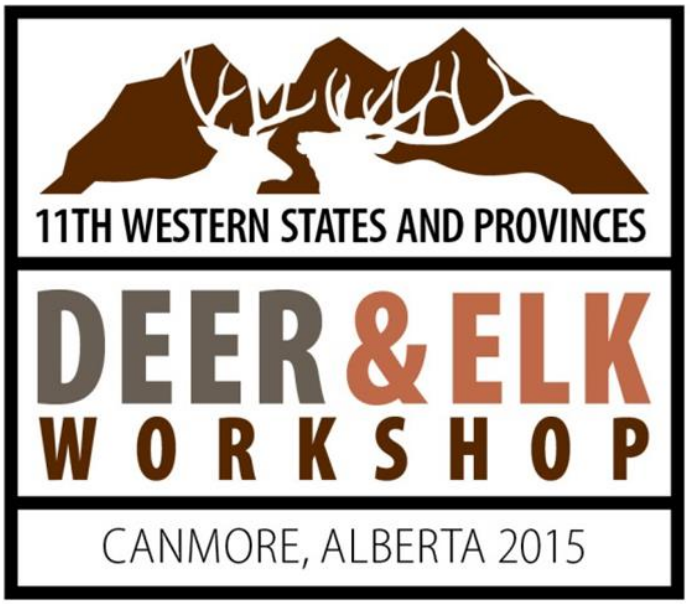
2015

Workshop Proceedings



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Abstract compiler: Margaret Neufeld, Alberta Conservation Association

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Eleventh Biennial Western States & Provinces Deer and Elk Workshop

Canmore, Alberta, Canada
11-14 May 2015

PROGRAM AGENDA

Monday May 11, 2015 – P.M.

12:00 – 20:00 Onsite Registration

13:00 – 17:00 Mule deer working group meeting

17:00 – 18:30 Poster session

18:00 – 20:00 Evening social

Tuesday May 12, 2015 – A.M.

PLENARY SESSION "Environmental Variability and Managing Ungulates"

8:15 – 8:20 Welcome and housekeeping ~ **R. Corrigan, AESRD**

8:20 – 8:30 Opening remarks ~ **M. Besko, AESRD**

8:30 – 9:00 Challenges of managing deer & elk herds in variable environments ~ **N. T. Hobbs, Colorado Division of Wildlife**

9:00 – 9:30 Influences of environmental variation on nutrition and body condition of elk ~ **J. Cook, NCASI**

9:30 – 10:00 Spatial and temporal heterogeneity of resources in arid lands: population consequences for mule deer ~ **K. M. Stewart, University of Nevada Reno**

10:00 – 10:30 Coffee Break

10:30 – 11:00 Predation in variable environnements: population consequences ~ **M. Hebblewhite, University of Montana**

11:00 – 11:30 Managing deer and elk harvests with environmental variability ~ **M. Boyce, University of Alberta**

11:30 – 12:00 Panel: discussion and questions

Tuesday May 12, 2015 – P.M.

Session 1a: MIGRATION

13:00 – 13:05 House keeping

13:05 – 13:25 Mule deer migration corridors and deer-vehicle collisions in Oregon ~ **P. Coe**

13:25 – 13:45 Mule deer migration corridors: effects of human disturbance on behavior and population dynamics **~ C. Schroeder**

13:45 – 14:05 Migration patterns of adult female Mule Deer in response to energy development **~ C. Anderson**

14:05 – 14:25 Habitat quality influences migratory strategy of female white-tailed deer **~ C. Henderson Jr.**

14:25 – 14:45 Behavioral flexibility in migratory behavior in a long-lived large herbivore **~ S. Eggeman**

Session 1b: POPULATION

13:00 – 13:05 House keeping

13:05 – 13:25 Ecological drivers of elk survival in Idaho **~ J. Horne**

13:25 – 13:45 Generality and precision of regional scale survival models for mule deer fawns **~ M. Hurley**

13:45 – 14:05 Survival, space use, and site fidelity of translocated mule deer **~ D. Smedley**

