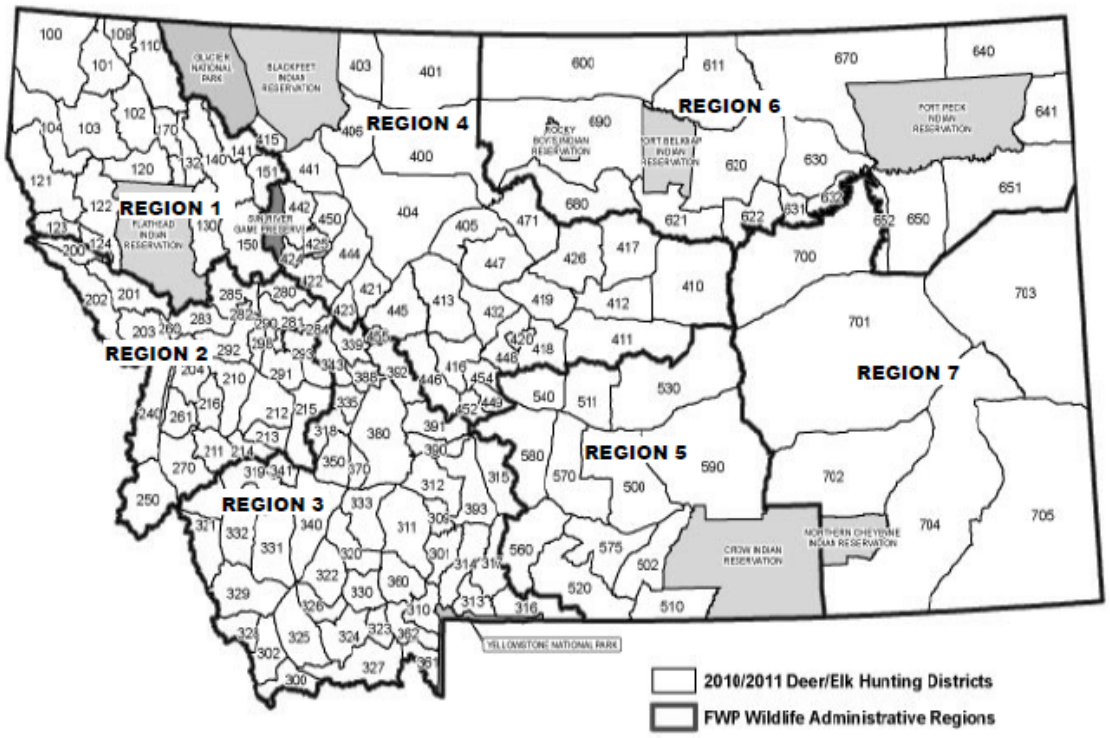
   [ ] It is *my LEAST important* hunting activity
   [ ] It is *one of my least important* hunting activities
   [ ] It is *no more or no less important* than my other hunting activities
   [ ] It is *one of my most important* hunting activities
   [ ] It is *my MOST important* hunting activity

3. Please refer to the map below. In what **REGION** of the state have you spent the MOST TIME hunting mule deer in Montana **during the past FIVE years**? **(check only one)**

   [ ] Region 1
   [ ] Region 2
   [ ] Region 3
   [ ] Region 4
   [ ] Region 5
   [ ] Region 6
   [ ] Region 7

   Please CHECK ONLY ONE region.

   Questions 4-8 on the following page will refer to this region of the state where you have spent the most time hunting mule deer during the past FIVE years.



Questions 4-8 focus on your mule deer hunting in the REGION you checked in question 3...the region of Montana where you have spent the most time hunting mule deer during the past FIVE years

4. On a scale from 1 (poor) to 5 (excellent), how would you rate the following in this **REGION** of Montana? **(Circle only one number for each item below)**

	Poor				Excellent
Opportunities to hunt mule deer overall	1	2	3	4	5
Opportunities to hunt antlerless mule deer	1	2	3	4	5
Opportunities to hunt small mule deer bucks	1	2	3	4	5
Opportunities to hunt medium mule deer bucks	1	2	3	4	5
Opportunities to hunt large mule deer bucks	1	2	3	4	5
Access to PUBLICLY owned land to hunt mule deer	1	2	3	4	5
Access to PRIVATELY owned land to hunt antlerless mule deer	1	2	3	4	5
Access to PRIVATELY owned land to hunt mule deer bucks	1	2	3	4	5

5. On a scale from 1 (too few) to 5 (too many), how would you rate the number of other hunters you typically see PER DAY when hunting mule deer in this **REGION** of Montana? **(check only one)**

(Too Few) 1 2 3 4 5 (Too many)

6. On a scale from 1 (very dissatisfied) to 5 (very satisfied), how satisfied are you with the current mule deer hunting regulations in this **REGION** of Montana? **(Circle only one number below)**

(Very dissatisfied) 1 2 3 4 5 (Very satisfied)

Comments: _____

_____

_____

(Please PRINT LEGIBLY)

7. On a scale from 1 (very difficult to understand) to 5 (very easy to understand), how would you rate the ease of understanding the current mule deer hunting regulations in this **REGION** of Montana? **(Circle only one number below)**

(Very difficult to understand) 1 2 3 4 5 (Very easy to understand)

8. During the past FIVE years, have you ever decided NOT to go mule deer hunting in this **REGION** of Montana because you thought the mule deer hunting regulations were too difficult to understand?

