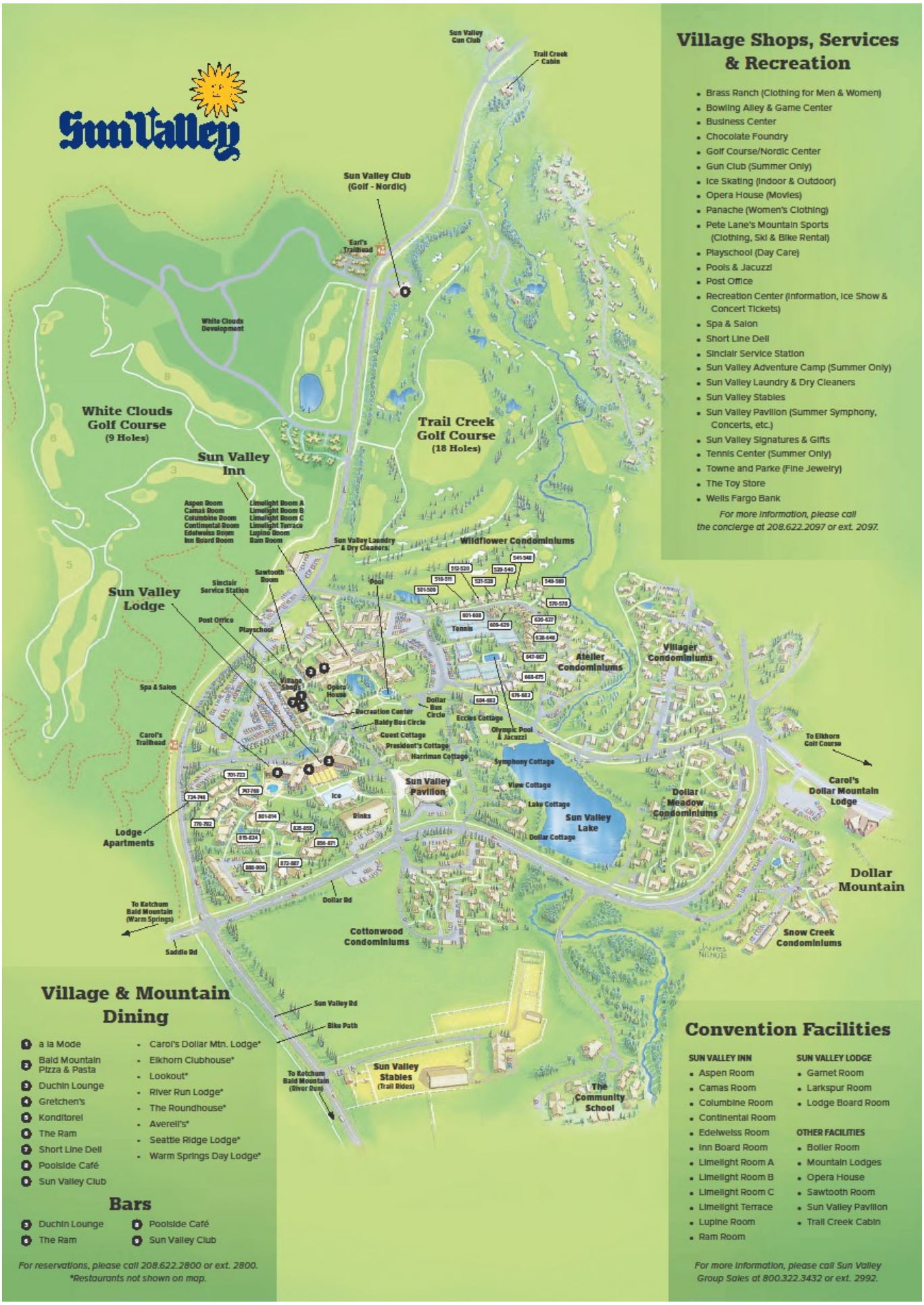
DEER & ELK WORKSHOP

May 1-4, 2017
Sun Valley Resort
Sun Valley, Idaho



Village Shops, Services & Recreation

- Brass Ranch (Clothing for Men & Women)
- Bowling Alley & Game Center
- Business Center
- Chocolate Foundry
- Golf Course/Nordic Center
- Gun Club (Summer Only)
- Ice Skating (Indoor & Outdoor)
- Opera House (Movies)
- Panache (Women's Clothing)
- Pete Lane's Mountain Sports (Clothing, Ski & Bike Rental)
- Playschool (Day Care)
- Pools & Jacuzzi
- Post Office
- Recreation Center (Information, Ice Show & Concert Tickets)
- Spa & Salon
- Short Line Deli
- Sinclair Service Station
- Sun Valley Adventure Camp (Summer Only)
- Sun Valley Laundry & Dry Cleaners
- Sun Valley Stables
- Sun Valley Pavilion (Summer Symphony, Concerts, etc.)
- Sun Valley Signatures & Gifts
- Tennis Center (Summer Only)
- Towne and Parke (Fine Jewelry)
- The Toy Store
- Wells Fargo Bank

For more information, please call the concierge at 208.622.2097 or ext. 2097.

Village & Mountain Dining

- a la Mode
- Bald Mountain Pizza & Pasta
- Duchin Lounge
- Gretchen's
- Konditorei
- The Ram
- Short Line Deli
- Poolside Café
- Sun Valley Club
- Carol's Dollar Mtn. Lodge*
- Elkhorn Clubhouse*
- Lookout*
- River Run Lodge*
- The Roundhouse*
- Averell's*
- Seattle Ridge Lodge*
- Warm Springs Day Lodge*

Bars

- Duchin Lounge
- The Ram
- Poolside Café
- Sun Valley Club

For reservations, please call 208.622.2800 or ext. 2800.
**Restaurants not shown on map.*

Convention Facilities

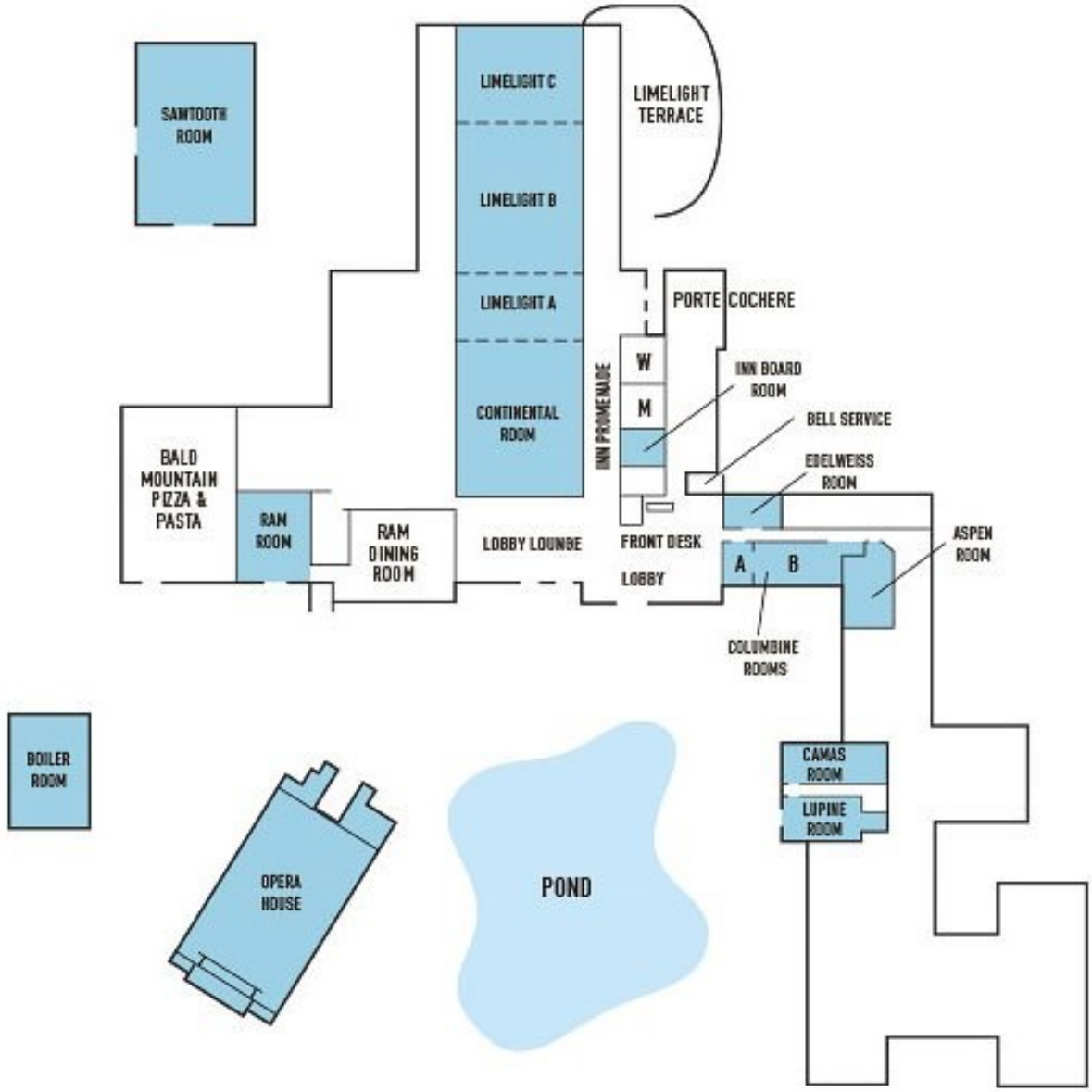
SUN VALLEY INN
- Aspen Room
- Camas Room
- Columbine Room
- Continental Room
- Edelweiss Room
- Inn Board Room
- Limelight Room A
- Limelight Room B
- Limelight Room C
- Limelight Terrace
- Lupine Room
- Ram Room

SUN VALLEY LODGE
- Garnet Room
- Larkspur Room
- Lodge Board Room

OTHER FACILITIES
- Boiler Room
- Mountain Lodges
- Opera House
- Sawtooth Room
- Sun Valley Pavilion
- Trail Creek Cabin

For more information, please call Sun Valley Group Sales at 800.322.3432 or ext. 2992.

Inn & Village Convention Facilities



12TH
DEER & ELK WORKSHOP

SUN VALLEY, IDAHO 2017

Table of Contents

Registration and Logistics

Conference Venue

All workshop activities, besides the field trips, will take place at the Sun Valley Resort (1 Sun Valley Road, Sun Valley, ID; Phone—(208) 622-4111; *www.sunvalley.com*) in the Opera House, Limelight A/B/C, Continental, and Larkspur rooms. The Monday social will be held at the Dollar and Lake Cottages.

Registration

Registration fees include admission to all presentation sessions, breaks, social activities, and banquet along with the program and a meeting gift bag.

Registration Fees:

$ 300	Early registration
$ 350	Late and on-site registration
$ 20	Field trip (pre-registration required)
$ 50	Extra banquet ticket

The registration desk will be open at the following times:

Monday	1 May	3:00 pm—6:00 pm
Tuesday	2 May	7:00 am—5:00 pm
Wednesday	3 May	8:00 am—12:00 pm
Thursday	4 May	8:00 am—12:00 pm

Organizing Committee

Toby Boudreau—Chair
David Smith—Logistics and on-site coordination
Kathy Archer—WAFWA representative

Eric Anderson	Paul Atwood	Michelle Commons-Kemner
Eric Freeman	Chris Gaughan	John Guthrie
Jerome Hansen	Kelton Hatch	Curtis Hendricks
Mark Hurley	Brad Lowe	Daryl Meints
Hollie Miyasaki	Barb Moore	Matt Pieron
Jake Powell	Jon Rachael	Shane Roberts
Josh Rydalch	Wayne Wakkinen	Ryan Walker
Craig White	Ross Winton	Laura Wolf

Contributing Artists

Eric Anderson—2017 Workshop Logo
Anna Owsiak—Cover Art

Workshop Sponsors

Platinum Level—$1,500+

Gold Level—$1,000-$1,500

Silver Level—$500-$1,000

Bronze Level—Up to $500

Program At a Glance

Monday 1 May		
Time		
13:00-17:00	Mule Deer Working Group Meeting (Larkspur Room, Sun Valley Lodge)	
18:00+	Casual Social—food and drinks provided (Dollar and Lake Cottages)	
Tuesday 2 May		
Time	**Room—Opera House**	
08:00-08:10	Welcome - Virgil Moore, Director, Idaho Dept. of Fish and Game	
08:10-12:10	**Plenary Session—*Integrating Technology into Deer and Elk Management*** Invited Speakers: Lisette Waits, Paul Cross, Paul Lukacs, Joseph Sexton, Mark Hebblewhite, Josh Nowak	
12:10-13:20	Lunch (**Room—Limelight A & B**)	
13:20-15:10	State/Province Updates	
	Room—Opera House	**Room—Limelight C**
15:30-18:00	New Tools/Technology	Nutrition (w/ group discussion)
18:00+	Social and Poster Session—hors d' oeuvres and drink **(Room—Continental)**	
Wednesday 3 May		
Time	**Room—Opera House**	**Room—Limelight C**
08:00-09:40	Population Dynamics I	National Topics/To The Point I
10:10-11:30	Population Dynamics II	To The Point II
11:45-17:00	Field trips (lunch provided, pre-registration required)	
18:00+	Banquet—dinner and drink, awards, entertainment (**Room—Limelight A/B/C)**	
Thursday 4 May		
Time	**Room—Opera House**	**Room—Limelight C**
08:00-09:40	Migration/Disease	Habitat
10:10-12:10	Disease	Harvest
12:10-13:30	Lunch—sign-up at registration desk required (**Room—Limelight A & B**)	
13:30-17:00	Conference rooms available for meetings/group discussions	

Presenter Information

Oral Presenters

Please note that all **full presentations** should be limited to 20 minutes total (including time for questions), whereas **To The Point** session talks should be limited to 10 minutes. Respect other speakers and your audience by staying within your scheduled time. It is extremely important that we maintain this schedule so that attendees can move between sessions. For **full presentations**, a brief (5 minute) period post-presentation should be left so members of the audience can ask a few questions. There likely won't be time for questions after each **To The Point** presentation and the audience will be instructed to catch you during breaks to discuss. Take the time to practice so your delivery fits into the scheduled interval; we will have to be very strict on time allotments to stay on schedule. Please save your presentation in Microsoft Office PowerPoint 2010 format. Plan to meet your session chair in the presentation room at least 20 minutes prior to your session to get your presentation loaded on the computer and familiarize yourself with the presentation equipment (remote control, laser pointer).

Posters

The poster session will be held during the Social on Tuesday, May 2, in the Continental Room. Posters must be 48 inches wide or less. Posters can be set up as early as Monday (talk to David Smith at the registration desk for instructions) but must be set up no later than immediately after the Tuesday afternoon contributed paper sessions. We will provide a method to attach your poster to the poster stands. All authors should be at their posters and prepared to discuss their work from 18:00 to 20:00 on Tuesday evening.

Banquet Awards

O.C. Wallmo Award
This award, presented by the Mule Deer Working Group, recognizes outstanding contributions to our knowledge and improved management of black-tailed and mule deer. 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 is 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 clear-cuts 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" still serves as the primary source of basic information about that species. 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.

Excellence in Elk Country—Wildlife Researcher/Biologist
This award, presented by Rocky Mountain Elk Foundation, 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.

Banquet Entertainment

Billy Braun
In showcasing all that is Idaho, we are proud to have a member of the Braun family, Billy Braun from Caldwell, Idaho, as our banquet entertainer. For over 60 years and three generations, the Braun family has been making and playing music in Idaho and across the country. Each year in August, the Braun Brothers and their family and friends host the Braun Brothers Reunion in Challis, Idaho. The three day music festival is attend by 1000's to see the best in country, blues and rock.

We hope you enjoy.

Tuesday Morning—Opera House

Plenary Session (Chair: Mark Hurley)

08:00-08:10 Welcome: Virgil Moore, Director, Idaho Dept. of Fish and Game

Integrating Technology into Deer and Elk Management

08:10-08:45 **Lisette Waits—**Genetic Contributions to Research and Management of Deer and Elk

08:45-09:20 **Paul Cross**—Advances in Disease Ecology

09:20-09:55 **Paul Lukacs**—Inference to Population Dynamics of Unmarked Populations of Deer and Elk

09:55-10:25 Break

10:25-11:00 **Joseph Sexton**—Satellite-based Monitoring of Wildlife Habitats: Status and Prospects for Scaling Adaptive Landscape Management in the Era of Big Data

11:00-11:35 **Mark Hebblewhite**—The Final Frontier? Strategies and Tools for Linking Populations to Habitats

11:35-12:10 **J. Joshua Nowak**—Practical Application of Integrated Population Models

12:10-13:20 Lunch (Limelight A & B)

Tuesday Afternoon—Opera House

State/Province Updates (Chair: Craig White)

13:20-13:29	**Idaho**—Craig White
13:29-13:38	**Alberta**—Grant Chapman
13:38-13:47	**California**—Terri Weist
13:47-13:56	**Colorado**—Andy Holland
13:56-14:05	**Montana**
14:05-14:14	**New Mexico**—James Pitman
14:14-14:23	**Oregon**—Don Whittaker
14:23-14:32	**South Dakota**—Andy Lindbloom
14:32-14:41	**Texas**—Shawn Gray
14:41-14:50	**Utah**—Justin Shannon
14:50-14:59	**Washington**—Sara Hansen
14:59-15:08	**Wyoming**—Justin Binfet
15:10-15:30	**Break**

Tuesday Afternoon—Concurrent Sessions

Opera House—New Tools/Technology (Chair: Jon Rachael)

15:30-15:50 **Can we estimate seasonal migration routes in areas without location data? Elk in south central Idaho as a test assessment.** SCOTT BERGEN, Kyle Anderson, Jon Horne, Shane Roberts, and Mark Hurley

15:50-16:10 **Picture this: monitoring migratory elk herds using remote photography.** TRAVIS ZAFFARANO, Matthew Kauffman, Doug McWhirter, Gregg Anderson, and Alyson Courtemanch

16:10-16:30 **Estimating abundance of unmarked populations using camera traps.** ANNA MOELLER, Paul Lukacs, and Jon Horne

16:30-16:50 **There's an app for that: integrating technology into Utah's depredation/mitigation program.** COVY JONES, Greg Evans, Brian Swaner, and Dax Mangus

16:50-17:10 **Closing the loop from data collection to decision.** J. JOSHUA NOWAK, Paul Lukacs, Mark Hurley, Andy Lindbloom, and Kevin Robling

17:10-17:30 **Data weighting for integrated population models.** CHARLES HENDERSON JR., Paul Lukacs, and Mark Hurley

Limelight C Room—Nutrition (Chair: Barb Moore)

15:30-15:50 **New insight into utilizing bone marrow to assess ungulate health.** JACOB KAY and James Cain III

15:50-16:10 **Overwinter body condition declines of mule deer in Utah.** KENT HERSEY, Randy Larsen, Justin Shannon, and Brock McMillan

16:10-16:30 **A comparison of nutrition and foraging behaviors between sympatric mule and white-tailed deer in northeastern Washington.** STEPHANIE BERRY, Lisa Shipley, Ryan Long, Mark Swanson, and Chris Loggers

16:30-16:50 **Variability in elk forage in a landscape of wildfire and changing fire management.** KELLY PROFFITT, Jesse DeVoe, Kristin Barker, Rebecca Durham, Teagan Hayes, Mark Hebblewhite, Craig Jourdonnais, and Philip Ramsey

16:50-17:10 **Alfalfa and buckwheat: Utah's approach to feeding the little rascals.** JUSTIN SHANNON and Kent Hersey

17:10-18:00 **Group discussion on winter feeding/nutrition**

18:00+ Social and Poster Session (Continental Room)