14:05 – 14:25 Potential effects of natural gas development on neonatal mule deer survival **~ M. Peterson**

14:25 – 14:45 Elk calf survival and elk population dynamics in the southern Bitterroot Valley **~ D. Eacker**

Session 2a: HARVEST

15:15 – 15:35 Deer and elk hunter success ~ **R. Nielson**

15:35 – 15:55 Factors affecting spatial distribution of archery vs. rifle hunters with varying levels of motorized access ~ **M. Rowland**

15:55 – 16:15 Adapting elk harvest in response to land use change-a 40-year case study **~ T. Cullinan**

16:15 – 16:35 Drought in South Texas: implications for recruitment, age structure, and harvest of white-tailed deer ~ **K. Gann**

16:35 – 16:55 Partnering with a non-profit for mule deer conservation: how the Mule Deer Foundation works with agencies and landowners to benefit mule deer and other wildlife ~ **S. Belinda**

Session 2b: MONITORING

15:15 – 15:35 Elk demographics and resource selection at parturition sites in the southern Black Hills, South Dakota ~**C. Lehman**

15:35 – 15:55 White-tailed deer occupancy dynamics and habitat selection in Alberta's boreal forest ~ **J. Fisher**

15:55 – 16:15 The use of distance sampling for deer and elk surveys with examples from Northern Alberta ~ **H. Mckenzie**

16:15 – 16:35 A system for remotely monitoring vaginal implant transmitters and fawn survival ~ **C. Rice**

16:35 – 16:55 Use of vaginal implant transmitters in determination of elk calf birth sites and age at capture ~ **J. Berg**

Wednesday May 13, 2015 – A.M.

CHRONIC WASTING DISEASE SPECIAL SYMPOSIUM

8:00 – 8:05 Housekeeping and introductory comments ~ **T. Hobbs, Colorado State University**

8:05 – 8:35 FEATURED SPEAKER: Overview and next directions for managing CWD in the wild ~ **Dr. M. Samuel**, **University of Wisconsin-Madison**

8:35 – 8:55 Effects of chronic wasting disease on elk populations: have we underestimated the risk? ~ **Dr. M. Wild, US National Park Service**

8:55 – 9:15 Changing genetics: What is the future for CWD ~ **Dr. J. Blanchong, Iowa State University**

9:15 – 9:35 What do we know about the mechanisms of transmission for managing CWD? ~ **Dr. T. Bollinger, Canadian Wildlife Health Cooperative**

9:35 – 9:55 Environmental contamination: Is it the real issue in CWD management? ~ **Dr. J. Aiken, University of Alberta**

9:55 – 10:25 Coffee Break

10:25 – 10:45 Modeling transmission of chronic wasting disease in Wisconsin white-tailed deer: making models useful for management ~ **Dr. C. Jennelle, Minnesota Department of Natural Resources**

10:45 – 11:05 Management for CWD: What have we learned? **~ Dr. N. Mateus-Pinilla, University of Illinois**

11:05 – 11:25 Population dynamics of Colorado mule deer with endemic chronic wasting disease **~ N. Galloway, Colorado State University**

11:25 – 11:45 Social and economic challenges for managing CWD **~ Dr. E. Goddard, University of Alberta**

11:45 – 12:15 Panel questions

Wednesday May 13, 2015 – P.M.

13:30 – 13:45 WAFWA Mule Deer Working Group products and progress ~ **J. Heffelfinger**

13:45 – 14:00 Texas ~ **S. Gray**

14:00 – 14:15 South Dakota ~ **A. Lindbloom**

14:15 – 14:30 New Mexico ~ **R. Darr**

14:30 – 14:45 Nevada ~ **C. Schroeder**

14:45 – 15:00 Montana ~ **S. Smith**

15:00 – 15:15 Idaho ~ **T. Boudreau**

15:15 – 15:30 Colorado ~ **A. Holland**

15:30 – 15:45 Arizona ~ **A. Munig**

15:45 – 16:00 Alberta ~ **Grant Chapman**

Thursday May 14, 2015 – A.M.