[ ] NO
[ ] YES, occasionally
[ ] YES, often

Satisfying the desires of a wide-range of hunter interests often leads to complex hunting regulation. *For questions 9-10, please indicate which ONE CHOICE would be most favorable to you.* **Please answer these two questions, even if you don't like either choice for a particular question.**

9. Given only ONE CHOICE, which of the following would be most favorable to you **in MONTANA as a whole**? **(check only one)**

[ ] With few exceptions, mule deer hunting regulations should be the same in most Hunting Districts across the state

-OR-

[ ] There should be a variety of different mule deer hunting regulations across the state to meet the desires of a wide-range of mule deer hunter interests

10. Given only ONE CHOICE, which of the following would be most favorable to you **in the REGION of Montana where you have spent the most time hunting mule deer during the past FIVE years**? **(check only one)**

[ ] With few exceptions, mule deer hunting regulations should be the same across most Hunting Districts in this REGION of the state

-OR-

[ ] There should be a variety of different mule deer hunting regulations across this REGION of the state to meet the desires of a wide-range of mule deer hunter interests

Managing for higher numbers of mature MULE DEER bucks (e.g., bucks 4-5 years of age or older) may require implementing more restrictive mule deer hunting regulations. For instance, in current limited permit areas the average drawing odds are once every four years. *For questions 11-13, please indicate which ONE CHOICE would be most favorable to you.* **Please answer these three questions, even if you don't like either choice for a particular question.**

11. Given only ONE CHOICE, which of the following would be most favorable to you **in MONTANA as a whole**? **(check only one)**

[ ] The opportunity to hunt mule deer bucks every year somewhere in Montana (with a *lower probability* of harvesting a mature buck)

-OR-

[ ] The opportunity to hunt mule deer bucks once every several years somewhere in Montana (with a *higher probability* of harvesting a mature buck)

12. Given only ONE CHOICE, which of the following would be most favorable to you **in the REGION of Montana where you've spent the most time hunting mule deer during the past FIVE years**? **(check only one)**

[ ] The opportunity to hunt mule deer bucks every year in this REGION of the state (with a *lower probability* of harvesting a mature buck)

-OR-

[ ] The opportunity to hunt mule deer bucks once every several years in this REGION of the state (with a *higher probability* of harvesting a mature buck)

13. Given only ONE CHOICE, which of the following would be most favorable to you **in the HUNTING DISTRICT where you most prefer to hunt mule deer in Montana**? **(check only one)**

[ ] The opportunity to hunt mule deer bucks every year in this Hunting District (with a *lower probability* of harvesting a mature buck)

-OR-

[ ] The opportunity to hunt mule deer bucks once every several years in this Hunting District (with a *higher probability* of harvesting a mature buck)

14. Implementing more restrictive mule deer hunting regulations in a Hunting District can lead to increased mule deer hunting pressure on less restrictive Hunting Districts in the state. In your opinion, how acceptable or unacceptable is this tradeoff? **(check only one)**

[ ] Very unacceptable
[ ] Unacceptable
[ ] Neither acceptable or unacceptable
[ ] Acceptable
[ ] Very acceptable

15. How important is it to you to be able to consistently hunt mule deer in the same place in Montana each and every year? **(check only one)**

[ ] Very unimportant
[ ] Unimportant
[ ] Neither important or unimportant
[ ] Important
[ ] Very important

16. To what extent do you support or oppose the hunting of mule deer **BUCKS** in Montana during the RUT (generally after mid-November)? **(check only one)**

[ ] Strongly oppose
[ ] Oppose
[ ] Neither support nor oppose
[ ] Support
[ ] Strongly support

17. How important is it to you to be able to hunt mule deer in Montana during the week that includes the Thanksgiving holiday? **(check only one)**

[ ] Very unimportant
[ ] Unimportant
[ ] Neither important or unimportant
[ ] Important
[ ] Very Important

18. To what extent do you support or oppose the current timing of the five-week general rifle season for mule deer hunting in Montana which starts the third weekend in October and ends the Sunday after Thanksgiving? **(check only one)**

[ ] Strongly oppose
[ ] Oppose
[ ] Neither support nor oppose
[ ] Support
[ ] Strongly support

19. How important is it to you that the timing of the general rifle season for mule deer hunting matches up with the timing of the general rifle season for elk hunting in Montana? **(check only one)**

[ ] Very unimportant
[ ] Unimportant
[ ] Neither important or unimportant
[ ] Important
[ ] Very Important

20. How interested are you in harvesting antlerless mule deer in Montana? **(check only one)**

[ ] Very disinterested
[ ] Disinterested
[ ] Neither interested or disinterested
[ ] Interested
[ ] Very interested

21. Below is a list of different reasons why people go deer hunting. On a scale from 1 (very unimportant) to 5 (very important), please indicate how important each of these reasons are to you for going MULE DEER hunting in Montana. **(Circle only one number for each reason listed below)**

Reason:	Very Unimportant				Very Important
To enjoy nature and the outdoors	1	2	3	4	5
To get venison for eating	1	2	3	4	5
To do something with my family	1	2	3	4	5
To be with friends who have similar interests	1	2	3	4	5
To feel the exhilaration of the hunt	1	2	3	4	5
To develop my skills and abilities	1	2	3	4	5
To test my hunting skills	1	2	3	4	5
To harvest a trophy buck	1	2	3	4	5
To feel a sense of accomplishment	1	2	3	4	5
To experience solitude	1	2	3	4	5

22. What is the single greatest BARRIER to you gaining the type of mule deer hunting experience you're looking for in Montana?

_____

_____

(Please PRINT LEGIBLY)

23. How many of the past FIVE years have you hunted mule deer in Montana? **(check only one)**

[ ] 1 year [ ] 2 years [ ] 3 years [ ] 4 years [ ] all 5 years

24. On average, about how many **DAYS PER YEAR** do you hunt mule deer in Montana? _____ (days per year)

25. In what hunting districts (HD's) have you spent the MOST TIME hunting mule deer in Montana during the past FIVE years?