Tuesday Evening—Continental Room

18:00+ **Social and Poster Session**—hors d' oeuvres and drinks provided

Posters

Central Idaho elk migration—the travels of 15 selected GPS-collared elk. Chris Gaughan, Dennis Newman, and Scott Bergen

Profiling poachers: using randomized response technique to estimate rates of hunting violations by deer and elk hunters in Washington State. Anthony Novack

Harvest of elk (*Cervus elaphus*): does hunting pressure from humans influence habitat selection? Maksim Sergeyev, Brock McMillan, Kent Hersey, and Randy Larsen

Do mule deer afwns born inside the peak parturition period have higher survival than those born outside? Jacob Hall, Brock McMillan, Eric Freeman, Kent Hersey, and Randy Larsen

Habitat use by Columbian white-tailed deer along the lower Columbia River. Jon Heale, Lisa Shipley, Dan Thornton, and Paul Meyers

Juvenile survival of mule deer in the Blue Mountains of Oregon. Nathan Jackson, Kelley Stewart, Danielle Walsh, and Darren Clark

Influence of agriculture on mule deer diets and nutrition in the Texas panhandle. Jacob Lampman, Laura Warner, Louis Harveson, David Hewitt, Warren Conway, Shawn Gray, Dana Wright, Timothy Fulbright, and Randy DeYoung

Migration choices and the impact on survival in the Pacific mule deer herd. Jerrod Merrell, Kelley Stewart, and Shelly Blair

Applying mobile technology to large mammal surveys: an example application of ArcGIS Collector. Jonathan Muir, Autumn Larkins, and Travis Schultz

Individual-based modeling of interactions between ungulates and wolves. Sarah Sells, Michael Mitchell, Angela Luis, and Kevin Podruzny

Comparison of trace mineral concentrations in Idaho's mule deer populations. Stacey Dauwalter, Tricia Hosch-Hebdon, Daniel Dauwalter, R. Katherine Keeton, and Mark Drew

Distribution and habitat use of female elk (*Cervus elaphus*) on forest and agricultural lands in Skagit County, WA. Jennifer Sevigny, Emily George-Wirtz, and Michael Sevigny

Alberta elk and mule deer harvest scenario modelling, population and occupancy estimation using remote cameras, and novel conflict data uses in game management. Grant Chapman, Justin Gilligan, and Emily Herdman

Black-tailed deer density estimation in western Oregon. Dewaine Jackson, Donald Whittaker, and Keith Kohl

Use of a remote-based cellular camera system to reduce cranberry crop damage by Roosevelt elk in coastal Washington. Scott Harris

Adaptive management of urban elk in western Wyoming. Ben Wise and Alyson Courtemanch

Influence of winter wheat production on mule deer movements in the Texas panhandle. Laura Warner, Jacob Lampman, David Hewitt, Shawn Gray, Dana Wright, Warren Conway, Timothy Fulbright, Randy DeYoung, Louis Harveson

Wednesday—Opera House

Population Dynamics I (Chair: Paul Atwood)

08:00-08:20	**Survival and movements of translocated mule deer in southeastern Brewster County, Texas.** J.C. KIDDO CAMPBELL, Louis Harveson, Ryan Luna, Ryan O'Shaughnessy, Shawn Gray, and Thomas Janke
08:20-08:40	**Effects of coyote control on the survival of neonate mule deer.** BROCK MCMILLAN, Eric Freeman, Jacob Hall, Kent Hersey, Justin Shannon, and Randy Larsen
08:40-09:00	**Survival rates and cause-specific mortality of mule deer in south-central Oregon.** ELIZABETH SCHUYLER, Katie Dugger, and Dewaine Jackson
09:00-09:20	**Modelling and forecasting mule deer survival in Utah: a look at reducing uncertainty in forecasts using adaptive techniques.** S. ANDREW SIMS, David Stoner, Kent Hersey, Heather Bernales, Jyothy Nagol, Joseph Sexton, and Thomas Edwards Jr.
09:20-09:40	**Disentangling weather and density-dependent effects on mule deer population dynamics.** MARK HURLEY, Josh Nowak, Paul Lukacs, Jean-Michel Gaillard, and Mark Hebblewhite
09:40-10:10	**Break**

Population Dynamics II (Chair: Toby Boudreau)

10:10-10:30	**Ecological drivers of elk survival in Idaho.** JON HORNE, Mark Hurley, Erin Roche, and Scott Bergen
10:30-10:50	**Evaluating effects of nutrition and predation on an elk population in New Mexico.** NICOLE QUINTANA, Stewart Liley, James Cain III, James Pitman
10:50-11:10	**Factors affecting gray wolf (*Canis lupus*) encounter rate of elk (*Cervus elaphus*) in Yellowstone National Park.** HANS MARTIN, L. David Mech, John Fieberg, Daniel MacNulty, Daniel Stahler, and Douglas Smith
11:10-11:30	**A framework for estimating elk abundance in Arizona.** KIRBY BRISTOW, Mathew Clement, Michelle Crabb, and Larisa Harding
11:45-17:00	**Field Trips (pre-registration required, info at registration desk)**
18:00+	**Banquet (Limelight A/B/C) - dinner & drinks, awards, entertainment**

Wednesday—Limelight C Room

National Topics (Chair: Dave Musil)

08:00-08:20	**National Deer Alliance and the political science of CWD.** NICK PINIZZOTTO
08:20-08:40	**Returning elk to eastern North America.** DON WHITE JR. and Tom Toman

To The Point I (Chair: Dave Musil)

08:40-08:50	**Partnerships for deer and grouse habitat restoration in southern Idaho.** Steve Belinda
08:50-09:00	**Eroding perceived barriers by landowners in establishing game fencing around high value crops.** Joseph Bridges
09:00-09:10	**Deer adenovirus discovered in Montana.** Keri Carson
09:10-09:20	**Land use diversification & intensification on elk winter range in the Greater Yellowstone Ecosystem.** Katie Epstein
09:20-09:30	**TelemetR: a tool for managing, visualizing, and analyzing animal movement data.** Cody McKee
09:30-09:40	**Strategic placement of wildlife crossings to mitigate deer/vehicle collisions.** Sara Holm
09:40-10:10	**Break**

To The Point II (Chair: Eric Anderson)

10:10-10:20	**Sampling deer fecal DNA in Alaska: progress and lessons learned.** Karin McCoy
10:20-10:30	**Mule deer herd range delineation in E. Oregon.** Philip Milburn
10:30-10:40	**Mule deer research and management in the Bitterroot Valley, Montana.** Rebecca Mowry
10:40-10:50	**Low calf recruitment in a New Mexico elk herd: investigation and management implications.** James Pitman
10:50-11:00	**Predicting nutritional condition and pregnancy of elk from remotely-sensed data.** Sierra Robatcek
11:00-11:10	**Identifying timing and peak of rut activity in mule deer using GPS radio collars.** Cody Schroeder
11:10-11:20	**British Columbia elk management plan.** Tara Szkorupa
11:20-11:30	**Estimating deer abundance using fecal DNA on a regional scale.** Terri Weist
11:45-17:00	**Field Trips (pre-registration required, info at registration desk)**
18:00+	**Banquet (Limelight A/B/C) - dinner & drinks, awards, entertainment**

Thursday—Opera House

Habitat (Chair: Jerome Hansen)

08:00-08:20	**Behavioral plasticity buffers mule deer from demographic impacts of energy development.** Joseph Northrup, CHARLES ANDERSON JR., Brian Gerber, and George Wittemyer
08:20-08:40	**Habitat selection by female mule deer: tradeoffs associated with reproduction.** LEVI HEFFELFINGER, Kelley Stewart, Kevin Shoemaker, Vernon Bleich, and Neal Darby
08:40-09:00	**Maternal trade-offs in habitat selection across scales influence calf survival.** JODI BERG, Evelyn Merrill, and Mark Hebblewhite
09:00-09:20	**Influence of agriculture on mule deer movement in the Texas panhandle.** LAURA WARNER, Jacob Lampman, David Hewitt, Shawn Gray, Dana Wright, Warren Conway, Timothy Fulbright, Randy DeYoung, and Louis Harveson
09:20-09:40	**Quantifying long-term effects of fire history on elk behavior.** DEREK SPITZ, Mike Wisdom, Taal Levi, Mary Rowland, and Darren Clark
09:40-10:10	**Break**

Habitat/Harvest (Chair: Toby Boudreau)

10:10-10:30	**Defending management decisions by using a resource selection function to estimate elk use on private property in Nevada.** CODY MCKEE, Brian Wakeling, and W. Scott Roberts
10:30-10:50	**The thorny world of cactus bucks.** JAMES HEFFELFINGER, Justin Shannon, and Anette Roug
10:50-11:10	**A 20+ year retrospective on spike-only general seasons/branched bull permits for elk hunting in eastern Washington.** SCOTT MCCORQUODALE, Jerry Nelson, Paul Wik, Jeff Bernatowicz, Kevin Robinette, and Brock Hoenes
11:10-11:30	**Trade-offs between forage and risk for elk during the fall archery hunting season.** JESSE DEVOE, Kelly Proffitt, Kristin Barker, Craig Jourdonnais, and Philip Ramsey
11:30-11:50	**Effects of hunter access on hunting season elk distributions in the Missouri River Breaks.** Scott Thompson, DREW HENRY, Kelly Proffitt, and Justin Gude
11:50-12:10	**Security areas for elk during archery and rifle hunting seasons.** Dustin Ranglack, Kelly Proffitt, Jodie Canfield, JUSTIN GUDE, Jay Rotella, and Robert Garrott
12:10-13:30	**Lunch** (sign-up at registration desk required)

13:30-17:00 Opera House and Limelight C available for meetings/group discussions

Thursday—Limelight C Room

Migration/Disease (Chair: Craig White)

08:00-08:20	**Nutritional and demographic consequences of varying elk migratory behaviors.** KRISTIN BARKER, Kelly Proffitt, Jesse Devoe, Michael Mitchell, Craig Jourdonnais, and Philip Ramsey
08:20-08:40	**Changing migration in the Ya Ha Tinda elk population: when, where, and why to migrate?** Joshua Killeen, EVELYN MERRILL, Holger Bohm, Jodi Berg, Scott Eggeman, and Mark Hebblewhite
08:40-09:00	**Defining brucellosis transmission risk areas and parturition ranges of elk in western Wyoming.** BRANDON SCURLOCK, Jared Rogerson, Eric Maichak, Benjamin Wise, and Rebecca Fuda
09:00-09:20	**Linking spring phenology with mechanistic models of elk movement to predict brucellosis transmission risk.** JEROD MERKLE, Paul Cross, Brandon Scurlock, Eric Cole, Alyson Courtemanch, Sarah Dewey, and Matthew Kauffman
09:20-09:40	**Investigating elk movement and connectivity to predict the spread of brucellosis.** ANGELA BRENNAN, Paul Cross, Ephraim Hanks, Elk Brucellosis Working Group
09:40-10:10	**Break**

Disease (Chair: Hollie Miyasaki)

10:10-10:30	**Multiple ways to be dense and transmit disease: patterns in elk aggregation and increasing brucellosis.** ANGELA BRENNAN, Paul Cross, William Edwards, Brandon Scurlock, and Scott Creel
10:30-10:50	**Chronic wasting disease in Wyoming.** HANK EDWARDS, Mary Wood, Jessica Jennings-Gaines, and Hally Killion
10:50-11:10	**Analysis of allelic variation in prion protein gene of Texas mule deer.** GAEL SANCHEZ, Randy DeYoung, Damon Williford, David Hewitt, Timothy Fulbright, Humberto Perotto-Baldiviseo, Louis Harveson, and Shawn Gray
11:10-11:30	**Endemic chronic wasting disease contributes to deer declines in Wyoming.** MELIA DEVIVO, Dave Edmunds, Matthew Kauffman, Brant Schumaker, Justin Binfet, Terry Kreeger, Bryan Richards, Hermann Schatzl, and Todd Cornish
11:30-11:50	**Characterization and progression of treponeme-associated hoof disease (TAHD) lesions in elk.** KRISTIN MANSFIELD, Sushan Han, and Jennifer Wilson-Welder
11:50-12:10	**Responding to the emergence of treponeme-associated hoof disease (TAHD) of elk in western Washington.** BROCK HOENES, Kristin Mansfield, Brooke George, Eric Holman, Sandra Jonker, Ilai Keren, Jerry Nelson, and Nicholle Stephens.
12:10-13:30	**Lunch** (sign-up at registration desk required)

Abstracts of Plenary Presentations

Presenter names are capitalized

CROSS, PAUL C. U. S. Geological Survey. ***ADVANCES IN DISEASE ECOLOGY.***

Pathogens and parasites have caused sudden die-offs as well as long term declines in ungulates. In addition, the potential for disease transmission to, or from, livestock affects wildlife management operations. In this talk, I present a number of new developments in methodology and research directions within the field of disease ecology. Methodologically, computing power continues to open new avenues of disease ecology research. Multiple streams of data can be combined across individual and population scales to estimate latent parameters such as disease transmission rates. In addition, new approaches are being developed that allow for the statistical estimation of parameters in mechanistic models (e.g. Susceptible-Infected-Removed (SIR) models), that allow for both process and observation error. Genetic sequencing capabilities combined with computational methods also provide new opportunities. Pathogen genomics can estimate diffusion rates, time to most recent common ancestor, the effects of habitat covariates, and transmission events between host species. Finally, proximity logging collars can record contact rates between individuals at a fine spatial scale (e.g. 2m) around the clock for several years, providing opportunities to investigate how contact patterns (and likely disease transmission for directly transmitted pathogens) vary by group size, population density and habitat. I illustrate a number of these new approaches using examples from the literature and from my past work. I end with a discussion of the application of disease theory to wildlife management.

HEBBLEWHITE, MARK. University of Montana. ***THE FINAL FRONTIER? STRATEGIES AND TOOLS FOR LINKING POPULATIONS TO HABITATS.***

Why is it so hard to understand how much habitat a population needs? In this talk, I begin by reviewing why we are interested in linking habitat and populations. I then review 3 challenges in this quest, starting with the first and most significant challenge, the challenge of defining habitat. Contrasting vegetation-based and a niche-based definition of habitat, I argue that only the niche-based definition of habitat can be conceptually linked to demographic consequences. Yet land management agencies manage lands based on vegetation-based habitat approaches. Advances in resource selection functions, species distribution models, and remote sensing provide wildlife managers tools to develop species-specific, spatially explicit definitions of habitat across ever-increasing spatial scales. I illustrate application of this niche-based habitat mapping approach drawing on case studies from lynx, Amur tigers, woodland caribou, and elk. The second major challenge is defining population units, and even a quick review of standard practices in wildlife management tell us we can do better at defining functional populations at meaningful scales. An example using deer species in South Dakota illustrates how spatial remote sensing data can help us overcome this challenge. Finally, the last challenge is in developing statistical models that link wildlife population size and dynamics, within and between populations, to spatial variation in species-specific habitat in space and time. Drawing on examples from woodland caribou, elk and mule deer, these approaches illustrate that we can in many cases successfully link habitat to populations to aid wildlife management and conservation.

LUKACS, PAUL M[1], J. JOSHUA NOWAK[2], CHARLES A. HENDERSON[1] and ANNA K. MOELLER[1]. [1]University of Montana. [2]Speedgoat Wildlife Solutions. ***INFERENCE TO POPULATION DYNAMICS OF UNMARKED POPULATIONS OF DEER AND ELK.***

Understanding population dynamics of deer and elk is important for informing management decisions. Radiotelemetry and similar methods based on marked animals provide robust information, yet most populations of deer and elk lack marked animals. Moreover, the cost and logistical complications of marking ungulates can make data collection methods such as telemetry impractical. Numerous methods exist to make inference to unmarked populations. We review methods for inference to deer and elk population dynamics from unmarked animals. We highlight new developments in count and photo based sampling. We emphasize the advantages of

combining multiple sources of data for more robust inference. We provide foundational linkages between harvest information and counts of unmarked animals. We also provide fundamentals similarities between social survey statistics and inference from unmarked wildlife populations. Finally, we stress the importance of data quality. Biologists should avoid the allure of counting large numbers of animals and instead focus on collecting high quality data based in the principles of survey sampling.

NOWAK, J. JOSHUA. University of Montana. ***PRACTICAL APPLICATION OF INTEGRATED POPULATION MODELS.***
Integrated population models (IPM) recently gained popularity for their ability to synthesize multiple sources of monitoring data, overcome limited data and make predictions while accounting for uncertainty. Because of these attributes, several western agencies have adopted IPMs as part of comprehensive species' management programs. In this talk, I present an overview of IPMs and their application to species management. Using case studies, I highlight the use of IPMs over a range of data types and quantities. In each case, discussion will focus on the model's ability to overcome data limitations, resolve conflicts among data sources and make predictions. Further discussion will consider how model development and use helps to identify the role of research and priorities. We will also briefly explore how model development can make monitoring programs more efficient. In conclusion, I hope to provide a thorough description of how IPMs relate to management and the inputs they provide to decision makers.

SEXTON, JOSEPH. University of Maryland. ***SATELLITE-BASED MONITORING OF WILDLIFE HABITAT: STATUS AND PROSPECTUS FOR SCALING ADAPTIVE LANDSCAPE MANAGEMENT IN THE ERA OF BIG DATA.***
Wildlife managers must sustain viable populations of game and nongame species in an increasingly dynamic environment. As climate and land-use changes impact the distribution, structure, and productivity of Western ecosystems, managers must have ready access to consistent, reliable information on the status, trends, and potential of habitat over large areas. To serve these and similar needs across the natural resources, advances in satellite imaging have led to rapid increases in the quality and availability of data, as well as capabilities for local and cloud-based processing, storage, and analysis of geospatial information. Annually updated maps of tree cover are now being used to monitor harvests and natural disturbance, retrieve fire histories, and predict site potential for growth and restoration. Maps of surface-water cover record inundation histories, identify wetland habitats, and estimate local flood risk. Remotely sensed vegetation indices monitor and predict crop growth, inform insurance, and forecast yields. Records of urban growth inform regional planning, watershed management, and responsible development of the wildland-urban interface. Meanwhile, wildlife managers are recognizing the potential for habitat monitoring systems to guide wildlife population management, control hunting pressure, and mitigate damage to crops, vehicles, and other property. Combining satellite information with expert field data, aerial surveys, and emerging data sources—including laser and radar imaging, meteorological and hydrological gauge stations, Global Positioning Systems, and crowd-sourced maps—is increasingly enabling wildlife biologists and managers to adapt large landscapes to their changing environment with the help of timely, accurate assessments of ecosystem history, status, and trends. Using examples from recent research and applications, this talk presents the status and prospects for monitoring wildlife habitat through satellite-based data streams, with an emphasis on practical cooperation between science, government, and the hunting community.

WAITS, LISETTE. University of Idaho. ***GENETIC CONTRIBUTIONS TO RESEARCH AND MANAGEMENT OF DEER AND ELK.***
Advances in molecular genetics have revolutionized wildlife and fisheries research and management. This talk will provide an overview of genetic contributions to deer and elk taxonomy, ecology, monitoring and management. These contributions include: 1) taxonomic assessment of subspecies and delineation of management units, 2) assessments of genetic diversity, effective population size and structure in native and reintroduced populations, 3) evaluation of hybridization and introgression, 4) detection of disease and

pathogens, 5) assessment of important demographic parameters such as population size, survival and dispersal, and 6) evolutionary adaptation to harvest and climate change. I will end with a discussion of potential new directions and contributions provided by the rapidly advancing fields of genomics and epigenetics.