Session 3a: MANAGEMENT

8:00 – 8:05 Housekeeping

8:05 – 8:25 Development of a regional management plan for mule deer ~ **P. Stent**

8:25 – 8:45 Kootenay elk management plan public survey ~ **T. Szkorupa**

8:45 – 9:05 White-tail deer expansion and abundance: ecological implications and management concerns in Alberta ~ **C. Stambaugh**

9:05 – 9:25 Mitigating elk and white-tailed deer conflicts with agriculture using a combined social-ecological approach ~ **R. Brook**

9:25 – 9:45 Apps for wildlife management? How customized software can up your game

~ J. Nowak

Session 3b: HABITAT I

8:00 – 8:05 Housekeeping

8:05 – 8:25 Orders of habitat selection by elk on disturbed heterogeneous landscapes **~ C. Prokopenko**

8:25 – 8:45 Ecology of adult female Rocky Mountain mule deer following habitat enhancements in North-Central New Mexico **~ G. Sorensen**

8:45 – 9:05 A comparative analysis of elk habitat selection and use at Mount St. Helens **~ S. Sparkes**

9:05 – 9:25 Bottom-up habitat changes and effects on elk nutrition in the Bitterroot Valley, Montana **~ K. Proffitt**

9:25 – 9:45 Effects of succession and forage plantings on nutritional carrying capacity and habitat selection by Roosevelt elk **~ L. Shipley**

Session 4a: PREDATION AND UNGULATES

10:15 – 10:35 A long-term study of elk-cougar relationships in Western Washington: removal can recover small herds **~ D. Vales**

10:35 – 10:55 Using ungulate biomass to estimate abundance of wolves in British Columbia **~ G. Kuzyk**

10:55 – 11:15 Spatial interactions and predation risk in multiple carnivore communities in the upper Red Deer River of Alberta **~ E. Spilker**

11:15 – 11:35 Feeding vs. fleeing: the foraging cost of wolf predation risk for deer **~ A. Craig**

11:35 – 11:55 Black bear carnivory of ungulates: global positioning system cluster analysis as a tool for estimation **~ S. Kindschuh**

Session 4b: HABITAT II

10:15 – 10:35 Effects of silvicultural herbicides on the nutritional ecology of Columbian black-tailed deer **~ A. Ulappa**

10:35 – 10:55 Are there green waves in Idaho? Habitat type, vegetation condition, winter severity and predation covariates and there influence on seasonal and inter-annual range selection **~ S. Bergen**

10:55 – 11:15 Mule deer use of juniper habitats during winter in south-central Oregon **~ S. Gregory**

11:15 – 11:35 Varied tastes: home range implications of foraging-patch selection **~ D. Seidel**

2015 CONFERENCE & PLENARY SESSION THEME

Cervids live in environments that vary across both space and time. Deer and elk responses to this variability can lead to changes in distribution, body condition, vital rates and ultimately carrying capacity which provide the context for managing deer and elk populations.

The extent of the environmental variability and its uncertainty can pose challenges for managers because some of the most basic premises on which we have managed these populations in the past may not hold.

In the plenary session of the 2015 workshop five invited speakers shared their views on how environmental variability influenced basic processes related to securing water and nutritional resources while escaping predation across a diverse set of ecosystems. This lead to a discussion of the implications for harvest management of deer and elk population.

CHRONIC WASTING DISEASE SPECIAL SYMPOSIUM

Managing chronic wasting disease: What is known, what needs to be learned?"

Special Invited Session

This session had nine speakers from varying disciplinary backgrounds who discussed chronic wasting disease from a variety of perspectives. Michael Samuel from the University of Wisconsin gave a lucid presentation summarizing the current state of knowledge about CWD transmission and its effects on population.

Margaret Wild (National Park Service) examined the impacts of CWD on elk, highlighting a study of the elk population in Rocky Mountain National Park, CO which estimated 12.9 per cent of the herd was infected with CWD and the population growth rate could be impacted by the disease.