HD: _____ HD: _____ HD: _____ HD: _____ HD: _____ HD: _____ HD: _____

26. How many of the past FIVE years have you hunted mule deer OUT-OF-STATE (not in Montana)? **(check only one)**

[ ] None [ ] 1 year [ ] 2 years [ ] 3 years [ ] 4 years [ ] all 5 years

27. What is the zip code of your current home residence? _____ (5-digit zip code)

28. What is your age? ____ (years) Are you? [ ] Female [ ] Male

29. Any additional comments or suggestions you have regarding MULE DEER management in Montana are more than welcome. *Thank you for printing legibly.*

_____

_____

_____

_____

_____

_____

_____

_____

_____

THANK YOU FOR YOUR HELP!

Please return your completed survey using the enclosed postage paid envelope.

Montana Fish, Wildlife & Parks
Human Dimensions Unit
1420 East Sixth Avenue, P.O. Box 200701
Helena, Montana 50620-0701

Montana Fish, Wildlife & Parks

APPENDIX B. Questions asked for Resident-Nonresident Mule Deer Hunter Preference Survey, 2023

«IDNO»

1. During the past FIVE years, have you hunted MULE DEER in Montana?

   [ ] NO ..... If no, you're done with the survey. Please return your survey using the enclosed postage-paid envelope.
   [ ] YES

2. How important is mule deer hunting to you in Montana? **(check only ONE below)**

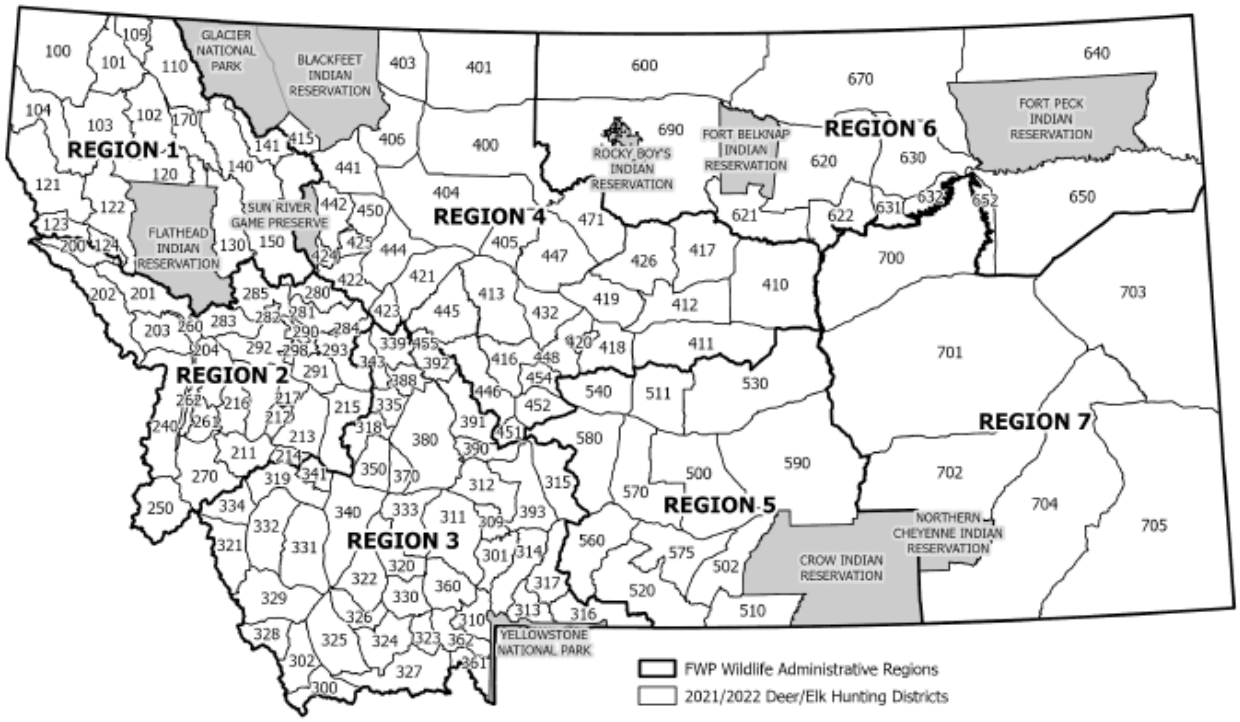
   [ ] It is ***my LEAST important*** hunting activity
   [ ] It is ***one of my least important*** hunting activities
   [ ] It is ***no more or no less important*** than my other hunting activities
   [ ] It is ***one of my most important*** hunting activities
   [ ] It is ***my MOST important*** hunting activity

3. Please refer to the map below. In what **REGION** of the state have you spent the MOST TIME hunting mule deer in Montana **during the past FIVE years**? **(check only ONE below)**

   [ ] Region 1
   [ ] Region 2
   [ ] Region 3
   [ ] Region 4
   [ ] Region 5
   [ ] Region 6
   [ ] Region 7

   Please **CHECK ONLY ONE** region.

   Questions 4-9 on the following pages refer to this region of the state where you have spent the most time hunting mule deer during the past FIVE years.