Abstracts of State/Province Updates

Presenter names are capitalized

ALBERTA

CHAPMAN, GRANT, Rob Corrigan, Justin Gilligan, and Emily Herdman. Alberta Environment and Parks. ***TECHNOLOGICAL ADVANCES IN ELK AND DEER MANAGEMENT IN ALBERTA, CANADA, 2017.***

Recent technological advances in population and harvest surveys, online licensing, data management and citizen science are providing a more fulsome understanding of populations and harvest and improving the efficiency of big game management in Alberta. We have advanced survey techniques to include multi-species distance sampling at broader scales to increase efficiency and data accuracy. In 2017, the completion of the Alberta Boreal Deer Project enabled a better understanding of population, occupancy, and resource selection using remote cameras and collars. Improvements to our recreational licensing system allow licence-specific harvest surveys, engagement on regulation and management changes, and online-only draw applications and online licence sales. This information has improved annual allocation of big game permits. Elk and deer harvest data analysis has informed harvest models that support management objectives and stakeholder engagement. Formerly under-utilized large data sets have been combined to analyze and inform the development of big game management objectives; automation of this process has made tools available provincially at multiple scales that enable more responsive management and permit allocation. Alberta has developed a publically available wildlife collision and sightings reporting app and is utilizing existing conflict data sets (including agricultural) to enhance understanding and develop strategies focused on reducing conflict.

CALIFORNIA

WEIST, TERRI. California Department of Fish and Wildlife. ***STATUS REPORT FOR DEER AND ELK POPULATIONS IN CALIFORNIA 2011-2017.***

Reliable population estimates for deer and elk are challenging to obtain in a state the size of California. Aerial counting methods are ineffective in heavily vegetated terrain. An alternative to traditional survey methods is noninvasive DNA capture-recapture (CR) estimation through fecal pellet collection, which has been found to be an effective method for monitoring other ungulate species in environments where direct observation is impractical (Brinkman et al. 2011; Lounsberry et al. 2015; Brazeal et al. 2016a). Consequently, the Department of Fish and Wildlife has instigated eight studies throughout the State to estimate population for several deer herds using this method. These studies include the use of radio telemetry and camera traps for an integration population modeling approach.

Due to the success of using fecal DNA CR on deer, the Department has begun investigating this technique to estimate elk populations. Presently, fecal DNA CR has been used primarily to investigate deer (*Odocoileus* spp) populations in California. Consequently, current protocols are tailored specifically to deer. In contrast to deer, elk are highly clustered in space and time, and occur at considerably lower densities at the landscape scale. Therefore, application of fecal DNA methods to elk requires development of new survey designs that account for these distinct life-history traits of elk.

COLORADO

HOLLAND, ANDY. Colorado Parks and Wildlife. ***COLORADO STATE UPDATE ON INTEGRATING TECHNOLOGY INTO DEER AND ELK MANAGMENT***

Colorado Parks and Wildlife (CPW) manages deer with individual herd management plans that use a public process to establish population objective ranges. We quantified land use changes for the 44 deer herds west of Interstate I-25 for 1980-2010 (Johnson et al., 2016). Between 1980 and 2010, an additional 1,004,331 ha were impacted by changes in residential development (96% was rural or exurban). On average in 2010, 31.2% of mule deer winter range overlapped residential development. By herd, between 0.7% and 66% of winter range overlapped with residential development, while between 0.8% and 46% of summer range overlapped with residential development. For energy development across all herds, the average proportion of mule deer winter range within 200m of a well pad increased from 0.2% in 1980 to 1.1% in 2010. Quantifying available habitat, and habitat loss, informs setting of population objective alternatives when revising mule deer herd management plans. CPW conducted quadrat-based elk abundance estimates for three years in one herd to produce population model anchor points. Population estimates were reasonably consistent across years but were plagued by large variances because of the clumped nature of elk distribution. In another herd, we flew quadrat-based age and sex classifications for three years in an attempt to reduce the negative bias inherent in opportunistic, ad hoc flights resulting from the differential sightability of bulls and cows. Methods seemed to reduce negative bias, with fewer hours flown; however, standard errors increased and the bull/cow ratio in 2016 was unrealistically high.

IDAHO

WHITE, CRAIG and Mark Hurley**.** Idaho Department of Fish and Game. ***BLENDING OLD SCHOOL AND NEW SCHOOL FOR TODAY'S BEST SCIENCE; IDAHO'S MANAGEMENT OF DEER AND ELK***

Idaho has a strong tradition and science based aerial survey population monitoring program. Idaho began using helicopter aerial surveys in the 1950s and 60s to count deer and elk, and by the late 1980s had developed a sightability correction model to estimate populations. Idaho continues to embrace and develop new technology to better understand and manage deer and elk populations. Just in the last 20 years Idaho has radio-marked thousands of deer and elk across the state to better understand population dynamics as influenced by predators, habitat quality, and movements to implement science based management changes. Over the last several years, most radio-marked deer and elk were marked with GPS collars (>800 collars placed a year). Today the Idaho Department of Fish and Game (IDFG) continues to embrace technology as rapidly as it can. IDFG in collaboration with scientists at the University of Montana, have incorporated aerial survey data, survival data, and harvest data to estimate population abundance and trajectory in a web based integrated population model (IPM). Our next steps are to improve the IPMs for mule deer, continue to develop an IPM for elk, and explore the development of a database/web-based interface that would store all GPS locations and allow easy access and display of deer and elk movement. Currently, Idaho is using normalized difference vegetation index (NDVI) and other remote sensing technology, as well, as on the ground data collection to build the latest habitat maps and examine ungulate use and nutritional ecology. Idaho is testing grids of remote camera to see if the technology can be used to estimate populations of ungulates. Idaho has recently explored the use of the latest infrared technology and aerial capability to determine its current applicability in population estimation. Idaho is in the process of starting a new study that will examine deer and elk response on private land to different deterrents including hazing drones. Idaho's goals are to merge the well-established and time-tested methods with the newer technological advances to best manage deer and elk populations in an ever changing environment.

NEW MEXICO

PITMAN, JAMES and Orrin Duvuvuei. New Mexico Department of Game and Fish. ***TECHNOLOGY IN ELK AND DEER MANAGEMENT IN NEW MEXICO, STATE UPDATE***

New Mexico's statewide elk surveys are flown annually during autumn to obtain bull:cow:calf ratio data. Historically this data has been collected by hand with paper datasheets. For the 2016 surveys the Department switched to an iPad data collection method using Collector for ArcGIS. The recorded data can be sent directly from the iPad in the field via Verizon cell coverage to the program website where it can be downloaded into ArcGIS and Excel on any Department computer. New Mexico's statewide deer surveys are flown annually in the winter and are being modified to obtain abundance estimates and composition ratios using a double observer framework. Biologists attempted to integrate similar use of iPads into these annual surveys; however, the lag time associated with recording data resulted in missed deer on the survey line and potentially biased detection probabilities. Mandatory harvest reporting requires all elk and deer hunters to report their harvest on the Department website. Using the survey data coupled with the harvest reports, biologists use the statistics program "R" to further develop management objectives. Several recent elk capture and research studies conducted throughout New Mexico have utilized a remote monitoring and trapping system with Jager Pro and Buckeye Cam devices attached to an existing corral trap. This method allows the remote capture of small numbers of elk where helicopter or other capture methods are not possible or feasible.

SOUTH DAKOTA

LINDBLOOM, ANDY[1], Kevin Robling[1], Josh Nowak[2], and Paul Lukacs[2]. [1]South Dakota Game Fish and Parks. [2]University of Montana. ***USING TECHNOLOGY TO GUIDE DEER MANAGEMENT DECISIONS IN SOUTH DAKOTA.***

South Dakota Game, Fish and Parks collects a multitude of biological and social data to manage both mule deer and white-tailed deer populations across the state. All field survey data are collected on mobile recording devices (e.g., cell phones, tablets), uploaded to a SQL server database via cell or wifi service, time and location stamped, and available instantly for summary statistics or to inform an integrated population model. All department staff have access to the same data and analyses tools, thus improving data interpretation and message consistency. Social data gathered via field staff contacts are also entered into a mobile application and broadly available for review and summary analyses. Social and biological data drive the determination of management direction for each deer management unit (i.e., substantial increase, slight increase, maintain, slight decrease, substantial decrease), which are transformed to a numeric scale and inform the management direction for a larger Data Analysis Unit via weighted averaging. Management unit objectives are directly correlated to a desired Lambda scale, which in turn is used to drive license allocation for each unit based on previous harvest rates and future harvest objectives.

TEXAS

GRAY, SHAWN S. and Alan Cain. Texas Parks and Wildlife Department. ***STATUS OF DEER AND ELK POPULATIONS IN TEXAS, 2005–2015.***

Texas Parks and Wildlife Department (TPWD) conducts post-season helicopter surveys for mule deer utilizing a stratified random sampling design within monitoring units. TPWD also uses a non-linear line-transect spotlight survey method (Distance Sampling) to survey and estimate white-tailed deer populations. CyberTracker software and Android tablets are used to collect population data. The data are used to determine population trends, estimate population densities, and document herd composition to evaluate the impacts of regulations and management actions on deer at an ecoregion and management unit scale. Since 2005, mule deer numbers have been stable to increasing in the Panhandle ecoregion with 64,527 mule deer estimated in 2015. In contrast, mule deer estimates have trended downward for the Trans-Pecos ecoregion, but are rebounding with a 2015 estimate of 152,554. Texas' white-tailed deer herd has been stable over the last 12 years and was estimated at over 4.2 million in 2016. Statewide deer harvest data are obtained by a questionnaire mailed to a random sample of 25,000 hunting license purchasers annually. In general, deer harvest mirrors population trends through time. Mule deer harvest was about 9,804 and white-tailed deer harvest was estimated at approximately 574,508 during the 2015 hunting season. Since the 1997 reclassification of elk as an exotic by the Texas Legislature, the Texas Animal Health Commission has been responsible for managing elk, primarily for disease monitoring. Elk reside throughout most of Texas with large populations within high-fenced ranches. Most free-ranging elk exist in west Texas. TPWD does not conduct annual elk surveys to determine population trends or harvest. There are no seasons or bag limits on elk in Texas.

UTAH

SHANNON, JUSTIN M. Utah Division of Wildlife Resources. ***USING EMERGING TECHNOLOGY TO IMPROVE MANAGEMENT OF DEER AND ELK IN UTAH***

Embracing and developing new technology has allowed the Utah Division of Wildlife Resources (UDWR) to better understand and manage deer and elk populations. Over the past 3 years, UDWR has placed GPS radio-collars on over 900 mule deer in 11 populations and 500 elk in 6 populations. This information has provided many biological and social benefits including more accurate survival rates and population estimates, a better understanding of migration routes and habitat use, body condition scores of deer and elk, and strengthened partnerships with sportsmen and conservation groups. For depredation, UDWR is in the process of developing a new geo-referenced database that will track management actions such as fencing, hazing, landowner payments, and removals of big game animals in agricultural settings. To help hunters and reduce biologists workload, UDWR recently created a new web based, interactive mapping program called the Utah Hunt Planner (www.wildlife.utah.gov/huntplanner), which allows hunters to search and filter specific hunt information. This website can display hunt boundaries, landownership, habitat layers, walk-in-access areas, population and harvest statistics, draw odds, notes from biologists, etc., and it has been well received by the public. Finally, over the past several years, UDWR has been using smart phones to enter wildlife/vehicle collision into a geo-referenced database. Areas of high wildlife/vehicle collisions are then mapped and shared with the Utah Department of Transportation to facilitate future underpass and fencing projects. Emerging technology has improved the big game program in Utah and provided UDWR with new resources to face today's management challenges.

WASHINGTON

HANSEN, SARA and Brock Hoenes. Washington Department of Fish and Wildlife. ***INCORPORATING THE USE OF MODERN TECHNOLOGIES TO IMPROVE THE MANAGEMENT OF DEER AND ELK POPULATIONS IN WASHINGTON STATE.***

Implementation and refinement of techniques the Washington Department of Fish and Wildlife (the Department) uses to monitor population status, animal movements, habitat use, and survival have progressed rapidly in recent years with the use of modern technologies. Innovative technologies have also improved the Department's ability to effectively respond to conflicts between ungulates and agricultural producers. Some examples of how the Department is incorporating the use of modern technologies to improve how we manage deer and elk populations include (1) investigating the use of digital rangefinders, Bluetooth enabled tablets and GPS units during aerial distance sampling surveys for white-tailed deer; (2) using GPS collars with high fix rates to collect fine scale location and activity data that will be used to develop an aerial sightability model for mule deer; (3) creating a Graphical User Interface (GUI) in R that biologists use to analyze aerial sightability survey data; (4) using Panasonic Toughbooks and ArcGIS data collection toolbars to assist with navigation and data collection during aerial surveys; (5) using geospatial PDF mobile apps to assist with delineating landowner boundaries during aerial captures; (6) using automated remote camera systems to provide real-time notifications when elk or deer are depredating agricultural crops; and (7) using online reporting tools to monitor the distribution of treponeme-associated

hoof disease. Lastly, the Department has recently initiated efforts to develop a centralized database to assist with managing a variety of large data sets (e.g., harvest data, survey data, telemetry data, etc.) we routinely use to assist with the management of deer and elk populations.

WYOMING

BINFET, JUSTIN. Wyoming Game and Fish Department. ***WYOMING APPLICATION OF TECHNOLOGY IN MULE DEER AND ELK MANAGEMENT***

Deer and elk population management in Wyoming is based on a Management by Objective strategy with most herds managed to postseason population objectives. Herd estimates are determined using EXCEL spreadsheet population models aligned to harvest and postseason herd ratios. Mule deer model precision is improved with abundance estimates obtained from sightability surveys which have been conducted in five key herd units on a rotating basis. Survival estimates are determined from radio-collared deer where research is being conducted. Researchers are now required through the permitting process to collect and provide survival data to the Department. Infrared technology was used to survey a segment of the Jackson Elk Herd where limited access, vegetative cover and subdivisions prevented the use of traditional survey methods. Managers estimate the survey resulted in greater than 90% of the elk detected. GPS radio-collar technology has provided for identification of detailed movement and migration routes which are now housed in a central database and available on an online viewer. Public outreach utilizing an online interactive Facebook webcast served to gather public perceptions following the hunting season as is online commenting on hunting season recommendations. Remote sensing using Landsat 8 satellite imagery has proven to be an innovative tool used to detect invasive plants such as cheatgrass and leafy spurge on rangelands providing for a more economical and effective treatment targeting infestations on key habitat areas. Additionally, the use of PRISM climate data has been used to analyze precipitation trends in key mule deer herds.

BARKER, KRISTIN[1], Kelly M. Proffitt[2], Jesse DeVoe[1], Michael S. Mitchell[1], Craig Jourdonnais[3], and Philip Ramsey[3]. [1]University of Montana. [2]Montana Fish Wildlife and Parks. [3]MPG Ranch. ***NUTRITIONAL AND DEMOGRAPHIC CONSEQUENCES OF VARYING ELK MIGRATORY BEHAVIORS .***
Elk (*Cervus elaphus*) populations in the American West exhibit wide variation in migratory behavior. Migratory elk typically move from winter range to track growth of highly nutritious fresh vegetation into higher elevation areas, while non-migratory elk tend to forage in lower elevation winter range areas throughout the summer. Although the effect of summer nutrition on elk body condition and reproductive success is well known, the nutritional and demographic consequences of these differing migratory behaviors remain unclear. We developed a predictive model of summer forage quality to compare the nutrition available to migrants and non-migrants in a partially migratory population of elk in western Montana. Non-migratory elk had access to significantly higher forage quality than their migratory counterparts; the lower forage quality available to migrants may result in reduced reproductive success. We therefore expect non-migrants to have higher fecundity rates and to comprise a higher proportion of the population relative to migrants. Harvest management actions that reduce survival rates of non-migrants or increase survival rates of migrants may be an effective tool for maintaining migratory behavior in partially migratory populations.

BERG, JODI E.[1], Evelyn Merrill[1], and Mark Hebblewhite[2]. [1]University of Alberta. [2]University of Montana. ***MATERNAL TRADE-OFFS IN HABITAT SELECTION ACROSS SCALES INFLUENCE CALF SURVIVAL.***
Understanding how maternal females cope with the constraints of nutritional requirements and vulnerability of young to predation can provide insights into individual behavioral choices and their population consequences. Females face trade-offs in maternal investment in current offspring and their own chances of survival and future reproduction. Because there is time-dependence in these trade-offs within the reproductive stage, maternal selection patterns should shift as offspring age and become less vulnerable, or change drastically to re-focus on the females' own survival and reproduction if offspring do not survive. To address how temporal trends in maternal trade-offs across spatial scales affect elk calf survival, we used data from n > 100 calves captured in 2013-2016 in the partially-migratory Ya Ha Tinda elk population of western Alberta. We examine resource selection by cow elk at 3 spatial scales: (1) calving area, (2) cow location, and (3) calf birth or bed site, and within 2 time periods: neonatal (calf birth to 10 days later) and summer (May through October). We use Cox proportional hazards models in a competing-risks framework to examine survival related to covariates of cow migratory strategy, predation risk, forage availability, human activity, and calf characteristics (sex, mass at birth). Results show that females trade forage for low risk of predation and that habitat selection differentially affects survival of migrant and resident elk calves. Our results are important to conservation and harvest management of ungulates due to vulnerability of elk calves and phenology of both forage and predation.

BERGEN SCOTT, Kyle Anderson, Jon S. Horne, Shane Roberts, and Mark Hurley. Idaho Department of Fish and Game. ***CAN WE ESTIMATE SEASONAL MIGRATION ROUTES IN AREAS WITHOUT LOCATION DATA? ELK IN SOUTH CENTRAL IDAHO AS A TEST ASSESSMENT.***
Migration routes are becoming more endangered across the globe and seasonal migration are of increasing conservation importance for planning and climate change management scenarios, especially in western North America. In this study we use elk location data collected from 2007 to 2016 to document and analyze spatiotemporal patterns of migrating elk in the south central Idaho uplands (Net Squared Displacement, Kernel Density Estimators, and Brownian Bridge Movement Models). These methods of documenting elk seasonal movement patterns are the used to 'inform' migration habitat suitability models which serve as base foundational data from which migration routes are estimated. Least cost paths, circuit theory circuits, and 'hybrid' models are used to estimate migration routes at an individual (3rd order), population level (2nd order), and regional (3rd order) and their accuracy assessed against the appropriate previous utilized distributions (i.e. sequential movement paths, Kernel Density Estimators, and Brownian Bridge Movement Models). At the regional scale, we calibrate a hybrid model to fit information from the most recent winter surveys as a means of estimating and prioritizing migration corridors across the study area. We find that addressing the spatial scale and order of seasonal movement also guides the appropriate management and *vice versa*. With the results of these accuracy assessments we then address prevalent management questions concerning wildlife vehicle collisions, migration route preservation and conservation. Model improvements and estimates of accuracy and logistical needs are reported.