Julie Blanchong (Iowa State University) considered the genetic aspects of CWD resistance and progression and the evidence for different strains of CWD and their epidemiological significance, presented data on potential population-level consequences of fitness differences of these genetic variants, and discussed management implications.

Trent Bollinger (Canadian Wildlife Health Cooperative) reviewed the mechanisms of CWD transmission and how deer social factors and their use of the environment influence the epidemiology of CWD. He concluded that reducing contact with environmental focal points should be part of any CWD management program.

Judd Aiken (University of Alberta) also discussed transmission of CWD, but focused on environmental contamination. He concluded that infective agents can persist in soils (both in clay minerals as well as in organic components) for years to decades, and although environmental sources and persistence of prions is well documented. However, the relative importance of direct versus indirect transmission routes is less clear. The challenges of managing the disease in a human-dominated landscape were described by Nohra Mateus-Pinilla.

Chris Jennelle (Minnesota Department of Natural Resources) presented a model utilizing hunter harvest data to model transmission mode, infection rate, and address how alternative harvest management strategies could affect CWD dynamics in a Wisconsin white-tailed deer population. He concluded effective harvest management (greater harvest of males) can be implemented to mitigate CWD prevalence.

Nathan Galloway (Colorado State University) reviewed an empirical study conducted in northern CO which attempted to understand how current CWD disease dynamics in the deer population affected population growth and assessment of whether the epidemic is increasing. The study concluded that spatially localized infection, similar infection rates among ages, and slow disease progression muted the effect of CWD on population growth.

Ellen Goddard (University of Alberta) closed the session by discussing the social and economic aspects of CWD management. Research results from two studies show significant differences in risk perceptions between hunters, the public, and consumers for meat and between residents of the United States and Canada. These differences are related to wide variation in preference for public management of the risks of CWD.

STATES AND PROVINCES STATUS REPORTS

ALBERTA PROVINCIAL 2015 STATUS REPORT FOR MULE DEER, WHITE-TAILED DEER, AND ELK

GRANT CHAPMAN, Alberta Environment and Sustainable Resource Development, 2nd Floor Provincial Building, 9503 Beaverhill Road, Lac La Biche, AB T0A 2C0 USA

ROB CORRIGAN, Alberta Environment and Sustainable Resource Development, 2nd Floor Great West Life Building, 9920-108 St, Edmonton, AB T5K 2M4 USA

Abstract: Alberta's 2007-14 provincial pre-hunting season population estimates indicate both elk and white-tailed deer have increased to ten per cent above goals, with estimates numbering 40,705 and 232,592 animals. Mule deer have declined to 11 per cent below goal at 142,083 animals.

Most of Alberta's 183 Wildlife Management unit population estimates are within their normal variability with densities lowest in the mountain and boreal habitat and highest in the aspen and peace parklands, boreal farmland fringe, foothills, and prairie habitats.

Hunter harvest for the 2013 hunting season was 12,932, 44,433, and 7,132 for mule deer, white-tailed deer, and elk respectively. Revision of the provincial mule deer management plan (1989) is needed and now underway, with the provinces first provincial elk management plan also currently being drafted.

Revision of the provincial white-tailed deer management plan (1995) is necessary and expected to occur in the near future. The priority deer management issues relate to the accuracy of population models, relevance of current management unit goals and allocation of harvest, spread of chronic wasting disease, status and inventory of habitat, optimizing aerial survey techniques, and improving understanding of white-tailed deer ecology, resource selection, and range expansion.

The primary elk management issues stem from the impacts of elk range expansion and increasing elk populations on agricultural and other competing social values. Elk reintroduction of 221 animals to the Canadian Forces Base Suffield near Medicine Hat, AB in 1998 is discussed. Several management challenges and increased hunting opportunities have been created by this herd which now exceeds 7000.