(OVER)

Questions 4-9 focus on the REGION you checked in question 3...the region of Montana where you have spent the most time hunting mule deer during the past FIVE years

4. On a scale from 1 (very unimportant) to 5 (very important), how important to you were the following potential reasons for why you spent most of your time hunting mule deer in this **REGION** of the state during the past five years? **(Circle only ONE number for each reason below)**

	Very Unimportant				Very Important
To hunt close to home	1	2	3	4	5
To hunt in a familiar location	1	2	3	4	5
Mule deer numbers	1	2	3	4	5
Antlerless mule deer numbers	1	2	3	4	5
Mule deer buck numbers	1	2	3	4	5
Access to hunt mule deer on PUBLICLY owned land	1	2	3	4	5
Access to hunt antlerless mule deer on PRIVATELY owned land	1	2	3	4	5
Access to hunt mule deer bucks on PRIVATELY owned land	1	2	3	4	5
To be able to hunt mule deer and other game species at the same time	1	2	3	4	5

Other reasons (please specify): _____

5. On a scale from 1 (poor) to 5 (excellent), how would you rate the following in this **REGION** of Montana? **(Circle only ONE number for each item below)**

	Poor				Excellent
Overall opportunities to hunt mule deer	1	2	3	4	5
Opportunities to hunt antlerless mule deer	1	2	3	4	5
Opportunities to hunt mule deer bucks	1	2	3	4	5
Opportunities to hunt mature mule deer bucks	1	2	3	4	5
Access to PUBLICLY owned land to hunt mule deer	1	2	3	4	5
Access to PRIVATELY owned land to hunt antlerless mule deer	1	2	3	4	5
Access to PRIVATELY owned land to hunt mule deer bucks	1	2	3	4	5

6. In terms of congestion & crowding, on a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable was the NUMBER of other hunters you typically observed PER DAY when hunting mule deer in this **REGION** of Montana? **(Circle only ONE number below)**

(Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

7. In terms of the behavior of people, on a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable was the BEHAVIOR of other hunters you typically observed when hunting mule deer in this **REGION** of Montana? **(Circle only ONE number below)**

(Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

8. On a scale from 1 (very dissatisfied) to 5 (very satisfied), how satisfied are you with the current mule deer hunting regulations in this **REGION** of Montana? **(Circle only ONE number below)**

(Very Dissatisfied) 1 2 3 4 5 (Very satisfied)

9. On a scale from 1 (very difficult to understand) to 5 (very easy to understand), how would you rate the ease of understanding the current mule deer hunting regulations in this **REGION** of Montana? **(Circle only ONE number below)**

(Very difficult to understand) 1 2 3 4 5 (Very easy to understand)

In addition to biological considerations, satisfying the desires of a wide range of hunter interests often leads to complex hunting regulation. *For questions 10-11, please indicate which ONE CHOICE would be most favorable to you.* **Please answer these two questions, even if you don't like either choice for a particular question.**

10. Given only ONE CHOICE, which of the following would be most favorable to you **in MONTANA as a whole**? **(check only ONE below)**

[ ] With few exceptions, mule deer hunting regulations should be the same in most Hunting Districts across the state

-OR-

[ ] There should be a variety of different mule deer hunting regulations across the state to meet the desires of a wide range of mule deer hunter interests

11. Given only ONE CHOICE, which of the following would be most favorable to you **in the REGION of Montana where you have spent the most time hunting mule deer during the past FIVE years**? **(check only ONE below)**

[ ] With few exceptions, mule deer hunting regulations should be the same across most Hunting Districts in this REGION of the state

-OR-

[ ] There should be a variety of different mule deer hunting regulations across this REGION of the state to meet the desires of a wide range of mule deer hunter interests

Managing for higher numbers of MATURE mule deer bucks (e.g., bucks 4-5 years of age or older) may require implementing more restrictive mule deer hunting regulations. For instance, in current limited permit areas the average drawing odds are once every ten years. *For questions 12-13, please indicate which ONE CHOICE would be most favorable to you.* **Please answer these two questions, even if you don't like either choice for a particular question.**

12. Given only ONE CHOICE, which of the following would be most favorable to you **in MONTANA as a whole**? **(check only ONE below)**

[ ] The opportunity to hunt mule deer bucks every year somewhere in Montana (with a *lower probability* of harvesting a mature buck)

-OR-

[ ] The opportunity to hunt mule deer bucks once every several years somewhere in Montana (with a *higher probability* of harvesting a mature buck)

(OVER)

13. Given only ONE CHOICE, which of the following would be most favorable to you **in the REGION of Montana where you've spent the most time hunting mule deer during the past FIVE years**? **(check only ONE below)**

[ ] The opportunity to hunt mule deer bucks every year in this REGION of the state (with a *lower probability* of harvesting a mature buck)

-OR-

[ ] The opportunity to hunt mule deer bucks once every several years in this REGION of the state (with a *higher probability* of harvesting a mature buck)

14. Implementing more restrictive mule deer hunting regulations in a Hunting District can lead to increased mule deer hunting pressure in less restrictive Hunting Districts across the state. On a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable or unacceptable to you is this tradeoff? **(Circle only ONE number below)**

(Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

15. On a scale from 1 (very unimportant) to 5 (very important), how important is it to you to be able to consistently hunt mule deer in the same place in Montana each and every year? **(Circle only ONE number below)**

(Very Unimportant) 1 2 3 4 5 (Very Important)

16. On a scale from 1 (strongly oppose) to 5 (strongly support), to what extent do you support or oppose the hunting of mule deer **BUCKS** in Montana during the RUT (generally after mid-November)? **(Circle only ONE number below)**

(Strongly Oppose) 1 2 3 4 5 (Strongly Support)

17. On a scale from 1 (very unimportant) to 5 (very important), how important is it to you to be able to hunt mule deer in Montana during the week that includes the Thanksgiving holiday? **(Circle only ONE number below)**

(Very Unimportant) 1 2 3 4 5 (Very Important)

18. On a scale from 1 (strongly oppose) to 5 (strongly support), to what extent do you support or oppose the current timing of the five-week general rifle season for mule deer hunting in Montana which starts the third weekend in October and ends the Sunday after Thanksgiving? **(Circle only ONE number below)**

(Strongly Oppose) 1 2 3 4 5 (Strongly Support)