BERRY, STEPHANIE[1], Lisa Shipley[1], Ryan Long[2], Mark Swanson[1], and Chris Loggers[3].[1]Washington State University. [2]University of Idaho. [3]United States Forest Service. ***A COMPARISON OF NUTRITION AND FORAGING BEHAVIOR BETWEEN SYMPATRIC MULE AND WHITE-TAILED DEER IN NORTHEASTERN WASHINGTON.***

Mule deer (*Odocoileus hemionus*) and white-tailed deer (*Odocoileus virgianus*) co-occur in a north-south zone from Canada to Mexico along the Rocky Mountains. Over the last few decades, white-tailed deer populations have expanded their distribution in many areas along this zone. Despite extensive research on life history and habitat use of sympatric mule and white-tailed deer, it is still unclear why current conditions seem to favor white-tailed deer in many areas traditionally occupied by mule deer. However, no study has yet compared foraging behavior and nutrition of the 2 species in a controlled field setting. Therefore, we hand-raised mule deer and white-tailed deer, and transported them to 33 ponderosa pine/Douglas fir stands in northeastern Washington. At each site, we measured forage biomass, recorded deer behavior, and conducted foraging trials with 4-5 animals of each species during which we measured intake rate, and diet composition, selection, and nutritional quality. In the same stands, mule and white-tailed deer selected diets with similar plant composition and had the same preference ranking for 86% of available plants. Likewise, diet quality and time spent in different behavioral activities did not differ between the species. However, mule deer took larger bites and harvested food faster, whereas white-tailed deer traveled further while foraging. Our findings indicate that mule and white-tailed deer have similar adaptations as large generalist herbivores to seek nutritious diets from available forage. Differences observed between free-ranging species likely reflect habitat choices occurring at larger spatial scales based on different adaptations for predator avoidance or reproduction.

BRENNAN, ANGELA[1] and Paul C. Cross[2], Ephraim Hanks[3], Elk Brucellosis Working Group. [1]University of Wyoming. [2]U.S. Geological Survey. [3]Pennsylvania State University. ***INVESTIGATING ELK MOVEMENT AND CONNECTIVITY TO PREDICT THE SPREAD OF BRUCELLOSIS .***

In the Greater Yellowstone Ecosystem (GYE), elk movement between subpopulations is likely to explain the spatial expansion of exposure to *Brucella abortus*, the bacteria that causes brucellosis, and could increase the risk of transmission from elk to livestock. The highest probability for *Brucella abortus* transmission among elk occurs during February and March when elk are largely aggregated on winter range, but transmission can also occur during the spring months when migration to summer range begins. Little is known, however, about how elk movement and regional connectivity varies during the transmission period, which limits our ability to predict the future rate and direction of disease spread. Therefore, we have compiled GPS collar data from roughly 850 GYE elk over 15 years, examined empirical network models describing contacts between elk subpopulations, and evaluated time-varying landscape resistances to movement using continuous time Markov chain models in an effort to better understand elk connectivity and the spread of brucellosis. Connections between subpopulations were widespread throughout the transmission period and positively related to elk density. The highest degree of connections occurred in May, with southern GYE and feedground elk connected to northern GYE elk through Yellowstone National Park. Feedground elk, however, did not connect to northern GYE elk during the highest risk months. Preliminary movement models suggest significant individual variation in response to landscape variables during the transmission period. We discuss explanations for this variation and relate our findings to historical patterns of disease spread.

BRENNAN, ANGELA[1], Paul C. Cross[2], William H. Edwards[3], Brandon M. Scurlock[3], and Scott Creel[4]. [1]University of Wyoming. [2]U.S. Geological Survey. [3]Wyoming Game and Fish Department.
Montana State University. ***MULTIPLE WAYS TO BE DENSE AND TRANSMIT DISEASE: PATTERNS IN ELK AGGREGATION AND INCREASING BRUCELLOSIS.***

To understand the relationship between host density and parasite transmission, we examined elk density and group size across ten regions in Wyoming where elk have been exposed to the bacteria (*Brucella abortus*) that causes brucellosis. Because external factors may influence host aggregation patterns and play a large role in our understanding of disease transmission, we also examined the land use, predation and climate factors associated with elk group sizes using quantile regression. We found that brucellosis seroprevalence increased over time in eight of the ten regions, and that these rates of increase were positively related to density and group size. Group sizes ranged from 1 to 1952 elk, and larger groups were found in open habitat and on private land. The largest effect on group size occurred between irrigated and non-irrigated land (e.g. the 90th quantile group size increased by 135 elk [42, 227] on irrigation). Only upper quantile group sizes were positively related to broad scale elk density and wolf abundance, and for wolf abundance this effect was greater in open habitats and private land than in closed habitats or public land. If we had limited our analysis to mean group sizes, we would not have detected these effects. Our findings suggest that most reasonable measures of aggregation had similar utility to predict changes in seroprevalence, but that these patterns may have been influenced by aggregation effects on disease-establishment within a

population. Our findings also suggest that land ownership, irrigation and wolf abundance were important to elk grouping patterns.

BRISTOW, KIRBY D., Mathew Clement, Michelle L. Crabb, and Larisa E. Harding. Arizona Game and Fish Department. ***A FRAMEWORK FOR ESTIMATING ELK ABUNDANCE IN ARIZONA.***
Elk (*Cervus elaphus*) populations in Arizona have historically been managed using relative estimates of abundance. Recent concerns over the influence of large wildfires, impacts to aspen regeneration, and predator-prey relations and management, have caused the Arizona Game and Fish Department to seek methods to more accurately estimate elk abundance. Between 2014 and 2016, we conducted intensive helicopter surveys of selected areas to compare several methods designed to model elk detection and provide algorithms to account for animals missed on subsequent surveys. We conducted annual fall helicopter surveys in 3 areas, which contained a subset of radio-collared elk, and recorded information on covariates affecting both sightability (i.e. vegetative cover, vegetation type, burn category, group size, activity, and ambient light) and observer bias (i.e. observer position, pilot experience). We used information theory to rank a set of candidate *a priori* models to determine which covariates affected detection and select the most parsimonious models among sightability, double observer, and hybrid modeling methods. We then used the top model from each method to calculate annual site-specific elk abundance estimates for comparison to concurrent mark-recapture abundance estimates. The best supported models included all sightability covariates, and influence of each covariate followed predictable patterns relative to elk detection. The best performing hybrid model consistently provided a more accurate and precise abundance estimate, relative to mark-recapture estimates, than either sightability or double observer models. Application of our hybrid model to future helicopter survey data should improve both precision and accuracy of elk abundance estimates in Arizona.

CAMPBELL, J.C. KIDDO[1], Louis A. Harveson[1], Ryan S. Luna[1], Ryan O'Shaughnessy[1], Shawn S. Gray[2], and Thomas S. Janke[1]. [1]Borderlands Research Institute, Sul Ross State University. [2]Texas Parks and Wildlife Department. ***SURVIVAL AND MOVEMENTS OF TRANSLOCATED MULE DEER IN SOUTHEASTERN BREWSTER COUNTY, TEXAS.***
Mule deer (*Odocoileus hemionus*) populations have dwindled in parts of southeastern Brewster County since the late 1990s. In February 2015, Texas Parks and Wildlife Department, Borderlands Research Institute, and CEMEX-USA initiated the first part of a restoration effort by translocating 41 mule deer does to the Black Gap Wildlife Management Area (BGWMA) and El Carmen Land and Conservation Company (ECLCC) properties (collectively called the Black Gap Complex) from Elephant Mountain Wildlife Management Area. Of the 41 does translocated in year 1, 34 were fitted with radio collars (16 GPS and 18 VHF). The following year, 75 does were translocated, 62 of which were fitted with radio collars (23 GPS and 39 VHF). These collars aided in monitoring and comparing survival, movements, and habitat selection of the translocated mule deer between two release methods (Soft-release: BGWMA; Hard-release: ECLCC). We conducted these different release methods in the thought that soft-release will yield a higher survival rate and higher site fidelity than that of deer that have been hard-released. For comparison of movements and home ranges between release methods, we only analyzed GPS collars (to date) from 2015 release (n = 11) using T-LoCoH from Program R. To compare survival, we used all collars from year 1 (n = 34) and year 2 (n = 62) in a known-fate analyses using Program Mark. With this information, we hope to improve our future restoration efforts at the Black Gap Complex as well as our future mule deer translocations efforts.

DEVIVO, MELIA[1], Dave Edmunds[2], Matthew Kauffman[3], Brant Schumaker[1], Justin Binfet[3], Terry Kreeger[3], Bryan Richards[4], Hermann Schätzl[5], and Todd Cornish[1]. [1]University of Wyoming. [2]U.S. Geological Survey, Colorado State University. [3]U.S. Geological Survey, University of Wyoming. [3]Wyoming Department of Game and Fish. [4]U.S. Geological Survey, National Wildlife Health Center. [5]University of Calgary. ***ENDEMIC CHRONIC WASTING DISEASE CONTRIBUTES TO DEER DECLINES IN WYOMING.***
The effects of chronic wasting disease (CWD) on cervid demography and population sustainability are poorly understood. In the absence of effective management tools, CWD prevalence in mule deer (*Odocoileus hemionus*) can exceed 20% as documented in southeastern Wyoming and was speculated to have contributed to regional population declines during the early 2000s. From 2010-2014 we radio-collared, CWD tested and genotyped 143 adult mule deer to determine the impacts of CWD on survival, fecundity, genetic selection, and population sustainability. During our study, CWD prevalence ranged from 21-27%. Kaplan-Meier annual survival estimates were significantly ($\chi 2 = 40.10$, $p < 0.01$) depressed in CWD-positive deer (0.32, SE = 0.06) compared to CWD-negative deer (0.76, SE = 0.04). While we observed substantial differences in adult survival, we did not detect a predicted decline in fawn production of CWD-positive deer. Using a CWD transition matrix model to determine the impact of CWD on population sustainability our estimate of population growth rate (λ) = 0.79, indicating an annual population decline of 21%. A model derived from the demography of only CWD-negative

individuals yielded; λ = 1.00, indicating a stable population if CWD were absent. These findings support CWD as a significant contributor to the recent population decline observed in this herd. Further investigation of this population decline using stochastic simulation models revealed a strong shift toward more deer with genotypes associated with reduced susceptibility to CWD. However, the sustainability of a remnant population comprised of mostly this genotype remains to be determined.

DEVOE, JESSE[1], Kelly M. Proffitt[2], Kristin Barker[1], Craig Jourdonnais[3], and Philip Ramsey[3]. [1]University of Montana. [2]Montana Fish Wildlife and Parks. [3]MPG Ranch. ***TRADE-OFFS BETWEEN FORAGE AND RISK FOR ELK DURING THE FALL ARCHERY HUNTING SEASON.***

The availability and distribution of nutritional resources during late-summer and fall are important for ungulates to establish pregnancy and survive the nutrient-limited winter months. The onset of the fall archery hunting season influences elk (*Cervus elaphus*) behavior and potentially access to nutritional resources as elk act to minimize the risk of harvest mortality. Our goals were to determine the effect of the archery hunting season on female elk selection of nutritional resources and security areas to understand this forage-risk trade-off. Within the North Sapphire elk herd in west-central Montana, we collected locations from 48 GPS-collared adult female elk and monitored survival. We developed a resource selection model to evaluate the relative effect of forage quality and risk factors (hunter access, distance to roads, density of roads, and security cover) influencing female elk selection prior to and during the archery season. This presentation discusses the importance of these forage and risk factors, and the role that the fall archery season has on altering female elk distributions and access to nutritional resources.

EDWARDS, HANK, Dr. Mary Wood, Jessica Jennings-Gaines, and Hally Killion. Wyoming Game and Fish Department. ***CHRONIC WASTING DISEASE IN WYOMING .***

Chronic Wasting Disease (CWD) was first described in captive mule deer from Colorado and Wyoming in the 1970's. In a collaborative effort between Dr. Elizabeth Williams of the University of Wyoming and the Wyoming Game and Fish Department (WGFD), surveillance of free-ranging populations began in 1982, and identified the first mule deer in 1985, and elk in 1986; both in southeastern Wyoming. Surveillance continued each year since the initial discovery, with peak surveillance occurring between 2003 and 2011 when federal funding was available. Retropharyngeal lymph nodes were collected from road-killed, targeted (animals showing signs of CWD), and hunter-harvested deer, elk, and moose, and tested with an enzyme linked immunosorbent assay. Currently the WGFD Wildlife Health Laboratory tests between 1500 and 3500 CWD samples each year with over 56,800 samples tested to date. Over the past 20 years, surveillance data has shown an increase in prevalence and distribution of CWD in Wyoming, particularly in deer. Using cumulative five-year estimates, the Laramie Mountain mule deer herd is approximately 23%, and the South Converse mule deer herd at 42% prevalence. Both herds have generally shown an increasing trend in prevalence over time. Distribution of CWD in elk is limited to southeastern Wyoming; where five year prevalence is estimated at 6-7%, but slowly increasing. This disease is now found across the majority of the state, and recent detections suggesting continued westward spread. A new CWD management plan was recently developed, and includes a goal to reduce the rate of spread and prevalence of CWD in the State. Management options for this disease are currently being explored by several states and provinces.

HEFFELFINGER, JAMES R.[1], Justin M. Shannon[2], and Annette Roug[2]. [1]Arizona Game and Fish Department. [2]Utah Division of Wildlife Resources. ***THE THORNY WORLD OF CACTUS BUCKS.***

The field of antler research has told us much about the physical and physiological process of antler development, but there remains many things we struggle to explain. Antlers grow as a protein-rich cartilage, which is then mineralized and changed to bone as mostly calcium and phosphorus, and transported by blood flow and deposited into the hardening antler. This growth and mineralization is orchestrated by a complicated system of hormonal fluctuations increasing and decreasing at various times throughout the year. The timing of most of these fluctuations is driven by the seasonal changes in the relative length of day and night cycles. Like everything in nature, things occasionally go wrong and in some cases they go very wrong. One of the most remarkable ways that antlers go "wrong" is when an individual retains the velvet on his antlers into the fall and sometimes carries a badly deformed mass of velvet antler material frequently referred to as "Cactus Bucks." It is not clear why most cases occur, but we know that it is mostly associated with things that interrupt the hormone cycle or damage tissues, including abnormal hormone levels, endocrine disruptors, genetics, age, injury, disease, deformed reproductive tissues, and antlered does. One or several of these acting together can cause the occurrence of what we call cactus bucks. We will highlight and explain possible causes of this phenomenon and discuss documented geographic clusters of cactus bucks as well as illustrate some of the more spectacular cases.

HEFFELFINGER, LEVI[1], Kelley Stewart[1], Kevin Shoemaker[1], Vernon Bleich[1], and Neal Darby[2]. [1]University of Nevada. [2]National Park Service. ***HABITAT SELECTION BY FEMALE MULE DEER: TRADEOFFS ASSOCIATED WITH REPRODUCTION.***

Wildlife species occupying arid regions throughout the west are faced with an array of environmental stressors. These regions typically have higher maximum daytime temperatures, which causes individuals to increase metabolic rates and thermoregulation, which exaggerates the physiological demand for nutrition and water. Mule deer (*Odocoileus hemionus*) have adapted to arid regions by increasing energy expenditure to meet these needs. We studied the effects these factors have on movement of a mule deer population in an arid ecosystem surrounding the time of reproduction. We focused on selection of resources by females with young at heel compared with females following mortality of offspring. Since lactation is considered the most nutritionally demanding period annually for individuals in this system, energetic costs should change rapidly with the loss of an offspring. We established 3 study areas on the Mojave National Preserve in southern California, USA that have varying topography, habitat, and number of water sources. We evaluated habitat and resource selection using the Random-forest machine learning technique with a data set of used and randomly generated points to quantify availability. Females selected higher elevation areas closer to water while young were at heel and relatively more herbaceous habitat types post-fawn mortality. These findings show that females select areas that increase survival of their young and support water demands during lactation. Our research could have substantive implications for management strategies throughout arid ecosystems by informing managers about tradeoffs associated with habitat selection during the rearing of young and the nutritionally demanding period of lactation.

HENDERSON JR, CHARLES R.[1], Paul M. Lukacs[1], and Mark A. Hurley[2]. [1]University of Montana. [2]Idaho Department of Fish and Game. ***DATA WEIGHTING FOR INTEGRATED POPULATION MODELS.***

Integrated population models (IPM) enable managers and researchers to analyze different types of data together, leading to an increase in the understanding of the demographic processes that drive population trajectories and ultimately providing better information for management decisions. Currently, all data types included in an IPM have equal influence on the abundance estimates generated by the model; however, the relative quality of different types of data varies. We sought to create a weighting system that reflects the relative quality of each data type. We used the amount of variance and the accuracy of underlying assumptions of the models associated with each data type as our measures of quality. We used data previously gathered by IDFG (Idaho Department of Fish and Game) about mule deer populations to construct and test this method. Data types included in this analysis are survival, sightability, composition, and harvest. We devised a weighting system based on improved variance structures that incorporates model assumptions and estimate precision within the current IPM framework. The expected result is a better representation of the variance around the abundance estimates generated by the IPM. This method of data weighting should ensure that each data type influences the IPM estimate of abundance in proportion to its relative quality and allows different quality data types to be exploited to their full potential. In addition, the weights will allow managers and researchers to compare the relative quality of different data types and allocate monitoring resources accordingly.

HERSEY, KENT R.[1], Randy T. Larsen[2], Justin M. Shannon[1], and Brock R. McMillan[2]. [1]Utah Division of Wildlife Resources. [2]Brigham Young University. ***OVERWINTER BODY CONDITION DECLINES OF MULE DEER IN UTAH.***

Utah Division of Wildlife Resources began monitoring mule deer survival on 7 management units representing the range of environmental conditions found across the state in 2009. Although this project provided valuable data on annual survival, specifics on factors influencing differences between units and among years were lacking. Consequently, UDWR switched to GPS collars and began assessing mule deer body condition on these units in December 2014. We also recaptured a subsample of deer on each unit the following March to assess the rate of decline of fat reserves during winter months. Percent ingesta-free body fat averaged 9.8 (8.1–10.7) and 9.0 (7.4–11.2) in December 2014 and 2015, respectively. Average rate of decline of fat reserves for the past 2 winters averaged 29% (22%–37%) for winter 2014-2015 and 33% (23%–43%) for winter 2015-2016. In general, percent ingesta-free body fat increased with latitude; however, percent decline of fat reserves during winter also increased with latitude. As this project progresses, data analyses will focus on identifying factors that have the greatest influence on the body condition of mule deer at the beginning and end of winter in Utah. Winter severity, summer drought, and population size relative to carrying capacity are all suspected to play a role in observed differences in body condition. Additionally, we will determine the influence of habitat treatment projects on mule deer. Specifically we will examine how treatment projects may improve body condition of mule deer going into winter or slow the rate of decline during winter.

HOENES, BROCK, Kristin Mansfield, Brooke George, Eric Holman, Sandra Jonker, Ilai Keren, Jerry Nelson, and Nicholle Stephens. Washington Department of Fish and Wildlife. ***RESPONDING TO THE EMERGENCE OF TREPONEME-ASSOCIATED HOOF DISEASE (TAHD) OF ELK IN WESTERN WASHINGTON.***
Observations of elk (*Cervus elaphus*) with deformed, broken, or missing hooves have increased dramatically in southwest Washington over the past decade. The recent emergence of an elk hoof disease in Washington is unique in that bacteria in the genus *Treponema* (aka "treponemes"), never previously associated with hoof diseases in any free-ranging ungulate, have been identified as causal. Treponemes are strongly associated with two hoof diseases of domestic livestock: bovine digital dermatitis of cattle and contagious ovine digital dermatitis of domestic sheep. The Washington Department of Fish and Wildlife (WDFW) confirmed the diagnosis of Treponeme-Associated Hoof Disease (TAHD) in 2014 and to date, has confirmed the presence of the disease within the range of four elk herds in western Washington. Elk that are affected by TAHD often have severely overgrown and deformed hooves with sole ulcers and sloughed hoof walls. The disease can also occur in multiple limbs and can affect all age and sex classes. The severity of clinical signs of TAHD coupled with the seemingly rapid expansion of impacted areas has generated a great deal of concern for WDFW, other resource management agencies, hunters, tribes, and local citizens. We discuss the numerous efforts WDFW has initiated to increase our understanding of TAHD and to collect information that will assist with the development of effective management strategies. We also present preliminary findings from initial efforts to monitor the prevalence and distribution of TAHD and from an ongoing study investigating the potential effects of TAHD on elk survival and reproduction

HORNE, JON S., Mark Hurley, Erin Roche, and Scott Bergen. Idaho Department of Fish and Game. ***ECOLOGICAL DRIVERS OF ELK SURVIVAL IN IDAHO.***
Effective management of elk populations is facilitated by an understanding of the factors that influence elk survival. Over the past ~10 years, elk across the state of Idaho have been monitored for mortality and often times cause-specific mortality but to date, these data have not been used in a comprehensive survival analysis. We compiled known-fate survival data from ~2000 radio-collared elk (1120 adult cows and 880 6-month-old calves) that were monitored from 2006 – 2016. Statewide, lion and wolf predation were the main causes of mortality for cows (30% and 29%, respectively) and 6-month old calves (41% and 33%, respectively). However, mortality rates were highly variable across population and years. To examine factors potentially causing this variation, each elk was assigned to one of 27 populations based on its winter range. We then modeled risk of mortality and cause-specific mortality as a function of winter severity, summer nutritional resources, and wolf abundance. We found that elk survival is inherently complex but by utilizing an data set encompassing substantial spatial and temporal variation, we were able to identify the main drivers of elk survival in Idaho.