Presenter and email: Grant Chapman; grant.chapman@gov.ab.ca

STATUS OF DEER AND ELK IN ARIZONA, 2015

AMBER A. MUNIG, Arizona Game and Fish Department, Game Branch, 5000 West Carefree Highway, Phoenix, AZ 85086 USA

Abstract: Deer and elk population levels exhibited independent patterns over the past 20 years. Elk numbers probably peaked in the early 1990s, but harvest was used to reduce their numbers. Their population levels have remained stable since about 2000.

Mule and white-tailed deer populations reached the most recent peak in the early 1980s. Mule deer declined through about 2000, and since then have probably increased by about 10 per cent.

White-tailed deer followed a similar trend, although the decline was not as pronounced. Most deer populations within the state are surveyed annually using fixed-wing aircraft or helicopter, and an increasing proportion of elk populations as well. Supplemental ground surveys are used mostly for elk.

All cervids are surveyed during the breeding season to estimate male to female and young to female ratios. Hunter harvest is estimated using a voluntary post card questionnaire which can be returned with postage prepaid or responses may be entered online. Currently, we receive about a 40 per cent response rate for deer and about a 50 per cent response rate for elk, with about 20-25 per cent of all responses online.

General deer harvest was about 19,000 animals in 1989, but last year harvest was estimated at about 13,700. General elk harvest was about 5,000 animals in 1989, whereas harvest estimates for last year were about 8,800. Buck to doe ratios for both mule and white-tailed deer are managed at 20–30:100, whereas elk bull to cow ratios are managed at 25–35:100.

For deer and elk, alternative management units are managed at higher male to female ratios with added guidelines regarding the age structure of the harvest or hunter density. These units approximate about five per cent of the hunter opportunity offered annually.

Recent wildfires have created situations that are favorable to improved growth of deer and elk populations, yet limited land management actions (e.g., prescribed fire, thinning) benefiting forage production are implemented annually.

In 2014, Arizona funded a Mule Deer Habitat Enhancement Initiative. The goal of this initiative is to improve mule deer populations through manipulations to their habitat in two areas where mule deer populations are significantly lower than in the past.

Presenter and email: Amber Munig; amunig@azgfd.gov

COLORADO DEER AND ELK POPULATION STATUS AND INVENTORY SUMMARY

ANDY HOLLAND, Colorado Parks and Wildlife, 317 West Prospect, Fort Collins CO 80526 USA

Abstract: Summary: Deer. The statewide post-hunt 2013 deer population estimate for Colorado is 391,000. Mule deer populations in the western portions of the state have experienced declines. Many of these are the largest herds in Colorado. Most deer herds in the central and northern mountains are performing well and plains deer populations have remained relatively stable.

Colorado Parks and Wildlife (CPW) just completed the Colorado West Slope Mule Deer Strategy Summit public involvement process. The resulting West Slope Mule Deer Strategy includes seven strategic priorities designed to guide management in achieving the goal of working together with the public and stakeholders, to stabilize, sustain and increase mule deer populations in western Colorado.

Deer hunting in Colorado is by limited license. In 2014, CPW issued 82,800 deer licenses. The 2013 harvest estimate was 33,000. CPW conducts post-hunt inventories with helicopters to estimate the sex ratios of males to 100 females and the age ratios of young to 100 females. During the post-hunt herd inventories in 2013, biologists classified 64,700 deer and observed an average sex ratio of 33 bucks per100 does and 55 fawns to 100 does.

Summary: Elk. The statewide 2013 post-hunt elk population estimate is 264,000. Elk numbers have been reduced from a peak of 305,000 in 2001. Most units include over-the-counter archery licenses and half have over-the-counter regular season rifle bull licenses. All rifle antlerless licenses are limited. The 2013 elk harvest was 43,600.

In 2013, during the post-hunt herd inventories, biologists classified 85,000 elk and observed a statewide average sex ratio of 22 bulls per 100 cows. During these surveys over the past few years we have observed lower than normal calf/cow ratios in the southern tier of the state with three year averages between 32 and 35 calves per 100 cows compared to 49 calves to100 cows in northern Colorado.