19. How important is it to you that the timing of the general rifle season for mule deer hunting matches up with the timing of the general rifle season for elk hunting in Montana? **(Circle only ONE number below)**

(Very Unimportant) 1 2 3 4 5 (Very Important)

20. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in hunting mule deer during the ARCHERY season in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

21. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in hunting mule deer during the MUZZLELOADER season in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

22. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in harvesting antlerless mule deer in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

23. On a scale from 1 (very unacceptable) to 5 (very acceptable, how acceptable to you is the hunting of antlerless mule deer for management purposes (e.g., population control, game damage, disease management, etc.)? **(Circle only ONE number below)**

(Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

24. Below is a list of different reasons why people go deer hunting. On a scale from 1 (very unimportant) to 5 (very important), please indicate how important each of these reasons are to you for going MULE DEER hunting in Montana. **(Circle only ONE number for each reason listed below)**

Reason:	Very Unimportant				Very Important
To enjoy nature and the outdoors	1	2	3	4	5
To get venison for eating	1	2	3	4	5
To do something with my family	1	2	3	4	5
To be with friends who have similar interests	1	2	3	4	5
To feel the exhilaration of the hunt	1	2	3	4	5
To develop my skills and abilities	1	2	3	4	5
To test my hunting skills	1	2	3	4	5
To harvest a mature buck	1	2	3	4	5
To feel a sense of accomplishment	1	2	3	4	5
To experience solitude	1	2	3	4	5

25. From what sources do you typically get MOST of your information regarding mule deer and mule deer management in Montana? **(check ALL that apply below)**

[ ] Family/friends
[ ] Word of mouth
[ ] Other mule deer hunters
[ ] Montana Fish, Wildlife & Parks
[ ] Montana hunting regulations
[ ] Mule Deer Foundation
[ ] Sportsperson Group(s)
[ ] Private landowners
[ ] Websites
[ ] Facebook
[ ] Instagram
[ ] Twitter
[ ] Television, radio, newspapers, or magazines
[ ] Local or regional online event calendars
[ ] Community bulletin boards
[ ] YouTube
[ ] Other (please specify): _____

(OVER)

26. On a scale from 1 (very dissatisfied) to 5 (very satisfied), how satisfied are you with current mule deer management in Montana? **(Circle only ONE number below)**

(Very Dissatisfied) 1 2 3 4 5 (Very satisfied)

27. On a scale from 1 (little or no trust) to 5 (very high trust), how much trust do you place in FWP to manage mule deer in Montana? **(Circle only ONE number below)**

(Little or no trust) 1 2 3 4 5 (Very high trust)

28. How many of the past FIVE years have you hunted mule deer in Montana? **(check only ONE below)**

[ ] 1 year [ ] 2 years [ ] 3 years [ ] 4 years [ ] all 5 years

29. On average, about how many **DAYS PER YEAR** do you hunt mule deer in Montana? _____ (days per year)

30. During the past FIVE years, have you hunted ELK in Montana?

[ ] NO
[ ] YES..... If yes, on a scale from 1 (never or rarely) to 5 (all the time), how often do you also hunt mule deer (or would harvest a mule deer) while you are primarily elk hunting? **(Circle only ONE number below)**

(Never or rarely) 1 2 3 4 5 (All the time)

31. During the past FIVE years, have you hunted ANTELOPE in Montana?

[ ] NO
[ ] YES..... If yes, on a scale from 1 (never or rarely) to 5 (all the time), how often do you also hunt mule deer (or would harvest a mule deer) while you are primarily antelope hunting? **(Circle only ONE number below)**

(Never or rarely) 1 2 3 4 5 (All the time)

32. How old are you? _____ (age in years)

THANK YOU FOR YOUR HELP!

Please return your completed survey using the enclosed postage paid envelope.

Montana Fish, Wildlife & Parks
Human Dimensions Program, Wildlife Division
1420 East Sixth Avenue, P.O. Box 200701
Helena, Montana 59620-0701

MONTANA FWP

APPENDIX C. Questions asked for Resident-Nonresident Elk Hunter Preference Survey, 2023

«IDNO»

1. During the past FIVE years, have you hunted ELK in Montana?

   [ ] NO ..... If no, you're done with the survey. Please return your survey using the enclosed postage-paid envelope.
   [ ] YES

2. How important is ELK hunting to you in Montana? **(check only ONE below)**

   [ ] It is *my LEAST important* hunting activity
   [ ] It is *one of my least important* hunting activities
   [ ] It is *no more or no less important* than my other hunting activities
   [ ] It is *one of my most important* hunting activities
   [ ] It is *my MOST important* hunting activity

3. Please refer to the map below. In what **REGION** of the state have you spent the MOST TIME hunting ELK in Montana **during the past FIVE years**? **(check only ONE below)**

   [ ] Region 1
   [ ] Region 2
   [ ] Region 3
   [ ] Region 4
   [ ] Region 5
   [ ] Region 6
   [ ] Region 7

   Please **CHECK ONLY ONE** region.

   Questions 4-10 on the following pages refer to this region of the state where you have spent the most time hunting elk during the past FIVE years.

(OVER)

Questions 4-10 focus on the REGION you checked in previous question...the REGION of Montana where you have spent the most time hunting ELK during the past FIVE years

4. On a scale from 1 (very unimportant) to 5 (very important), how important to you were the following potential reasons for why you spent most of your time hunting ELK in this **REGION** of the state during the past five years?
(Circle only ONE number for each reason below)

	Very Unimportant				Very Important
To hunt close to home	1	2	3	4	5
To hunt in a familiar location	1	2	3	4	5
Elk numbers	1	2	3	4	5
Antlerless elk numbers	1	2	3	4	5
Bull elk numbers	1	2	3	4	5
Access to hunt antlerless elk on PUBLICLY owned land	1	2	3	4	5
Access to hunt antlerless elk on PRIVATELY owned land	1	2	3	4	5
Access to hunt bull elk on PUBLICLY owned land	1	2	3	4	5
Access to hunt bull elk on PRIVATELY owned land	1	2	3	4	5
To be able to hunt elk and other game species at the same time	1	2	3	4	5

Other reasons (please specify): _____

_____

5. On a scale from 1 (poor) to 5 (excellent), in general, how would you rate the following in this **REGION** of Montana?
Please circle only ONE number for each item below or check the "I don't know box" if you don't know.