HURLEY, MARK A.[1], Josh Nowak[2], Paul Lukacs[2], Jean-Michel Gaillard[3], Mark Hebblewhite[2]**.** [1]Idaho Department of Fish and Game. [2]University of Montana. [3]University C. Bernard - Lyon I. ***DISENTANGLING WEATHER AND DENSITY-DEPENDENT EFFECTS ON MULE DEER POPULATION DYNAMICS.***
Ungulate population dynamics in temperate latitudes can be simultaneously affected by weather and density of conspecifics. Weather can mimic the demographic effects of density dependence by influencing vital rates similarly. Unfortunately, the management prescription to reverse a declining population would be very different, demonstrating the importance of correctly identifying the processes involved. We used integrated population models to understand the relative contributions of density-dependent and density-independent drivers to ungulate population dynamics in six environmentally diverse study areas in Idaho. We tested two competing hypotheses to determine if density or weather was more important in limiting population growth rates of mule deer. We measured the influence of density on population growth rate, density on each vital rate, and then the relative contribution of each vital rate to overall population growth. To isolate the effects of weather from density, we estimated the influence of density on juvenile recruitment (December fawn ratios) and overwinter survival of fawns. We introduced a weather effect using important weather covariates from previous analyses to model overwinter survival of fawns. Negative density dependence was evident across all populations and was more pronounced in areas with severe winter weather. We found that density of the previous year depressed recruitment in the following year, but the influence on fawn survival was variable. In contrast, fawn survival estimated by weather covariates was highly correlated with population growth while recruitment weakly influenced population growth, suggesting that weather may if fact be mimicking the effect of density and be a more important force in mule deer population dynamics. We will discuss the changes in the strength of density

dependence as populations increase. Quantifying how intrinsic or extrinsic factors regulate or limit mule deer population size provides critical information for harvest management, including an estimate of biologically relevant population goals.

JONES, COVY, Greg Evans, Brian Swaner, and Dax Mangus. Utah Division of Wildlife Resources. ***THERE'S AN APP FOR THAT: INTEGRATING TECHNOLOGY INTO UTAH'S DEPREDATION/MITIGATION PROGRAM .***
With private land overlapping the majority of Utah's elk and deer winter ranges depredation can often be a limiting factor for these populations. State code in Utah allocates $700,000 to mitigate damages from big game depredation for commercial growers and directs wildlife managers to alleviate the damage. Landowner specialists have the primary responsibility to work on depredation issues whereas biologists have herd management responsibilities. In order to facilitate collaboration between these positions and their responsibilities Utah saw a need for a geo-referenced database that would track locations of where conflict was occurring, and actions taken to mitigate damages. Our technology team to did just that with a web based application records landowner information both on and offline. It tracks all actions taken by the landowner specialist and any permits or vouchers issued. Getting the data out of the application is simple and allows biologists to see where conflict is occurring between private lands and the herds they manage. Data is presented in either table or map form it can be queried by species, landowner, herd unit, county or a myriad of other possibilities. We hope to use the results to better apply pressure with antlerless and depredation hunts, show landowners what actions we are taking on their properties, and visually demonstrate to elected officials what wildlife officials are doing for their constituents. This application tracks and visually demonstrates the hard work our staff is doing every day to resolve conflict and maintain robust elk and deer populations.

KAY, JACOB H.[1] and James W. Cain III[2]. [1]New Mexico State University. [2]U.S. Geological Survey, New Mexico State University. ***NEW INSIGHT INTO UTILIZING BONE MARROW TO ASSESS UNGULATE HEALTH.***
Bone marrow fat content has commonly been utilized as a metric to assess ungulate body condition. Evaluating body condition of individuals provides important insight to wildlife managers that allows them to better understand local population dynamics and sustainably manage herds. Studies have compared different methods of measuring bone marrow fat content as well as identified which bones are most representative of an individual's health. However, no previous research has examined how the amount of time from death to sample collection affects bone marrow fat measurements of ungulates in natural conditions. It is not always feasible to collect marrow samples from an individual at the time of mortality, which could potentially bias fat estimates from bone marrow samples. We examined how bone marrow fat content is affected by time post mortem and other factors by collecting multiple bones from individual elk and deer at different time intervals. We found that marrow fat content can change significantly over time. Our top model that explained this change included time between samples, initial fat content and sex of the species. Future research efforts that utilize bone marrow fat content should attempt to retrieve bone samples immediately after death. Failure to do so can lead to false conclusions regarding the nutritional state of individual animals.

Killeen, Joshua[1], **EVELYN MERRILL**[1], Holger Bohm, Jodi Berg, Scott Eggeman[2], and Mark Hebblewhite[2], [1]University of Alberta. [2]University of Montana. ***CHANGING MIGRATION IN THE YA HA TINDA ELK POPULATION: WHEN, WHERE AND WHY TO MIGRATE?***
In most temperate systems, spring migration to high elevations by ungulates is key for increasing energy intake in a variable environment. A trophic mismatch can occur if the timing of migration is not consistent with plant growth either along the migration route or on their summer ranges. Major migrations routes may change over time due to shifts in land use, predation, human disturbance, or their interactions. We used movement data from 305 elk collared on winter ranges of the Ya Ha Tinda near Banff National Park, Alberta, Canada during 2002-2015 to investigate the routes used, timing and duration of migration, and factors associated with the distributional shifts in migrating herd segments over time in a partially migratory elk herd. Individual elk showed strong fidelity to migration routes between seasons and across years, but the proportion of elk that migrated westward to high elevation ranges declined while the proportion of migrants moving eastward to low-elevation summer ranges increased. Timing of migration across years was most closely associated with plant phenology on summer ranges, rather than information on the winter range. Elk moving to low-elevation ranges migrated earlier and were exposed to higher green vegetation early in the calving season compared to residents or elk migrating to high elevations. Average exposure to bear and wolf predation risk was similar along migration routes but not on summer ranges. Trade-offs between forage and predation in summer rather than along migration routes may account for

distributional shifts in migrating elk over the past decade.

MANSFIELD, KRISTIN[1], Sushan Han[2], and Jennifer Wilson-Welder[3]. [1]Washington Department of Fish and Wildlife. [2]Colorado State University. [3]National Animal Disease Center USDA-ARS. ***CHARACTERIZATION AND PROGRESSION OF TREPONEME-ASSOCIATED HOOF DISEASE (TAHD) LESIONS IN ELK.***
Reports of elk (*Cervus elaphus*) with severely deformed or missing hooves increased dramatically in southwest Washington during the late winter and early spring of 2008. Histopathology and silver staining of lesions from affected hooves demonstrated the presence of deeply invasive spirochete bacteria accompanied by significant inflammation. Furthermore, pathogenic spirochete bacteria in the genus *Treponema* , known to have a causal role in the development of digital dermatitis, the most common infectious hoof disease of dairy cattle, were isolated from diseased elk hooves. In order to describe the progression of treponeme-associated hoof disease (TAHD) in individual animals, 30 radio-collared elk were initially examined in February 2015, and again 10 months later in December 2015. Hoof lesions were assigned Grades ranging from 1 (erythematous to ulcerative lesion limited to the skin) to 4 (complete sloughing of the hoof capsule) at each examination. At initial examination, 18 animals were TAHD-positive and 12 animals were classified as negative controls. Ten months later, one initially TAHD-positive animal with a Grade 1 lesion on one hoof had recovered; while disease remained the same (n=5) or progressed to a more severe grade (n=12) in the remaining TAHD-positive animals. Of the 12 animals initially classified as negative controls, 9 maintained their negative control status, while 3 developed TAHD. Findings to date suggest that TAHD is a rapidly progressive disease with little evidence thus far of recovery from advanced stages.

MARTIN, HANS[1], L. David Mech[2], John Fieberg[1], Daniel R. MacNulty[3], Daniel R. Stahler[4], and Douglas W. Smith[4]. [1]University of Minnesota. [2]U.S. Geological Survey. [3]Utah State University. [4]Yellowstone National Park. ***FACTORS AFFECTING GRAY WOLF* (CANIS LUPUS) *ENCOUNTER RATE OF ELK* (CERVUS ELAPHUS) *IN YELLOWSTONE NATIONAL PARK***
Few studies of wolf predation have quantified gray wolf (*Canis* lupus) encounter rates of prey and the factors that influence them. Elk (*Cervus elaphus*) population decline, variable weather, and changing wolf-pack dynamics on the Northern Range (NR) of Yellowstone National Park (YNP) provided an opportunity to examine these factors and their role in wolf hunting success. We also identified factors that affect wolf kill-rates in other systems and developed models to assess the effect of these on prey encounter rates. We used data from 46 NR wolf-pack observations and quantified wolf-elk encounter rates during 30-day periods in early and late winter over 9 years (2003-2012). Elk density was the only factor significantly driving wolf-elk encounter rates, and encounter rates were correlated with hunting success during early winter, although not late winter. Elk density did not affect kill-rates in Yellowstone, so the factors affecting wolf hunting success of elk on the NR do not explain variation in prey encounter rates. Wolves appear to adjust their hunting behavior to compensate for all the factors predicted to affect elk encounter rates except for elk density.

MCKEE, CODY J., Brian F. Wakeling, and W. Scott Roberts. Nevada Department of Wildlife. ***DEFENDING MANAGEMENT DECISIONS BY USING A RESOURCE SELECTION FUNCTION TO ESTIMATE ELK USE ON PRIVATE PROPERTY IN NEVADA.***
Resource selection functions (RSFs) are commonly used to describe patterns of habitat use exhibited by ungulates. Despite many basic applications, the potential of RSFs by wildlife managers has yet to be fully realized. The Nevada Elk Incentive Tag Program issues saleable tags to land owners to encourage tolerance of elk use on private property and to incentivize management of private lands for elk. Although successful at reducing conflict, discrepancies occur between reported use by land owners and documented use by Nevada Department of Wildlife (NDOW). These discrepancies, if contested, are subsequently reviewed by an independent arbitration panel. We used an RSF and its resulting predictive map to estimate the number of elk likely to occupy a private parcel where incentive tag disputes are often resolved by arbitration. We used GPS data collected from 15 elk, during 2011-2014, and 2016, to calibrate a RSF depicting habitat use by elk in the Cherry Creek Range of central Nevada. RSFs built for each season included elevation, slope, aspect, distance to road, distance to water, and cover class. We used the resulting RSFs to build predictive maps representing elk habitat by season and determined proportion of elk habitat occurring on the private land of interest. An estimate of elk on the private parcel was then derived based on the proportion of suitable elk habitat within the private boundary and the population estimate of elk occurring in the Cherry Creek Range. Using this process, 24.8 elk were estimated to use the private parcel during the summer or 4.6 elk year-round. In June 2016, we presented these results to the arbitration panel in support of NDOW's estimate of elk use to refute information provided by the landowner. The landowners request for an increase in their incentive tag award was subsequently denied by the arbitration panel. The decision by the arbitration panel highlights the successful use of a RSF to defend a management decision in Nevada.

MCCORQUODALE, SCOTT, Jerry Nelson, Paul Wik, Jeff Bernatowicz, Kevin Robinette, and Brock Hoenes. Washington Department of Fish & Wildlife. ***A 20+ YEAR RETROSPECTIVE ON SPIKE-ONLY GENERAL SEASONS / BRANCHED BULL PERMITS FOR ELK HUNTING IN EASTERN WASHINGTON.***

By the early 1980s, after decades of "*any bull*" general seasons in eastern Washington, the Blue Mountains, Yakima, and Colockum elk herds were characterized by low post-hunt bull:cow ratios and a paucity of older bulls. There was also some evidence of extended, bimodal breeding and subpar pregnancy rates. In 1989, a spike-only general season regulation was adopted for the Blue Mountains herd. Under the spike-only regulation a legal bull had to have only a single, unbranched antler on at least 1 side. In 1994, the same regulation was adopted for the Yakima and Colockum herds. Under this harvesting scheme, branch-antlered bull hunting in all 3 herds was to be controlled via limited entry permits that would be allocated based on annual availability of older bulls. In the Blue Mountains and Yakima herds, post-hunt bull:cow ratios increased rapidly following the regulations change, and older bull numbers soon reached objectives. In the Colockum, these increases were more modest. Telemetry-based estimates of adult bull survival from studies in all 3 herds (non-overlapping in time) were 0.83 [95%CI = 0.76-0.88], 0.63 [95%CI = 0.52-0.73], and 0.60 [95%CI = 0.46-0.73] under limited entry permits in the Blue Mountains, Yakima, and Colockum herds, respectively. Telemetry estimates of yearling bull survival are available only from the Blue Mountains general seasons in the early 2000's and were 0.41 [95%CI = 0.29-0.53]. Harvest and survey data from the Yakima and Colockum herds suggested moderate mortality of yearling bulls in Yakima under spike only management, but relatively high mortality in the Colockum. To increase yearling bull escapement in the Colockum, the general season regulation was modified in 2009 to be a "*true spike*" regulation with only 1 × 1 bulls legal. Harvest and survey data indicated a substantial improvement of yearling bull recruitment into the 2-yr-old class under this modification. We discuss effects of spike-only general seasons, branched-bulls by permit, on hunter participation, harvest, and herd demographics. We also discuss acceptance of this harvesting scheme by Washington elk hunters. We also discuss possible reasons for observed differences between the Colockum herd and the other 2 eastern Washington herds under 2+ decades of spike-only management.

MCMILLAN, BROCK R.[1], Eric D. Freeman[2], Jacob T. Hall[1], Kent R. Hhersey[3], Justin M. Shannon[3], and Randy T. Larsen[1]. [1]Brigham Young University. [2]Idaho Department of Fish and Game. [3]Utah Division of Wildlife Resources. ***EFFECTS OF COYOTE CONTROL ON THE SURVIVAL OF NEONATE MULE DEER***.

Predation is a factor that potentially influences survival of adult deer and recruitment of juveniles. However, the effectiveness of efforts to mitigate predation are largely unknown—especially for neonate mule deer. To better understand the effects of predation on mule deer, we implemented a study to experimentally examine the effects of predator control on survival of neonate mule deer in southern Utah. Our objectives were to determine 1) survival and cause-specific mortality of neonate mule deer, and 2) whether control of coyotes increased survival of neonates. We documented survival of fawns in areas where coyotes were experimentally controlled and areas where they were not controlled using a four-year crossover design. During 2012–15, we monitored 268 neonate mule deer using VHF-radio collars to determine survival. We located deceased fawns and determined probable cause of death based on evidence found at that location. Our results indicate that coyote-related mortality was lower and overall fawn survival was higher in the coyote removal area than in the non-removal area during 2012–13, and, this increase was correlated with a subsequent increase in fawn:doe ratios. However, there were no differences in mortality during 2014–2015. The landscape position of where coyotes were removed relative to the location of birth site influenced the likelihood of fawn survival and likely explains conflicting results between the two study sites. We suggest that targeted coyote control in fawning areas has the potential to enhance fawn survival and recruitment. However, coyote control outside areas of fawning habitat likely has little or no impact on the survival of fawns.

MERKLE, JEROD A[1], Paul C. Cross[2], Brandon M. Scurlock[3], Eric K. Cole[4], Alyson B. Courtemanch[3], Sarah R. Dewey[5], and Matthew J. Kauffman[6]. [1]University of Wyoming. [2]U.S. Geological Survey. [3]Wyoming Game and Fish Department. [4]U.S. Fish and Wildlife Service, National Elk Refuge. [5]National Park Service. [6]U.S. Geological Survey, University of Wyoming. ***LINKING SPRING PHENOLOGY WITH MECHANISTIC MODELS OF ELK MOVEMENT TO PREDICT BRUCELLOSIS TRANSMISSION RISK.***

We used a mechanistic movement modeling approach to simulate the spatio-temporal variation in brucellosis transmission risk in northwestern Wyoming. Using GPS collar data from 288 female elk captured on winter feedgrounds, we parameterized Step Selection Functions (SSFs) of elk behavior and then translated the SSFs into a daily probability density function of elk distribution (at 500m resolution) for five winter weather scenarios (from a heavy snow to an extreme drought year). We combined the predicted elk distributions with empirical estimates of daily abortion rates, spatially varying elk seroprevelance and elk population counts, to predict the spatio-temporal distribution of disease transmission for a given year. As the abortion season progresses in spring, elk behavior shifts from a reliance on supplemental feed to selecting

habitat at higher elevations, on southerly slopes, with lower canopy cover and less snow, farther away from roads, and with higher vegetation biomass. We predicted that approximately 700 abortions occur across the study area per year. During average snow years, we predicted that most abortions occur on US Forest Service lands (43%) and on feedgrounds (33%); however, during drought years, up to 64% of abortions occurring on feedgrounds shift to occurring mainly on US Forest Service lands and to a lesser extent on other public lands, with little change on private land. Linking mechanistic models of host movement with disease dynamics leads to a novel bridge between movement and disease ecology – providing managers with the tools needed to proactively mitigate risks posed by mobile disease hosts.

MOELLER, ANNA[1], Paul Lukacs1, and Jon Horne[2]. [1]University of Montana. [2]Idaho Department of Fish and Game. ***ESTIMATING ABUNDANCE OF UNMARKED POPULATIONS USING CAMERA TRAPS.***
Estimating abundance is an essential part of understanding population dynamics and managing populations. To estimate deer and elk abundances, most western wildlife agencies rely on aerial survey methods, which can be expensive, dangerous, and difficult to implement. Remote camera traps are gaining traction as a cost-effective and non-invasive method for monitoring animals and estimating abundance. However, most camera trap abundance estimates rely on a traditional capture-recapture framework that requires individually identifiable animals. We developed two methods for estimating abundance of unmarked animals using camera trap data. First, we used instantaneous sampling to obtain unbiased estimates of density. Then we generalized this to a time-to-event framework to estimate abundance from the time between detections of the target species. Intuitively, as the number of animals in an area increases, the rate of encounter increases, and the time between trapping events decreases. When scaled by movement rate, the time between detections of a species can be used to estimate abundance. We developed both methods and tested them with simulated data and field data from Idaho. These methods provide a new framework for estimating abundance from unmarked animals and for utilizing more information from camera data.

Northrup, Joseph M.[1], **CHARLES R. ANDERSON JR**[2], Brian D. Gerber[1], and George Wittemyer[1]. [1]Colorado State University. [2]Colorado Parks and Wildlife. ***BEHAVIORAL PLASTICITY BUFFERS MULE DEER FROM DEMOGRAPHIC IMPACTS OF ENERGY DEVELOPMENT.***
Developing effective measures to mitigate development impacts has become important for wildlife managers but has been hindered by inability to identify factors driving populations. Current research predominantly addresses behavioral responses to development, but often lacks assessment of demographic and population-level influences. We assessed the demographic and behavioral responses of a mule deer population to natural gas development on winter range in the Piceance Basin of Colorado, USA between 2008 and 2015. We focused data collection on two winter range study areas that experienced different levels of energy development (0.1 pads/km^2 and 0.9 pads/km^2). We assessed mule deer behavioral responses by examining habitat selection patterns of adult female mule deer. To address demographic responses, we compared annual adult and over-winter fawn survival, fawn and adult female body condition, pregnancy rates, fetal counts, and annual changes in density. We noted strong differences in habitat selection between study areas, but found no differences in any demographic parameters measured. Our results indicate that deer were able to alter their behavior in response to development on winter range to avoid any demographic consequences. Given our results, mitigation efforts should focus on the drilling phase of development, as it appears that deer can adjust to relatively high densities of producing well pads, provided there is sufficient vegetative and topographic cover available. Our study highlights the importance of concomitant assessments of behavior and demography to provide a holistic understanding of the impacts of habitat modification on wildlife.

NOWAK, J. JOSHUA[1], Paul M. Lukacs[1], Mark Hurley[2], Andy Lindbloom[3], and Kevin A. Robling[3]. [1]University of Montana. [2]Idaho Department of Fish and Game. [3]South Dakota Game, Fish and Parks. ***CLOSING THE LOOP FROM DATA COLLECTION TO DECISION.***
Data collection, storage and analysis all play a central role in the management of deer and elk. However, moving data from the field through an analysis and to a report can be an arduous task. For example, during data collection we might find it time consuming to collate GPS points with paper data sheets. Excel spreadsheets may be convenient for storing data locally, but when analyses cover multiple jurisdictions or times it can be difficult to aggregate data. And while statistical methods have improved markedly in the last decade there is often a lag in the transfer of such innovations to decision makers. Several western states have adopted technology to solve these problems. We discuss some of the successes, limitations and unique challenges of adopting technology within the context of deer and elk management. We will cover the use of mobile applications for check stations and aerial surveys, automation of harvest estimation and predictive modeling of fawn survival, and web based data entry. We survey the field to review the state of tools that make the

biologist's life easier and more efficient. Finally, we conclude by discussing assimilation of these pieces and how biologists might benefit.

PINIZZOTTO, NICK J.. National Deer Alliance. ***NATIONAL DEER ALLIANCE AND THE POLITICAL SCIENCE OF CWD.***
The mission of the National Deer Alliance (NDA) is to serve as the guardian of wild deer conservation and our hunting heritage. Despite 83% of the nearly 14 million hunters in the
United States identifying themselves as deer hunters, there was no national organization geared toward protecting the interests of all deer, hunters and the deer hunting industry before the formation of NDA. NDA serves as a policy-focused umbrella group to its founding organizations, QDMA, Mule Deer Foundation, and Whitetails Unlimited. NDA's key priorities include wild deer conservation, diseases, hunter access, predators and competitors, and state and federal land management. Deer diseases are the current top priority of the organization, particularly chronic wasting disease (CWD). NDA recently formed a special working group made up of national conservation groups and other thought leaders to submit comments to
USDA for their CWD Program Standards for management of captive cervids. In addition, the organization is working on a critical strategy for ensuring that the threat of CWD is better understood on Capitol Hill, as well as in the state legislators. While the threat of CWD to wild deer is real, we face a number of challenges when it comes to creating a sense of urgency among sportsmen, legislators, and other decision makers. In addition, some individuals prominent in the deer community are actively downplaying the threat. In this presentation, the political science of managing CWD will be discussed, and a brief background on the history of NDA and its goals will be provided.

PROFFITT, KELLY M.[1], Jesse DeVoe[2], Kristin Barker[2], Rebecca Durham[3], Teagan Hayes[3], Mark Hebblewhite[2], Craig Jourdonnais[3], and Philip Ramsey[3]. [1]Montana Fish Wildlife and Parks. [2]University of Montana. [3]MPG Ranch. ***VARIABILITY IN ELK FORAGE IN A LANDSCAPE OF WILDFIRE AND CHANGING FIRE MANAGEMENT.***
Forest management practices can modify ungulate nutritional resources through landscape-scale processes such as prescribed fire and wildfire. The resulting availability and distribution of nutritional resources can impact ungulate survival, reproduction, and distribution. Our goals were to evaluate how landscapes with varying post-fire successional stages influence elk summer forage quality and abundance and quantify the variability of forage quality and abundance associated with varying fire histories during 1900–2015. Within 3 elk population ranges located in the Bitterroot Valley, Montana, we measured elk forage quality and abundance across a range of land cover types and fire histories and developed landscape-scale forage quality and abundance models. Based on historical wildfire and prescribed fire data, we reconstructed decadal land cover models and used our forage models to predict fire-related variations in forage quality and abundance each decade within the elk summer ranges. Forage quality was predicted to decrease with successional stage and herbaceous abundance peak in mid-successional dry forests and early-successional mesic forests. The area burned by wildfire increased 242–1,772% during 1990–2015 as compared to 1900–1990, resulting in fire-related variations in predicted forage quality and abundance. Herbaceous forage abundance increased 2.2–12.4% and area of highest quality forage quality varied, increasing 31.3–48.5% in 2 ranges and decreasing 2.4% in 1 range, from 1900–1990 as compared to 1990–2015. These results highlight the important effect of wildfire on the distribution and abundance of ungulate nutritional resources, and demonstrate that ungulate nutritional resources likely vary over time with variation in fire history and management practices.

QUINTANA, NICOLE TATMAN [1], Stewart Liley[1], James W. Cain III[2], and James W. Pitman[1]. [1]New Mexico Department of Game and Fish. [2]U.S. Geological Survey, New Mexico State University. ***EVALUATING EFFECTS OF NUTRITION AND PREDATION ON AN ELK POPULATION IN NEW MEXICO.***
We conducted a 4-year study (2009–2012) evaluating the role of predation and nutrition in limiting productivity of an elk population in northern New Mexico. We captured and fixed ear-tag radio transmitters to 245 elk calves to determine cause specific mortality. During the second half of our study, we implemented spring black bear harvest and evaluated response in calf survival. The primary cause of death for calves across all years was black bear predation (57 of 140 non-anthropogenic mortalities). Point estimates for annual calf survival were higher when spring black bear harvest was moderate to heavy (0.44–0.47) compared to low (0.33–0.35). We determined herd-wide nutritional condition and productivity by quantifying percent ingesta-free body fat (IFBF) of 1,808 female elk harvested by hunters. Our herd-wide estimate of autumn IFBF was 11.41% (SE = 0.19) but varied by age class, pregnancy status, and lactation status. Across years and age classes 82% (SE = 1%) of females were pregnant. Pregnancy rate was greatest for prime aged (2–9 years) females (88%, SE = 1%) and lower for young (<2 years, 12%, SE = 5%) and senescent (63%, SE = 4%) females (χ^2 =

272.6, $P < 0.001$). Observed low calf recruitment despite adequate nutrition of adult females suggested that substantial black bear predation was limiting population productivity. Additionally, calf survival was higher in drought years, the same years when spring black bear harvest was implemented. Results from our study demonstrated that productivity could be increased by implementing a spring black bear harvest strategy and targeting it around calving areas.

Ranglack, Dustin H.[1], Kelly M. Proffitt[2], Jodie E. Canfield[3], **JUSTIN A. GUDE[2]**, Jay Rotella[1], and Robert A. Garrott[1]. [1]Montana State University. [2]Montana Fish, Wildlife, and Parks. [3]USDA Forest Service. ***SECURITY AREAS FOR ELK DURING ARCHERY AND RIFLE HUNTING SEASONS.***

Fall elk habitat management on public lands has focused on providing security areas that allow for reasonable bull elk survival and hunter opportunity. However, in areas that include lands that restrict public hunter access, elk may alter their space use patterns during the hunting season by increasing use of areas that restrict public hunter access rather than utilizing security areas on adjacent public lands. We used GPS location data from 325 adult female elk in 9 southwest Montana populations to determine resource selection during the archery and rifle hunting seasons. We found that during the archery season, in order of the strength of selection, elk selected for areas that restricted access to public hunters, had higher time-integrated NDVI, higher canopy cover, were farther from motorized routes, and had lower hunter effort. During the rifle season, in order of the strength of selection, elk selected for areas that restricted access to public hunters, farther from motorized routes, had higher canopy cover, and higher hunter effort. Interactions among several of these influential covariates revealed dependencies in elk resource selection patterns. Further, cross-population analyses revealed increased elk avoidance of motorized routes with increasing hunter effort during both the archery and rifle hunting seasons. Given increased elk avoidance of motorized routes with higher hunter effort, we recommend that to maintain elk on public lands managers consider increasing the amount of security area in areas that receive high hunter effort, or hunting seasons that limit hunter effort in areas of high motorized route densities.

SANCHEZ, GAEL A.[1], Randy W. Deyoung[1], Damon L. Williford[1], David G. Hewitt[1], Timothy E. Fulbright[1], Humberto Perotto-Baldiviseo[1], Louis A. Harveson[2], and Shawn S. Gray[3]. [1]Texas A&M University. [2]Sul Ross State University. [3]Texas Parks and Wildlife Department. ***ANALYSIS OF ALLELIC VARIATION IN PRION PROTEIN GENE OF TEXAS MULE DEER.***

Chronic Wasting Disease (CWD) was discovered in North American cervids in 1981 and has become a major management concern in recent decades. Chronic wasting disease was detected in Texas mule deer (*Odocoileus hemionus*) in 2012, most likely spread to Texas from New Mexico via natural movements of mule deer in the Hueco Mountains. Management has focused on containment of the disease as the most realistic and economically viable option. There is no cure or evidence of resistance to CWD, but mutations in the prion protein gene (*PrP*) affect susceptibility, incubation time, and the ability to detect the disease. We amplified and sequenced the *PrP* gene from tissue samples collected at CWD check stations in the Trans-Pecos and Panhandle regions of Texas during 2012-2015. We observed both synonymous and nonsynonymous mutations in the *PrP* gene, including several not previously reported in cervids. Six deer phenotypically identified as mule deer had nucleotide substitutions at codon 96, mutations originally identified in the white-tailed deer (*O. virginianus*) *PrP* gene. Two mule deer had mutations at codon 225, resulting in an amino acid substitution associated with CWD prevalence and progression in Colorado and Wyoming populations. Our preliminary results reveal a diverse set of *PrnP* alleles in Texas mule deer, due to past hybridization and backcrossing with white-tailed deer, as well as novel nonsynonymous mutations, with unknown significance. Genetic variation in the *PrP* gene has implications for detection of CWD and future management decisions throughout the state aimed at controlling the spread of the disease.

SCHUYLER, ELIZABETH M.[1], Katie M. Dugger[2], and Dewaine H. Jackson[3]. [1]Oregon State University. [2]U. S. Geological Survey, Oregon State University. [3]Oregon Department of Fish and Wildlife. ***SURVIVAL RATES AND CAUSE-SPECIFIC MORTALITY OF MULE DEER IN SOUTH-CENTRAL OREGON.***

We report on a seven year (2005-2012) study designed to investigate survival and cause-specific mortality of female mule deer in eastern Oregon. We used known-fate data for 408 adults radio-collared mule deer to estimate monthly survival rates and to investigate factors that might affect these rates including seasonal distribution, temporal effects (seasonal, annual, and trends across season and year), movement behavior, and local weather and regional climatic covariates. We also quantified cause-specific mortality for adult mule deer (n=480) using a nonparametric cumulative incidence function estimator (NPCIFE). Variation in survival rates of female mule deer was best explained by an additive effect of migration behavior, differences in survival during the fall migration period compared to the rest of the annual cycle, and precipitation levels on winter ranges of individual deer. Estimates of annual survival were higher for migrants (0.81-0.82), compared to residents (0.76-0.77). Survival was lower for both migrants and residents during the fall migration period (Oct – Nov) and higher levels of winter precipitation increased survival of both groups. Predation was the cause of mortality that resulted in

the highest cumulative risk across the annual cycle for females (0.044, 95%CI=0.028-0.065) with anthropogenic causes (0.038, 95%CI=0.021-0.054) and illegal harvest (0.031, 95%CI=0.17-0.054) also important. The results suggested that migrating to potentially higher quality summer foraging areas outweighed the cost of traveling through unfamiliar habitats and energy expenditure associated with migration. Conversely, these results could reflect the negative effect of summer ranges on resident survival during this study potentially due to poor habitat quality or human disturbance. Surprisingly, we observed high levels of illegal harvest on female deer during this study. Future research is focused on investigating influence of restoration treatments and wildfire on mule deer survival and selection of habitat patches.

SCURLOCK, BRANDON, Jared Rogerson, Eric Maichak, Benjamin Wise and Rebecca Fuda. Wyoming Game and Fish Department. ***DEFINING BRUCELLOSIS TRANSMISSION RISK AREAS AND PARTURITION RANGES OF ELK IN WESTERN WYOMING.***

Operation of winter feedgrounds (November–April) in Wyoming concentrates elk (*Cervus canadensis*) during the brucellosis transmission period (February–June), maintaining the disease at an elevated prevalence. Feedgrounds help to control elk distribution and separate elk and cattle (*Bos taurus*), yet brucellosis infections in Wyoming cattle were linked to elk from nearby feedgrounds on multiple occasions during the last 15 years, likely resulting from spatiotemporal overlap of elk with cattle during March-July. We delineated areas of high risk for elk-cattle brucellosis transmission in Wyoming by identifying elk calving ranges and use areas using Vaginal Implant Transmitters (VITs) and, Global Positioning System (GPS) collars. From January 2006 through February 2016 we deployed 640 VITs and collected 553 GPS collar-years of data from elk captured on 20 feedgrounds and 4 native winter ranges adjacent to feedgrounds. A total of 566 (88%) of VITs were accounted for, and we documented 526 parturition sites, 31 reproductive failures (abortion events), and 9 cows died before VIT expulsion. We recovered *Brucella abortus* from abortion and live birth events, and abortions peaked during March-May with 95% of brucellosis transmission risk occurring before 6 June, but the risk period extended until 10 July. Nearly 73% of parturition sites identified by VITs were recovered outside of previously delineated elk parturition ranges illustrating the pitfalls of basing seasonal ranges on observation records. We produced maps of areas where a high risk for brucellosis transmission exists in western Wyoming for livestock managers seeking to reduce disease risk of their cattle herds.

SHANNON, JUSTIN M. and Kent R. Hersey. Utah Division of Wildlife Resources. **ALFALFA AND BUCKWHEAT: UTAH'S APPROACH TO FEEDING THE LITTLE RASCALS.**

During winter 2016-2017, the Utah Division of Wildlife Resources (UDWR) and some other western state wildlife management agencies initiated deer feeding or baiting programs because of severe winter conditions. At the most recent Mule Deer Working Group meeting, deer feeding programs were discussed and it was decided that a presentation on factors that influence deer feeding would be beneficial. As part of UDWR's emergency winter feeding policy, biologists monitor five biological and environmental factors on a weekly basis that include: 1) evaluating the condition of deer going into winter, 2) documenting the declining rate of body condition throughout winter, 3) assessing the availability of shrubs, 4) measuring snow depths, and 5) monitoring temperatures. Each of these factors has an associated trigger, and if three of the five triggers are met or exceeded, emergency feeding measures will be considered. Other considerations include depredation pressure, current snow conditions (e.g. hard crusts), and the long-term weather forecast. If a decision is made to feed deer, local biologists write a plan and work closely with sportsmen and landowners to distribute specialized deer pellets in approved locations. UDWR, however, will not feed in areas where chronic wasting disease, brucellosis, or tuberculosis has been detected. Finally, management strategies that enhance the body condition of mule deer (e.g. habitat treatments or increased antlerless harvest) should be considered for the long-term health of these populations and their habitats.

SIMS, S. ANDREW[1], David Stoner[1], Kent Hersey[2], Heather Bernales[2], Jyothy Nagol[3], Joseph O. Sexton[3], and Thomas Edwards, Jr[4]. [1]Utah State University. [2]Utah Division of Wildlife Resources. [3]University of Maryland. [4]U.S. Geological Survey, Utah State University. ***MODELLING AND FORECASTING MULE DEER SURVIVAL IN UTAH: A LOOK AT REDUCING UNCERTAINTY IN FORECASTS USING ADAPTIVE TECNIQUES.***

Forecast modelling is playing an ever more crucial role in the management of ungulate species, specifically in the face of widespread anthropogenic and environmental change. Due to their large distributions across a variety of environments, large-scale change is likely to affect critical habitats and distribution of ungulates, forcing species to interact with novel environmental conditions. Uncertainty of exactly how ungulate species will respond to change provides a need for developing a framework for creating and optimizing forecast models with the purpose of assisting management decisions. The goal of our study was to develop models for forecasting mule deer (*Odocoileus hemionus*) survival for a short time into the future (~10 months). Furthermore, we demonstrate the ability to reduce error and uncertainty in forecast models through

adaptive techniques. The mule deer survival dataset utilized in this study was collected by the Utah Division of Wildlife Resources for 7 study sites distributed across the state of Utah from 2010 to 2015. The relationships for the forecast models were developed using that data from 2010 to 2014 and were used to forecast survival 10 months into 2015, which was then compared with the 2015 field data estimates. Lastly, new data was integrated into the model in an adaptive format in small time intervals throughout 2015 to measure how error and uncertainty in the forecasted estimates reacted with the addition of more information. Forecast models can provide as a useful tool in aiding the annual management and conservation decisions that are required for ungulate species.

SPITZ, DEREK[1], Mike Wisdom[2], Taal Levi[1], Mary Rowland[2], and Darren Clark[3]. [1]Oregon State University. [2]US Forest Service. [3]Oregon Department of Fish and Wildlife. ***QUANTIFYING LONG-TERM EFFECTS OF FIRE HISTORY ON ELK BEHAVIOR.***

Fuel reduction treatments are widely prescribed to enhance habitat for large ungulates. In coniferous forests these treatments are expected to improve nutritional resources by opening the canopy and facilitating growth of understory vegetation. Previous work suggests that ungulates should reap long-term benefits as this growth peaks and gradually diminishes through time while trees reestablish. Past research on ungulate responses to fuel treatments has overwhelmingly focused on short-term effects—often with contradictory results. Consequently the progression and duration of ungulate responses to fuel treatments remain poorly understood. We used discrete choice models to quantify the magnitude and duration of elk (*Cervus elaphus*) response to fuel treatments in the Starkey Experimental Forest and Range. Between 2001 and 2003, 26 stands of fir (*Abies* spp.) and Douglas-fir (*Pseudotsuga menziesii*) were thinned and burned, while 27 similar stands were held as experimental controls. Our analysis included 599 animal-years (1997—2012) of elk location data from n = 274 unique individuals. Rather than showing consistent selection for treated stands, elk response to fuel treatments varied as a function of years-since-burn, behavior (foraging/resting) and season (spring/summer). Our results support the hypothesis that fuel treatments have long-lasting (>10yrs) effects on ungulate behavior and emphasize the importance of tailoring resource selection methods to specific animal behaviors. Finally, the strategies of resource selection we observed are only possible within a landscape with a heterogeneous fire history, suggesting that elk benefit from the ability to choose between a range of conditions with different attendant risks and rewards.