	Poor				Excellent	I Don't Know
Overall opportunities to hunt elk	1	2	3	4	5	[ ]
Opportunities to hunt antlerless elk	1	2	3	4	5	[ ]
Opportunities to hunt bull elk	1	2	3	4	5	[ ]
Opportunities to hunt mature bull elk	1	2	3	4	5	[ ]
Access to PUBLICLY owned land to hunt antlerless elk	1	2	3	4	5	[ ]
Access to PRIVATELY owned land to hunt antlerless elk	1	2	3	4	5	[ ]
Access to PUBLICLY owned land to hunt bull elk	1	2	3	4	5	[ ]
Access to PRIVATELY owned land to hunt bull elk	1	2	3	4	5	[ ]

6. On a scale from 1 (too few) to 5 (too many), in general, how would you rate the following in this **REGION** of Montana during the HUNTING SEASON? **Please circle only ONE number for each item below or check the "I don't know box" if you don't know.**

	Too Few				Too Many	I Don't Know
Overall numbers of elk	1	2	3	4	5	[ ]
Overall numbers of antlerless elk	1	2	3	4	5	[ ]
Overall numbers of bull elk	1	2	3	4	5	[ ]
Overall numbers of mature bull elk	1	2	3	4	5	[ ]
Numbers of antlerless elk on PUBLICLY owned lands	1	2	3	4	5	[ ]
Numbers of antlerless elk on PRIVATELY owned lands	1	2	3	4	5	[ ]
Numbers of bull elk on PUBLICLY owned lands	1	2	3	4	5	[ ]
Numbers of bull elk on PRIVATELY owned lands	1	2	3	4	5	[ ]
Number of elk hunters	1	2	3	4	5	[ ]
Number of roads open for motorized access to elk	1	2	3	4	5	[ ]

7. In terms of congestion & crowding, on a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable was the NUMBER of other hunters you typically observed PER DAY when hunting ELK in this **REGION** of Montana? **(Circle only ONE number below)**

(Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

8. In terms of the behavior of people, on a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable was the BEHAVIOR of other hunters you typically observed when hunting ELK in this **REGION** of Montana? **(Circle only ONE number below)**

(Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

9. On a scale from 1 (very dissatisfied) to 5 (very satisfied), how satisfied are you with the current elk hunting regulations in this **REGION** of Montana? **(Circle only ONE number below)**

(Very Dissatisfied) 1 2 3 4 5 (Very satisfied)

10. On a scale from 1 (very difficult to understand) to 5 (very easy to understand), how would you rate the ease of understanding the current elk hunting regulations in this **REGION** of Montana? **(Circle only ONE number below)**

(Very difficult to understand) 1 2 3 4 5 (Very easy to understand)

(OVER)

Managing for higher numbers of MATURE bull elk (e.g., bull elk 4-5 years of age or older) may require implementing more restrictive elk hunting regulations. For instance, in current limited permit areas the average drawing odds are once every ten years. *For questions 11-12, please indicate which ONE CHOICE would be most favorable to you.* **Please answer these two questions, even if you don't like either choice for a particular question.**

11. Given only ONE CHOICE, which of the following would be most favorable to you **in MONTANA as a whole**? **(check only ONE below)**

    [ ] The opportunity to hunt bull elk every year somewhere in Montana (with a *lower probability* of harvesting a mature bull)

    -OR-

    [ ] The opportunity to hunt bull elk once every several years somewhere in Montana (with a *higher probability* of harvesting a mature bull)

12. Given only ONE CHOICE, which of the following would be most favorable to you **in the REGION of Montana where you've spent the most time hunting elk during the past FIVE years**? **(check only ONE below)**

    [ ] The opportunity to hunt bull elk every year in this REGION of the state (with a *lower probability* of harvesting a mature bull)

    -OR-

    [ ] The opportunity to hunt bull elk once every several years in this REGION of the state (with a *higher probability* of harvesting a mature bull)

13. On a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable would it be to you if more restrictive elk season types were implemented to reduce congestion and crowding in places where the number of elk hunters observed in the field per day has become unacceptable to most elk hunters? Under such a scenario, more restrictive elk season types might be considered even if elk population numbers support more liberal elk season types. **(Circle only ONE number below)**

    (Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

14. On a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable would it be to you if more restrictive elk season types were implemented to reduce congestion and crowding in places where the number of elk hunters observed in the field per day has become unacceptable to most private landowners? Under such a scenario, more restrictive elk season types might be considered even if elk population numbers support more liberal elk season types. **(Circle only ONE number below)**

    (Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

15. Implementing more restrictive ELK hunting regulations in a Hunting District can lead to increased elk hunting pressure in less restrictive Hunting Districts across the state. On a scale from 1 (very unacceptable) to 5 (very acceptable), how acceptable or unacceptable to you is this tradeoff? **(Circle only ONE number below)**

    (Very Unacceptable) 1 2 3 4 5 (Very Acceptable)

16. On a scale from 1 (very unimportant) to 5 (very important), how important is it to you to be able to consistently hunt ELK in the same place in Montana each and every year? **(Circle only ONE number below)**

    (Very Unimportant) 1 2 3 4 5 (Very Important)