Thompson, Scott, **DREW HENRY**, Kelly M. Proffitt, and Justin A. Gude. Montana Fish, Wildlife and Parks. ***EFFECTS OF HUNTER ACCESS ON HUNTING SEASON ELK DISTRIBUTIONS IN THE MISSOURI RIVER BREAKS.***

Increasing harvest of adult female elk is the primary management tool for curtailing elk population growth. However, this tool is not effective when elk are located on private properties that restrict hunter access. We used GPS location data from 46 adult female elk for 2-years in 2 adjacent populations, the Missouri River Breaks (MRB) population and the Larb Hills population, to evaluate the effects of hunter access and other landscape factors on elk resource selection during the archery and rifle hunting seasons. We found that elk in both MRB and Larb Hills selected their home ranges in areas with no hunter access, and the strength of selection for locations with no hunter access was stronger in the archery season than the rifle season. However, individual models revealed that although population-level selection for no hunter access was strong, the majority of all MRB elk locations occurred in areas accessible to hunters, particularly in the MRB, where only a small amount of area has restricted hunter access. In Larb Hills, individual models confirmed results of the population-level analysis, and most elk selected for locations with no hunter access during the archery and rifle seasons. Elk refuge situations, even in relatively small geographic areas, may have a disproportionate effect on elk distributions and prevent effective harvest of female elk to maintain elk at objective levels. Working cooperatively with stakeholders to minimize these situations is necessary for curtailing further elk population increases and maintaining a distribution of elk across public and private lands.

WARNER, LAURA S.[1], Jacob R. Lampman[2], David G. Hewitt[1], Shawn S. Gray[3], Dana J. Wright[3], Warren C. Conway[4], Timothy E. Fulbright[1], Randy W. DeYoung[1], and Louis A. Harveson[2]. [1]Texas A&M University. [2]Sul Ross State University. [3]Texas Parks and Wildlife Department. [4]Texas Tech University. ***INFLUENCE OF AGRICULTURE ON MULE DEER MOVEMENT IN THE TEXAS PANHANDLE.***

Mule deer (*Odocoileus hemionus*) occur in the Texas Panhandle, a region of rangeland fragmented by row-crop agriculture. Anecdotal observations suggest that deer in the region make large seasonal movements during fall and spring to access and use crops to supplement natural forage in their diet, but the relationship between deer movement and crop use is not well-understood. We captured and marked 43 adult mule deer with GPS collars during October 2015, and fixes were taken every two hours for one year. Adaptive kernel home range analysis with 50% isopleths was used to identify the core areas of use

within the home range of each deer. Movements between core areas of use were defined as seasonal or non-seasonal, and the distances between the areas were measured. Seasonal movement between core areas of use was not common, with only 4 deer exhibiting this behavior. Long-distance movements were also not common, with an average distance between core areas of 3.66 km. Crops were present in most core areas (78%) and predominantly utilized during the winter months, with winter wheat (*Triticum* spp.) being the most utilized crop. These results suggest that mule deer in the Texas Panhandle, in general, do not make seasonal, long-distance movements to access crops and are likely being managed on an appropriate scale. Evidence of heavy use of winter wheat could aid in correcting inflated density estimates calculated from surveys conducted during times when deer are aggregated on wheat fields, which would produce more accurate harvest recommendations.

WHITE, JR, DON[1] and Tom Toman[2]. [1]University of Arkansas. [2]Rocky Mountain Elk Foundation. ***RETURNING ELK TO EASTERN NORTH AMERICA.***

Naturalist Ernest Thompson Seton (1927), in the 3rd volume of his *Lives of Game Animals*, estimated as many as 10 million elk were once present in North America. As early as the late 1700s, due to consumptive uses by settlers, miners, market hunters, and others, elk range contracted westward, becoming restricted to the Rocky Mountain region and several isolated areas along the Pacific Coast. Beginning in the early 1900's, many attempts were made to reintroduce elk to portions of its former range in eastern North America. Many of the early attempts were unsuccessful, primarily because of lack of understanding of elk habitat requirements and excessive, human-caused mortality. Ongoing successes in Ontario, Canada, and Arkansas, Kentucky, Michigan, Minnesota, Pennsylvania, Tennessee, and Wisconsin, however, along with their evolving management strategies, have contributed to the formerly scant knowledge relevant to the necessary elements of a successful restoration. In addition, recent releases in Missouri, North Carolina, Virginia, and West Virginia are being closely monitored, and important data and agency experience has been obtained relevant to restoration ecology. In this presentation, we will provide an overview of elk restoration efforts in eastern North America during the last 100 years with emphasis on the challenges of managing elk in landscapes that contain a complex mosaic of land ownerships and land uses, where human densities are high, and public lands tend to be small and fragmented.

ZAFFARANO, TRAVIS J.[1], Matthew J. Kauffman[2], Doug McWhirter[3], Gregg Anderson[3], and Alyson Courtemanch[3]. [1]University of Wyoming.[2]US Geological Survey, University of Wyoming. [3]Wyoming Game and Fish Department.

PICTURE THIS: MONITORING MIGRATORY ELK HERDS USING REMOTE PHOTOGRAPHY.

Population estimates of big games species are essential for biologists to manage productive herds while still maintaining annual hunter harvests. Many state agencies conduct herd composition surveys via helicopter or fixed wing aircraft, which are both costly and potentially dangerous to the biologists involved. Further complicating the estimation of herd productivity is the aggregation of migratory and resident herds on seasonal habitats. Several migratory elk (*Cervus elaphus*) herds in northwestern Wyoming share winter habitat with resident herds, making it difficult to attain herd-specific composition data. To gather herd specific composition data, and to better understand the timing of migration, we deployed remote trail cameras at geographic 'bottlenecks' to monitor migrating elk herds. Between 29 and 32 trail cameras were deployed in the fall season of 2014—2016 along migration routes of four migratory herds in Northwest Wyoming. Cameras were left in place to capture both fall and spring seasonal migrations. Although our results are preliminary, the camera data allow for several useful comparisons, namely i) variation in peak migration timing between herds, ii) the timing of fall migration for bulls versus cows, and iii) indices of calf survival. Successful camera locations have potential to be used as a long term monitoring network where migratory herds can be predictably photographed year after year. Long-term data on compositional trends and timing of spring and fall migrations, will aid in developing herd management objectives and reduce annual survey costs.

Abstracts of To The Point Presentations

Presenter names are capitalized

BELINDA, STEVE. Beartooth Strategies. Red Lodge, MT. ***PARTNERSHIPS FOR DEER AND GROUSE HABITAT RESTORATION IN SOUTHERN IDAHO.***

The Mule Deer Foundation (MDF) has partnered with the Bureau of Land Management (BLM), Idaho Fish and Game Department (IDFG), Idaho Office of Species Conservation (OSC) and the North American Grouse Partnership (NAGP) to restore burned areas in southern Idaho to functional mule deer and sage-grouse habitats. Prompted by a grant from the BLM, MDF is working with its partners and local MDF chapter volunteers to identify priority areas for restoration where crucial mule deer winter range and sage-grouse focal areas overlap. Restoration work involves planting year-old sagebrush and bitterbrush in order to provide forage and jump-start shrub recovery and ultimately habitat function and restoring local populations of mule deer and sage-grouse.

BRIDGES, JOSEPH A. Washington Department of Fish and Wildlife. ***ERODING PERCEIVED BARRIERS BY LANDOWNERS IN ESTABLISHING GAME FENCING AROUND HIGH VALUE CROPS.***

Damage to high value crops is a real problem in Washington, but simple, logical solutions that empower the landowner to prevent/reduce the conflict are often not available or result in a circular process where the problem is seldom resolved. I will discuss the process I have established in Washington to assist landowners with erecting self-funded game fencing around privately owned high value crops. I will also highlight the perceived barriers that landowners encounter, my approach to successfully working with interested landowners, the cause for a fundamental ideology shift away from cost share fencing programs, and the management implications of privately funded game fences.

CARSON, KERI, Jennifer Ramsey, and Emely Almberg. Montana Fish, Wildlife and Parks. ***DEER ADENOVIRUS DISCOVERED IN MONTANA.***

Every year Montana Fish, Wildlife and Parks wildlife health lab receives biological samples from a range of species from all corners of the state for diagnostic purposes. In 2016 two deer tested positive for deer adenovirus. One death was an isolated incident while the other presented as a small localized die-off.

EPSTEIN, KATIE. Montana State University. ***LAND USE DIVERSIFICATION & INTENSIFICATION ON ELK WINTER RANGE IN GREATER YELLOWSTONE ECOSYSTEM.***

The amenity migration describes the movement of peoples to rural landscapes and the transition towards more consumptive land uses (tourism, recreation) and away from production-oriented uses (ranching, timber-harvesting). The resulting mosaic of land uses and community structures have mixed outcomes for migrating wildlife and their management. In this research note, we investigate the state of on-going amenity-driven change to social-ecological systems in the Greater Yellowstone Ecosystem (GYE). We agglomerate land use data from the Montana counties of the GYE into a "social-impact" index to track land use change on elk winter ranges. We also compare the spatial distributions of land use changes with insights from a focus group with wildlife management experts. Our findings suggest that elk are encountering an increasingly diverse landscape with respect to land use and that new ownership patterns increase the complexity of social and community dynamics. These factors in turn contribute to increasing administrative challenges and difficulty meeting wildlife management objectives. To deal with rising complexity across social and ecological landscapes of the GYE we present a research agenda that focuses on property life-cycle dynamics and a systems approach.

Mitchell A. Gritts and CODY MCKEE. Nevada Department of Wildlife. ***TelemetR; A TOOL FOR MANAGING, VISUALIZING, AND ANALYZING ANIMAL MOVEMENT DATA.***
Animal movement data is an increasingly important tool for the management of deer and elk. The increased usage of telemetry data has not been met with equal enthusiasm for good data management practices. TelemetR is an application to help wildlife managers manage, visualize, and analyze GPS data collected from telemetry devices.

HOLM, SARA. California Department of Fish and Wildlife. ***STRATEGIC PLACEMENT OF WILDLIFE CROSSINGS TO MITIGATE DEER/VEHICLE COLLISIONS.***
The multi-agency Highway 89 Stewardship Team has collaborated to use research, mitigation and outreach to solve connectivity and deer/vehicle collision issues on a rural stretch of Highway in Sierra County, California. Using a combination of grants, collared deer, cameras, and a long running roadkill database the Team has successfully designed and built three underpasses with fencing and jump outs on a 25-mile stretch of highway. In doing so , the Team has changed the local culture of Transportation Ecology and provided safe crossing for a declining migratory mule deer herd.

MCCOY, KARIN R., Jason Waite, and Rodney W. Flynn. Alaska Department of Fish and Game. ***SAMPLING DEER FECAL DNA IN ALASKA: PROGRESS AND LESSONS. LEARNED.***
Deer fecal DNA sampling for population abundance and density estimation has been successfully conducted in several locations in Southeast Alaska. Initial efforts were successfully conducted in areas where populations were believed to be at relatively moderate to high densities. Preliminary attempts to do similar work in areas with lower densities of deer were more challenging due to both lower pellet group encounter rates and low recapture rates of individual deer, and therefore required a revision of sampling design. We present an overview of methods and techniques employed in each situation, as well as new analysis methods we have been exploring.

MILBURN, PHILIP. Oregon Department of Fish and Wildlife. ***MULE DEER HERD RANGE DELINEATION IN EASTERN OREGON.***
This presentation will give an update on ongoing work to define mule deer herd ranges and data analysis units in E. Oregon. Since March 2015, GPS collars have been deployed on 750 adult does. Kernel density analysis of seasonal range centroids is used to describe discrete winter groupings that meet an identified threshold of spatial integrity on summer range. The results are then fitted to other management constraints to create data analysis units.

MOWRY, REBECCA. Montana Fish, Wildlife, and Parks. ***MULE DEER RESEARCH AND MANAGEMENT IN THE BITTERROOT VALLEY, MONTANA.***
Mule deer have declined in many parts of western Montana, including the Bitterroot Valley. In order to better understand what drives mule deer populations in this area, we initiated a pilot project involving capture and collaring of ~30 adult does in two hunting districts to monitor survival, collect baseline information, and evaluate possible competition with large elk populations.

PITMAN, JAMES W. New Mexico Department of Game and Fish. ***LOW CALF RECRUITMENT IN A NEW MEXICO ELK HERD: INVESTIGATION AND MANAGEMENT IMPLICATIONS.***
The Mt. Taylor elk herd has declined in recent years, largely due to a reduction in calf recruitment as shown by low calf: cow ratios on annual fall surveys. A study has been implemented to investigate the causes of this low calf survival and recruitment. Preliminary results are discussed as well as potential management actions to increase calf recruitment pending final study results.

ROBATCEK SIERRA L[1], Ryan A. Long[1], Craig White[2], and Eva Strand[1]. [1]University of Idaho. [2]Idaho Dept of Fish and Game. ***PREDICTING NUTRITIONAL CONDITION AND PREGNANCY OF ELK FROM REMOTELY SENSED DATA.***

Over the last two decades, some elk populations in Idaho have begun to display uncharacteristic variability in population performance. One hypothesis for explaining this variability is that poor quality and low quantity of forage resources on many summer-autumn ranges is negatively affecting the nutritional condition of individuals, leading to cascading effects on population vital rates and dynamics. The potential role of nutrition in influencing population dynamics, resource selection, and behavioral ecology has led to an increase in studies attempting to quantify the distribution, abundance, and quality of forage available to ungulates, and the influence these forage characteristics have on individual performance. The focus of this research is to: 1) evaluate the nutritional resources available to elk in Idaho via remotely sensed and ground-based methods; 2) determine how elk are using these nutritional resources using GPS collar data; and 3) model pregnancy rates of elk as a function of the nutritional landscape and the way in which elk utilize this landscape. The overall goal of this project is to provide managers with a spatiotemporally dynamic model that can be used to predict and extrapolate pregnancy rates of elk across the state as a function of remotely sensed data, and offer insight into why some elk populations in Idaho are experiencing depressed pregnancy rates and overall performance. If modeling nutritionally mediated population vital rates using remotely sensed data proves to be reliable, it will ameliorate many of the financial and logistical constraints often associated with ecological studies that span large geographical areas, or are focused on highly mobile species.

SHROEDER, CODY. Nevada Department of Wildlife. ***IDENTIFYING TIMING AND PEAK OF RUT ACTIVITY IN MULE DEER USING GPS COLLARS.***

Ungulates may drastically change activity patterns and intersexual associations during the breeding season. These changes can affect management of mule deer in various ways including minimizing bias of sex ratios during aerial surveys. We use a variety of analytical methods to determine the onset and peak of rutting activity for GPS radio-collared mule deer in Nevada.

SZKORUPA, TARA. Fish and Wildlife Branch, Ministry of Forests, Lands, and Natural Resource Operations, British Columbia. ***BC ELK MANAGEMENT PLAN.***

The Province of BC is currently developing an Elk Management Plan. I'll provide a high level overview of this plan and identify some of the challenges we're dealing with. The plan includes background ecological information, a description of management issues, management tools available or proposed for BC, and management direction (goals and objectives).

WEIST, TERRI. California Dept of Fish and Wildlife. ***ESTIMATING DEER ABUNDANCE USING FECAL DNA ON A REGIONAL SCALE.***

Obtaining accurate data necessary to monitor deer populations, especially in forested environments, is difficult. The California Department of Fish & Wildlife has embarked on a large scale effort to utilize non-invasive DNA based mark-recapture techniques to obtain rigorous estimates of abundance and density with moderate precision for several deer herds over the next six years. Results of this effort will aid in establishing hunt quotas and direct management decisions.

Abstracts of Posters

Presenter names are capitalized

CHAPMAN, GRANT, Justin Gilligan, and Emily Herdman. Alberta Environment and Parks. ***ALBERTA ELK AND MULE DEER HARVEST SCENARIO MODELLEING, POPULATION AND OCCUPANCY ESTIMATION USING REMOTE CAMERAS, AND NOVEL CONFLICT DATA USES IN GAME MANAGEMENT***.
Recent technological advances and population and harvest modelling, population surveying, and data management and accessibility are providing a more fulsome understanding of big game conflict, population, and harvest and enable improved effectiveness of big game management in Alberta. This poster provides additional detail to sections touched on in Alberta's oral presentation given at this workshop. We specifically focus on 3 topics: results of the recently completed "Alberta Boreal Deer Project", modelling regulation-specific elk and deer harvest scenario outcomes, and analysis of human and agriculture conflict datasets in Alberta. The Alberta Boreal Deer Project 2017 enabled population estimation, occupancy, and resource selection through the novel use of remote cameras and GPS collars. Provincial management planning 2017 harvest scenario and outcomes tables were generated for deer and elk that apply information from population monitoring, hunter harvest, and the evolution of regulation types in Alberta which provide tools for understanding expected harvest and management outcomes by regulation type. These modeled outcomes will allow for more appropriate objective based management of elk and deer. Alberta conducted spatial analyses and mapping of three provincial scale long term wildlife, agricultural, and vehicle collision conflict datasets resulting in an improved understanding of elk and deer human conflicts with great potential to improve conflict reduction strategies.

DAUWALTER, STACEY, Tricia Hosch-Hebdon, Daniel Dauwalter, R. Katherine Keeto, and Mark Drew. Idaho Department of Fish and Game. ***COMPARISON OF TRACE MINERAL CONCENTRATIONS IN IDAHO'S MULE DEER POPULATIONS.***
Routine winter captures of mule deer (*Odocoileus hemionus)* throughout the state of Idaho has provided the opportunity for health assessment through biological sampling. The evaluation of trace mineral concentrations from symptomatically healthy mule deer is the first step in determining if deficiencies or toxicity exist chronically or acutely in Idaho. This poster demonstrates a step in providing a known range of trace mineral concentrations for 12 population management units (PMU) in Idaho. Serum and whole blood are most commonly used to assess trace mineral status in live animals and were obtained thru venipuncture on yearling and adult does between December and January of each sampling year (2004-2014). Concentrations of calcium, copper, iron, magnesium, phosphorus, zinc, and selenium are summarized to determine mean, median, and range for each PMU. Population management units were compared to each other using Kruskal-Wallis one-way ANOVA. Pairwise comparisons were conducted using a Nemenyi test; all analyses were done in R 3.3.1.

GAUGHAN, CHRIS, Dennis Newman, and Scott Bergen. Idaho Department of Fish and Game. ***CENTRAL IDAHO ELK MIGRATION – THE TRAVELS OF 15 SELECTED GPS COLLARED ELK.***
We used data from 15 selected elk with GPS collars to look at migration corridors and timing in Central Idaho. The 15 elk had a total of 8985 data points. Seven of the elk had 2 years of data and the remaining 8 elk had only one year of data. The number of data points per animal ranged from 415 to 868. The data points were split into 5 different seasons. The seasons consisted of Spring (March 1 – May 15), Calving (May 16 – June 14), Summer (June 15 – Aug 31), Hunting (September 1 – December 15), and Winter (December 16 – February 28). Each animal had multiple data points from all 5 seasons presented. Due to the overlapping nature of presenting nearly 9000 data points we used a thinning process to select clusters of points within close proximity to one another and delete all but one point from each animal within these clusters. The process made the graphical display easier to interpret. While losing the ability to see where animals congregate for long periods of time the map did not lose the detail of movement over time. The data show elk using multiple wintering areas during different years. One individual elk is shown to migrate through 5 different elk zones during the two years of monitoring.