17. On a scale from 1 (strongly oppose) to 5 (strongly support), to what extent do you support or oppose the current timing of the five-week general rifle season for ELK hunting in Montana which starts the third weekend in October and ends the Sunday after Thanksgiving? **(Circle only ONE number below)**

(Strongly Oppose) 1 2 3 4 5 (Strongly Support)

18. How important is it to you that the timing of the general rifle season for ELK hunting matches up with the timing of the general rifle season for mule deer hunting in Montana? **(Circle only ONE number below)**

(Very Unimportant) 1 2 3 4 5 (Very Important)

19. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in hunting ELK during the ARCHERY season in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

20. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in hunting ELK during the GENERAL RIFLE season in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

21. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in hunting ELK during the MUZZLELOADER season in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

22. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in hunting ELK during the winter/late SHOULDER season in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

23. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in harvesting antlerless ELK in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

24. On a scale from 1 (very disinterested) to 5 (very interested), how interested are you in harvesting bull ELK in Montana? **(Circle only ONE number below)**

(Very Disinterested) 1 2 3 4 5 (Very Interested)

25. Prior to this hunting season (2022), did you apply for any special elk hunting permits?

[ ] NO
[ ] YES..... If yes, please answer the following question. Under a new Montana elk hunting regulation, individuals who successfully draw an either-sex elk permit are limited to hunting bull elk in Montana ONLY in the hunting district for which their permit is valid. Did this new regulation affect how you approached applying for permits?

[ ] NO Comments: _____
[ ] YES _____

(OVER)

26. This past hunting season (2022), did you hunt elk in any special permit elk hunting districts?

[ ] NO
[ ] YES..... If yes, please answer the following two questions. Under a new Montana elk hunting regulation, individuals who successfully draw an either-sex elk permit are limited to hunting bull elk in Montana ONLY in the hunting district for which their permit is valid.

a. Do you think this new regulation resulted in any changes to hunting pressure in the special permit area(s) you hunted? **(check only ONE below)**

[ ] NO
[ ] YES, it decreased hunting pressure
[ ] YES, it increased hunting pressure
[ ] I don't know

b. Do you think this new regulation resulted in any changes to elk harvest in the special permit area(s) you hunted? **(check only ONE below)**

[ ] NO
[ ] YES, it decreased elk harvest
[ ] YES, it increased elk harvest
[ ] I don't know

27. On a scale from 1 (very dissatisfied) to 5 (very satisfied), how satisfied are you with ELK management in Montana? **(Circle only ONE number below)**

(Very Dissatisfied) 1 2 3 4 5 (Very satisfied)

28. On a scale from 1 (little or no trust) to 5 (very high trust), how much trust do you place in FWP to manage ELK in Montana? **(Circle only ONE number below)**

(Little or no trust) 1 2 3 4 5 (Very high trust)

29. Below is a list of different reasons why people go ELK hunting. On a scale from 1 (very unimportant) to 5 (very important), please indicate how important each of these reasons are to you for going ELK hunting in Montana. **(Circle only ONE number for each reason listed below)**

Reason:	Very Unimportant				Very Important
To enjoy nature and the outdoors	1	2	3	4	5
To get venison for eating	1	2	3	4	5
To do something with my family	1	2	3	4	5
To be with friends who have similar interests	1	2	3	4	5
To feel the exhilaration of the hunt	1	2	3	4	5
To develop my skills and abilities	1	2	3	4	5
To test my hunting skills	1	2	3	4	5
To harvest a mature bull	1	2	3	4	5
To feel a sense of accomplishment	1	2	3	4	5
To experience solitude	1	2	3	4	5

30. From what sources do you typically get MOST of your information regarding ELK and ELK management in Montana? **(check ALL that apply below)**

[ ] Family/friends
[ ] Word of mouth
[ ] Other elk hunters
[ ] Montana Fish, Wildlife & Parks
[ ] Montana hunting regulations
[ ] Rocky Mountain Elk Foundation
[ ] Sportsperson Group(s)
[ ] Private landowners
[ ] Websites
[ ] Facebook
[ ] Instagram
[ ] Twitter
[ ] Television, radio, newspapers, or magazines
[ ] Local or regional online event calendars
[ ] Community bulletin boards
[ ] YouTube
[ ] Other (please specify): _____

31. How many of the past FIVE years have you hunted ELK in Montana? **(check only ONE below)**

[ ] 1 year
[ ] 2 years
[ ] 3 years
[ ] 4 years
[ ] all 5 years

32. On average, about how many **DAYS PER YEAR** do you hunt ELK in Montana? _____ (days per year)

33. During the past FIVE years, have you hunted MULE DEER in Montana?

[ ] NO
[ ] YES..... If yes, on a scale from 1 (never or rarely) to 5 (all the time), how often do you also hunt ELK (or would harvest an ELK) while you are primarily mule deer hunting? **(Circle only ONE number below)**

(Never or rarely) 1 2 3 4 5 (All the time)

34. How old are you? _____ (age in years)

THANK YOU FOR YOUR HELP!

Please return your completed survey using the enclosed postage paid envelope.

Montana Fish, Wildlife & Parks
Human Dimensions Program, Wildlife Division
1420 East Sixth Avenue, P.O. Box 200701
Helena, Montana 59620-0701

MONTANA FWP

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www.sfw.net

The mission of SFW is to promote the protection and enhancement of wildlife habitat, assist in providing quality wildlife management programs, educating the public about the role hunters play in wildlife conservation, and perpetuating the family tradition of hunting and fishing.

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ARIZONA MULE DEER ORGANIZATION

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www.azmuledeer.org

Arizona Mule Deer Organization is an Arizona wildlife conservation group that focuses on water catchments, water hauling, and riparian protection. AMDO also believes deeply in the hunting heritage in Arizona and we hold 7 youth hunting camps throughout Arizona.

MULE DEER FOUNDATION

Steve Belinda
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P: 307-231-3128
www.muledeer.org

The Mule Deer Foundation is the only national non-profit conservation organization dedicated to the conservaiton of mule deer, black-tailed deer, and their habtiats.

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ARIZONA ELK SOCIETY
Stephen Clark
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www.arizonaelksociety.org
The mission of the Arizona Elk Society is to benefit elk and other wildlife by generating resources for habitat conservation and restoration, and to preserve our hunting heritage for present and future generations. Arizona Elk Society is the premier organization for supporting habitat restoration for elk and wildlife.

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Bearizona is a 160 acre wild animal park that specializes in the display and education of North American Wildlife.

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www.ckwri.tamuk.edu
The Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville is the leading wildlife research organization in Texas and one of the finest in the nation. Established in 1981 by a grant from the Caesar Kleberg Foundation for Wildlife Conservation, the Institute operates as a nonprofit organization and depends financially upon private contributions and faculty grantsmanship. Our mission is to provide science-based information for enhancing the conservation and management of Texas wildlife.

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Maria Hernandez
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P: 210-447-0126
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The East Foundation is an Agricultural Research Organization that promotes the advancement of land stewardship through ranching, science, and education. Our land, spanning over 217,000 acres of south Texas native rangeland, is managed as a working laboratory with cattle ranching as an integral part of the overall operation.

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Founded more than 38 years ago fueled by hunters and a membership of more than 231000 strong the Rocky Mountain Elk Foundation (RMEF) has protected or enhanced more than 8.1 million acres of wildlife habitat and opened or secured public access to 1.3 million acres. RMEF also works to fund and advocate for science-based resource management and to ensure the future of America's hunting heritage.

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The TRCP is a national 501(c)(3) non-profit organization that works with 60 partner groups and our Corporate Council members to guarantee all Americans quality places to hunt and fish.

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Tuesday Breakfast Sponsor

Russ Austad
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P: 920-743-6777
www.whitetailsunlimited.com

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Kay Nicholson
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P: 602-530-1605
wildlife.org/sw-section

The Wildlife Society's mission is to inspire, empower, and enable wildlife professionals to sustain wildlife populations and habitats through science-based management and conservation. The Southwest Section of The Wildlife Society serves members in Arizona, New Mexico, Texas, Mexico, and Costa Rica.

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Carolyn Nistler
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Specializing in cementum age analysis, Matson's Laboratory receives teeth by the thousands each month. Established in 1969, our work is familiar to most regional game managers and biologists, many of whom collect teeth at hunter check stations. The data we provide is used as an indispensable tool in wildlife management. Our wildlife conservation work behind the scenes is sometimes less apparent. The Lab receives teeth, soft tissue, and an assortment of bones for age analysis of threatened and endangered species. Our tetracycline screening services provide data for animal disease vaccine development and mark-recapture studies. Accurate and dependable age data is an important covariate for many ongoing research projects, and we have partnered with management and conservation agencies worldwide. Trusted by wildlife professionals for over 50 years, Matson's Laboratory embraces Conservation through Science!

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Emma DiMarco
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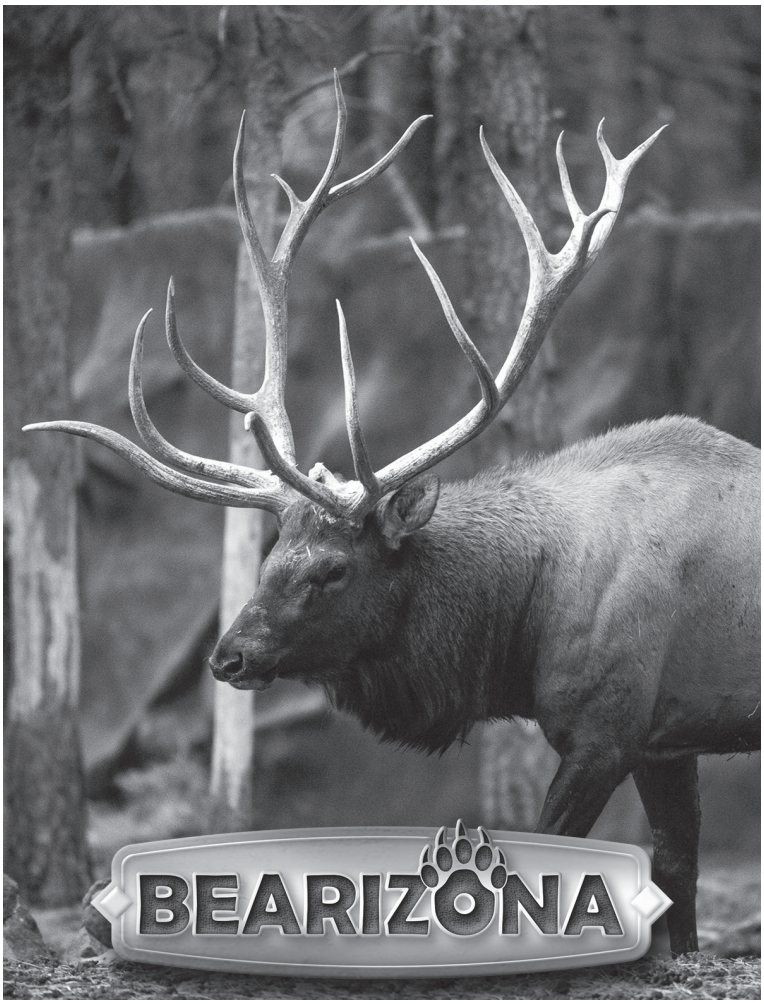

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