HALL, JACOB T.[1], Brock R. McMillan[1], Eric D. Freeman[2], Kent R. Hersey[3], and Randy T. Larsen[1]. [1]Brigham Young University. [2]Idaho Department of Fish and Game. [3]Utah Division of Wildlife Resources. ***DO MULE DEER FAWNS BORN INSIDE THE PEAK PARTURITION PERIOD HAVE HIGHER SURVIVAL THAN THOSE BORN OUTSIDE?***
Mule deer (*Odocoileus hemionus*) are an iconic species in the western U.S. with intriguing life history strategies, including reproductive synchrony. Multiple hypotheses exist to explain why reproductive synchrony may have evolved. One

hypothesis suggests reproductive synchrony is a strategy to minimize the likelihood of predation. A surge of prey may swamp predator populations, thereby increasing survival rates. Animals born before or after this surge may be subjected to greater risk of predation. While predator swamping is a strategy employed by many plants and animals, it has not been well-documented in mule deer. Our objective was to test the predator-swamping hypothesis that fawns born during the peak of the parturition period were less likely to die via predation compared to those born before or after peak parturition. During June of 2012–15, we recorded birth dates of 268 mule deer fawns on Monroe Mountain in south-central Utah. We fitted fawns with VHF-radio collars and monitored their survival for the first several months of life. To determine whether birth synchrony was advantageous for survival to multiple ages, we analyzed fawn mortality due to predation at one, three, and six months post parturition, and compared survival inside and outside the peak period. Our findings indicated that fawns born outside the peak parturition period did not exhibit higher predator-related mortality than those born inside. We did not find support for the predator-swamping hypothesis in mule deer. Environmental factors may have a greater impact on parturition synchrony than predation.

HARRIS, SCOTT M. Washington Department of Fish and Wildlife. ***USE OF A REMOTE BASED CELLULAR CAMERA SYSTEM TO REDUCE CRANBERRY CROP DAMAGE BY ROOSEVELT ELK IN COASTAL WASHINGTON.***

Food quality concerns, damage to plants and equipment, and consumption of cranberry plants and fruit are becoming increasing concerns for coastal Washington cranberry growers due to intrusion of their crops by Roosevelt Elk. The Washington Department of Fish and Wildlife (WDFW) is directed through the Washington State Administrative Code to work with producers to minimize crop damage by wildlife. WDFW staff and cranberry producers, with the assistance of volunteers, installed a Cellular Based Remote Camera System (RCS), capable of incorporating several cameras, to provide notification of a depredation event by elk. Less than five minutes after a picture is taken, the RCS sends a picture to a host computer that generates an email with the picture attached to a distribution list. Participating producers check email regularly and those with smart phones are able to receive almost instant notification of an intrusion. Early notification of an intrusion has increased the amount of, and improved the effectiveness of, nonlethal hazing efforts and has aided in focusing harvest efforts on specific groups of elk causing damage. Producers have reported that the RCS has greatly reduced crop losses and has become an important tool for them in preventing crop damage. Use of cellular based cameras can be an effective and efficient tool in managing or reducing wildlife conflict in some situations. Further testing of different types of cameras with cellular capabilities for the variety of damage scenarios is recommended to provide additional data and refine the use of this tool.

HEALE, JON[1], Lisa Shipley[1], Dan Thornton[1], and Paul Meyers[2]. [1]Washington State University. [2]US Fish and Wildlife Service. ***HABITAT USE BY COLUMBIAN WHITE-TAILED DEER ALONG THE LOWER COLUMBIA RIVER.***

In 2013, an imminent dike failure along the Columbia River threatened the Julia Butler Hansen Refuge (JBH) in Cathlamet, Washington. Subsequently, the US Fish and Wildlife Service translocated 88 Columbian White-tailed Deer (*Odocoileus virginianus leucerus*) from JBH and surrounding areas to Ridgefield National Wildlife Refuge (RNWR). Both Refuges employ mowing, cattle grazing, and haying as part of their management scheme. Therefore, habitat use and availability is likely irregularly distributed across various spatial and temporal scales. I hypothesized that deer select areas that are close to cover or riparian habitat, while avoiding areas that have been mowed, grazed, or hayed. I also hypothesized that resident deer are selecting habitat with available cover more strongly than translocated deer. To test this, I examined GPS data from collars that were placed on resident (JBH) and translocated (RNWR) deer, overlaid them on habitat maps, and modeled habitat selection using a resource selection function. Preliminary results indicate that deer select areas with more cover. These results suggest potential approaches for enhancing vegetation at RNWR and JBH that will assist in the recovery of this federally-listed distinct population segment.

JACKSON, DEWAINE H., Donald G. Whitaker, and Keith L. Kohl. Oregon Department of Fish and Wildlife. ***BLACK-TAILED DEER DENSITY ESTIMATION IN WESTERN OREGON.***

In an effort to estimate black-tailed deer (*Odocoileus hemionus columbianus*) densities, the Oregon Department of Fish & Wildlife (ODFW) has been sampling fecal DNA across 4 Wildlife Management Units (WMU) in western Oregon. Each WMU was gridded into 10km^2 blocks that were classified according to the major landowner within the grid cell. We used stratified random selection to choose individual grids for sampling and random point sampling within the grid to select the 1.13km^2 sampling areas completed by technicians. Technicians surveyed a 2m width along 8, 600m transects radiating from the randomly chosen central point. In addition to technician sampling, we also used trained fecal detection dogs in a 4- or

9-km^2 block positioned in the center of the selected grid. Fecal sample quality was subjectively graded into 3 categories based on age and only good quality (fresher) samples were submitted to the laboratory for DNA extraction. Since 2013, nearly 26,000 samples have been collected using technicians and trained detection dogs from 478 sample areas. Fecal DNA sampling protocol is straightforward, provides density estimates with confidence intervals, and has the potential for replacing spotlight trend data for management of black-tailed deer in Oregon. Results of the DNA extraction have allowed ODFW to make density estimates and male:female ratios for each landowner type and, by extrapolation, for each WMU.

JACKSON, NATHAN J.[1], Kelley M. Stewart[1], Danielle R. Walsh[1], and Darren A. Clark[2]. [1]University of Nevada-Reno. [2]Oregon Department of Fish and Wildlife. ***JUVENILE SURVIVAL OF MULE DEER IN THE BLUE MOUNTAINS OF OREGON.***

Declines in mule deer (*Odocoileus hemionus*) populations over the past half century have become a wildlife management concern across the west. Mule deer in temperate regions face varying seasonal challenges with respect to nutrition and environmental conditions, as well as, variation occurring from year to year. Despite these challenges, adult survival is generally high and stable across most populations. We focused our efforts on assessing juvenile survival and recruitment as an indicator of population performance. We used the nest module in program MARK to investigate juvenile survival in an environment experiencing years of variable winter severity. We investigated the relative effects of body size, body weight, mother's nutritional status, timing of parturition, and location or characteristics of birth site on survival of young. Juvenile survival to 120 days was 0.32 (SE=0.706) across two years of the study. We found a strong relationship between juvenile age and survival. We observed the highest rate of juvenile mortality during the first month of life. We also found that being born on a south facing slope positively affected survival during the first week. South facing slopes tend to be warmer and drier which minimizes the amount of energy required for thermoregulation.

LAMPMAN, JACOB R.[1], Laura S. Warner[2], Louis A. Harveson[1], David G. Hewitt[2], Warren C. Conway[3], Shawn S. Gray[4], Dana J. Wright[4], Timothy E. Fulbright[2], and Randy W. DeYoung[2]. [1]Sul Ross State University. [2] Texas A&M University. [3]Texas Tech University. [4]Texas Parks and Wildlife Department. ***INFLUENCE OF AGRICULTURE ON MULE DEER DIETS AND NUTRITION IN THE TEXAS PANHANDLE.***

Mule deer (*Odocoileus hemionus*) occur in the Panhandle region of Texas. This region is characterized by large amounts of agriculture interspersed across the landscape. The use of agriculture may put mule deer on a greater nutritional plane resulting in greater body mass and condition, antler growth, and fawn survival. This research has three main objectives, 1) document seasonal forage of native rangeland and agricultural crops, 2) document monthly nutritive values of forages in native rangeland and agricultural crops used by mule deer, and 3) determine if deer taking advantage of the agricultural crops are on a greater nutritional plane, and if these foraging behaviors are correlated with body mass, body condition, antler size, and fawn recruitment. Fecal samples were collected opportunistically from individual mule deer to document an annual, seasonal diet. Fecal material will be analyzed for plant DNA via high-throughput sequencing of a chloroplast intron (*trnL*), allowing for quantitative reconstruction of the taxonomic composition of diets. Composite samples of individual plant and crop species were collected monthly across the entire study area to estimate nutritive forage value including, crude protein, fiber, digestible dry matter, and digestible energy. Diet and nutrition data will be compared to biological data recorded from deer captures to determine if foraging behaviors are correlated with body mass, body condition, antler size, and fawn recruitment. This information will allow biologists to determine which crops and forage are most beneficial to mule deer for future management decisions, including harvest regulations and habitat management.

MERRELL, JERROD L., Kelley M. Stewart, and Shelly D. Blair. ***MIGRATION CHOICES AND THE IMPACT OF SURVIVAL IN THE PACIFIC MULE DEER HERD.***

Mule deer (*Odocoileus hemionus*) are charismatic large mammals and are an important game species in the western United States. By conserving mule deer habitat open space for other species also is protected. Mule deer populations are in decline for a variety of reasons including: loss of habitat from development, recreational pressures on critical ranges, poaching, disease, and predation. The Pacific Deer Herd (PDH) is a migratory herd found on the western slope of the Sierra Nevada in Central California. Population estimates for this herd are estimated between 3,868 and 4,431 based on fecal DNA transects. The PDH occupies 914 km^2 that includes national forests as well as private lands owned by Sierra Pacific Industry (timber) and Sacramento Municipal Utility District. We captured and attached radio collars to female mule deer during summer and autumn of 2015 (n = 14) and 2016 (n =13). We used Program MARK to evaluate factors (climate, habitat, and individual migration variables) that were correlated with adult survival. We documented 8 mortality events resulting from poaching (n=3), predation (n=4) and adenovirus (n=1).

MUIR, JONATHAN, Autumn Larkins, and Travis Shultz. Oregon Department of Fish and Wildlife. ***APPLYING MOBILE TECHNOLOGY TO LARGE MAMMAL SURVEYS: AN EXAMPLE APPLICATION OF ARCGIS COLLECTOR.***

The development of mobile technologies with both explicit and potential applications to natural resource management have grown exponentially over the last decade. In spite of these developments, many natural resource agencies have been slow to adopt these new tools as a viable replacement for long standing data collection techniques and tools. Oregon Department of Fish and Wildlife evaluated, over a 5 year period, several of the mobile platform based field data collection options currently available including Terrain Navigator, ArcPAD, ArcMOBILE, and ArcGIS Collector. In addition, several devises including Palm Pilots, notebook computers, ruggedized laptop computers, tablet computers, and smart phones were evaluated. We have found that the Apple iPad Pro provides a suitable bridge between the computing power of a laptop and the mobility of a smart phone without compromising effectiveness in a field setting or incurring exorbitant startup costs. In addition, ESRI's mobile application ArcGIS Collector provides a relatively simple software solution that facilitates the development of personalized data collection forms, easily and quickly facilitates spatial data collection, and offers superior performance over other available solutions. Track log collection is available within the Collector application, though we have found that a separate, stand-alone application called Trail Tracker provides a more useful product. An example mule deer data set, collected using the recommended devises is presented, along with recommendations for wildlife managers searching for a mobile solution to field data collection.

NOVACK, ANTHONY. Washington State Department of Fish and Wildlife. ***PROFILING POACHERS: USING RANDOMIZED RESPONSE TECHNIQUE TO ESTIMATE RATES OF HUNTING VIOLATIONS BY DEER AND ELK HUNTERS IN WASHINGTON STATE***

Hunting regulations have contributed significantly to the conservation of North American deer and elk populations. Illegal hunting activity can severely impair the ability of wildlife managers to manage deer and elk harvest. Furthermore, hunters that violate the law; take harvest opportunity away from other hunters, detract from the overall hunting experience, and negatively affect the general public's perception of recreational hunting. The primary objective of this research was to determine rates of common hunting violations among deer and elk hunters in the state of Washington. A total of 2522 active deer and elk hunters were surveyed from April 2011 to March 2012 using Randomized Response Technique (RRT). The RRT method allows respondents to disclose illegal activity without risk of incrimination. Self-reported rates of hunter violations are reported for three types of illegal activity and ranged from a high of 11.6% ± 3.0% for road violations, 8.7% ± 3.0% for trespassing, 7.0% ± 3.1% for tagging violations. Relationships were found between the likelihood to commit a given violation and numerous demographic factors. The results set a baseline measurement for illegal deer and elk hunting activity in the state of Washington. Managers can use the information to direct changes to future policy or enforcement activity and, evaluate the effectiveness of such changes on violation rates over time.

SELLS, SARAH N.[1], Michael S. Mitchell[2], Angelad. Luis[1],and Kevin M. Podruzny[3]. [1]University of Montana. [2]U.S. Geological Survey, University of Montana. [3]Montana Fish, Wildlife and Parks. ***INDIVIDUAL-BASED MODELING OF INTERACTIONS BETWEEN UNGULATES AND WOLVES.***

We are developing individual-based models (IBMs) of how deer (*Odocoileus* spp.) and elk (*Cervus elaphus*) select seasonal home ranges to understand how wolves (*Canis lupus*), in turn, select territories in response to ungulate behavior. IBMs are used to model individual behaviors, which provide predictions of population-level patterns. Our models are based on the expectation that animals are adapted to select home ranges and territories efficiently based on spatially distributed resources. This means animals should select habitat that maximizes benefits acquired from resources (e.g., food) against costs of acquiring them (e.g., travel costs, predation risk, etc.). We are using our models to predict how deer and elk select seasonal home ranges. We are then predicting how wolves select territories in response to density and distribution of deer and elk. Preliminary results suggest that ungulate home ranges and wolf territories are smaller and of higher quality where food resources are more clumped. This means, for example, that wolf territories should vary in size based on ungulate behavior, which varies by species and season. In future steps, we will parameterize the models with data from real landscapes (e.g., terrain, vegetation, etc.). This will allow us to estimate size and location of actual wolf territories in relation to ungulate distribution. Biologists will be able to predict wolf pack locations and abundance in absence of extensive empirical data to help inform management decisions for both ungulates and carnivores.

SERGEYEV, MAKSIM[1], Brock R. McMillan[1], Kent R. Hersey[2], and Randy T. Larsen[1]. [1]Brigham Young University. [2]Utah Division of Wildlife Resources. ***HARVEST OF ELK* (CERVUS ELAPHUS): *DOES HUNTING PRESSURE FROM HUMANS INFLUENCE HABITAT SELECTION?***

Human activity can greatly influence the survival and distribution of individuals within populations. Pursuit and harvest by hunters can be a driving force in shaping patterns of movement and resource selection for game species like elk (*Cervus elaphus*). Our objective was to determine the effects of hunting and hunting pressure on population dynamics and the distribution of elk on the landscape—particularly the relative use of public vs. privately owned lands. We captured 320 cow and 42 bull elk via helicopter net gunning along the Wasatch Range of Utah and fitted each individual with a GPS transmitter during the winters of 2015 and 2016. Location of each individual was recorded twice daily. When we received a mortality signal, we located the deceased animal and determined cause of death within 48 hours. We determined the distribution of elk on private versus public lands throughout the year, focusing specifically on the period during and surrounding the fall hunting seasons. Annual survival of collared elk was 84.25% during the first year of study. Hunter harvest accounted for 81% of all deaths, with remaining deaths resulting from road kill or predation. Elk altered their habitat use patterns in response to harvest pressure, selecting private land 60% of the time in October compared to only 25% before the harvest season in July. Our results suggest that hunting pressure is among the driving forces in influencing habitat use among elk. A more thorough understanding of the impact of hunting pressure on game species will lead to more effective management practices and hunting strategies.

SEVIGNY, JENNIFER[1], Emily George-Wirtz*[2], and Michael Sevigny[3]. [1]Stillaguamish Tribe of Indians. [2]Sauk-Suiattle Indian Tribe. [3]Tulalip Tribes. ***DISTRIBUTION AND HABITAT USE OF FEMALE ELK* (CERVUS ELAPHUS) *ON FOREST AND AGRICULTURAL LANDS IN SKAGIT COUNTY, WA***

The North Cascades elk herd is the smallest of ten herds in Washington State. This herd provides a valued cultural, subsistence, and ceremonial resource to Native American Tribes. Following successful augmentation efforts, this herd has grown with a consequent increase in elk conflict issues. In response to damage complaints within Skagit Valley, three Tribes partnered on a GPS collaring effort to identify female elk home ranges and habitat use. Between 2013 and 2016, GPS collars were applied to 13 female elk in groups along the Skagit River corridor and in the forest lands north of State Route 20. Using ArcGIS, we determined home ranges and used kernel density estimation (KDE) to visualize habitat neighborhoods and movement tracks within each home range. We found that collared groups on both agricultural and forest lands appeared to have well-defined ranges with no temporal overlap. The KDE revealed more random movements in upland forest elk and non-random movements in lowland elk. We found that lowland elk spent most of their time in elk tolerant neighborhoods. Movements into elk conflict zones were seasonal and travel corridors between neighborhoods varied little throughout the year. These results allow us to manipulate elk groups through a combination of exclusion fences, forage enhancements, harvest, and seasonal non-lethal hazing techniques. Understanding the distribution and migration of elk in conflict zones will improve management efforts that benefit both elk and private landowners.

WARNER, LAURA S[1], Jacob R. Lampman[2],David G. Hewitt[1], Shawn S. Gray[3], Dana J. Wright[3], Warren C. Conway[4], Timothy E. Fulbright[1], Randy W. DeYoung[1], and Louis A. Harveson[2]. [1]Texas A&M University. [2]Sul Ross State University. Texas Parks and Wildlife Department. [4]Texas Tech University. ***INFLUENCE OF WINTER WHEAT PRODUCTION ON MULE DEER MOVEMENT IN THE TEXAS PANHANDLE.***

Mule deer (*Odocoileus hemionus*) occur in the Texas Panhandle, a region of rangeland fragmented by row-crop agriculture. Deer often use crops to supplement natural forage, especially when natural forage is scarce or nutritional quality is low. Anecdotal observations suggest that deer in the region make large seasonal movements during late fall and winter, which mainly coincide with the early growing season of winter wheat (*Triticum* spp.). Our goal is to determine how winter wheat phenology affects deer movements, particularly those that deviate from the home range. We captured and fitted 43 adult mule deer with GPS collars during October 2015, and fixes were taken every two hours for one year. Data from these fixes will be used to quantify movement distances and position on the landscape. Any movement to winter wheat outside the home range will be paired with the season during which that movement occurred and the phenology of the wheat at that time. Our findings will quantify the influence of wheat production on deer movements and thereby improve deer population surveys by defining possible points of aggregation where wheat is seasonally present. These findings may also refine management practices to include potentially larger deer management areas based on the scale of seasonal movements.

WISE, BEN and Alyson Courtemanch. Wyoming Game and Fish Department. ***ADAPTIVE MANAGEMENT OF URBAN ELK IN WESTERN WYOMING.***

Abstract: Over the last 20 years a population level shift in movement patterns among migratory elk in Western Wyoming has been documented showing a gradual reduction of individuals that utilize a long distance migratory pattern to a shorter, more condensed migration. This has resulted in an increased amount of time that these elk herds utilize private, developed lands in close proximity to traditional winter ranges. This change in movement patterns has resulted in increased conflict between private land owners, livestock producers and wildlife management agencies. The Wyoming Game and Fish Department has instituted several novel techniques to both account for and mitigate damage, co-mingling and conflict. Among these is the use of Forward Looking Infrared (FLIR) thermal imaging flights to classify elk over urban areas where traditional herd survey techniques have limited success. We have also implemented several methods of damage mitigation including WIG's ("Wacky Inflatable Guys"), "low-stress" hazing and multiple non-lethal deterrents that can be utilized discreetly when needed. Results have at time been mixed, but when used in conjunction with traditional methods to dissuade elk from conflict/damage situations, these techniques have proven effective.