Presenter and email: Andy Holland; andy.holland@state.co.us

STATUS OF DEER AND ELK POPULATIONS IN IDAHO 2000-2014

TOBY BOUDREAU, Idaho Department of Fish and Game, 324 South 417 East, Suite 1 Jerome, ID 83338 USA

Abstract: Deer and elk population statuses vary greatly based on geography throughout Idaho. Changes in predator composition and long-term habitat changes are some of the factors influencing declines. In other areas, populations have increased to the point of exceeding social carrying capacity.

Harvest trends have shown a general decline in elk harvest as well as stable harvest mule deer and white-tailed deer statewide over the previous decade. The bulk of our surveys are aerial sightability and composition surveys with some added ground surveys in several locales. Harvest information is collected through an automated mandatory harvest reporting system.

Maintaining hunter opportunity is the main management strategy in the state. However, we also provide a variety of trophy opportunities for deer and elk. Management programs are guided by our species management plans with a variety of metrics used to manage harvest and opportunity from aerial population and composition surveys, research data, harvest numbers, and antler point counts of harvested males.

Presenter and email: Toby Boudreau; toby.boudreau@idfg.idaho.gov

STATUS OF DEER AND ELK IN MONTANA, 1960-2013

JAY NEWELL, Montana Fish, Wildlife and Parks, 1425 2nd St. W., Roundup, MT, 59072 USA

JOHN VORE, Montana Fish, Wildlife and Parks, 1420 East 6th Avenue, P.O. Box 200701, Helena, MT, 59620 USA

SONJA SMITH, Montana Fish, Wildlife and Parks, P.O. Box 938, Lewistown, MT, 59457

Abstract: Although annual aerial surveys are conducted on many of the state's elk and deer herds, Montana does not have a robust methodology for estimating deer and elk populations. However, harvest information has been collected since at least 1945.

Although methods for estimating harvests have changed over time, we believe it provides the best insight into state-wide population trends over long periods of time. State-wide, elk harvest has shown an increasing trend since 1970.

Montana may have reached a peak in elk numbers, in the early 1990s when harvest exceeded 30,000 animals. Since 2007, in some hunting districts in the western part of the state, elk harvests are declining. Meanwhile in the eastern part of the state harvest on relatively "new" populations of elk continues to increase rapidly.

Mule deer harvest and populations have shown a long-term decline since 1960. Peak harvests of male mule deer (greater than 60,000) were achieved in the latter part of the 1960s, 1970s and 1980s. Between 1995 and 2007 harvest fell to around 40,000 males and in 2010, 2011 and 2012 near record low numbers of males were killed.

Harvest numbers improved slightly in 2013, but remained 31.6 per cent below the long-term average 1960-2012. Numbers and distribution of white-tailed deer has increased since 1960. In the 1960s, less than 17,000 males were harvested annually. Numbers of males harvested increased to nearly 30,000 for most of the 1990's, and the first eight years of this century.

Since 2008, harvest has declined on a state-wide basis. However, male harvest in 2013 still was 3.8 per cent above the long-term average 1960-2012. Harvest indicates that the western part of the state has seen the largest increases in white-tailed deer numbers, while the eastern part of the state has a relatively stable population.

Presenter and email: Sonja Smith; sonjasmith@mt.gov

STATUS OF MULE DEER AND ELK IN NEVADA

CODY SCHROEDER, Nevada Department of Wildlife, 1100 Valley Rd, Reno, NV 89512 USA

MIKE COX, Nevada Department of Wildlife, 1100 Valley Rd, Reno, NV 89512 USA

CALEB MCADOO, Nevada Department of Wildlife, 1100 Valley Rd, Reno, NV 89512 USA

Abstract: Nevada's statewide estimate for mule deer is about 108,000 and 17,500 for elk as of 2014. Deer populations have remained stable over the past decade and are slightly below the 20 year average of 115,000.

Elk populations are relatively new in Nevada. They have increased from 2,000 in 1990 to 17,500 in 2014. Helicopter surveys are used to conduct herd composition counts. Population models are

used to assess trends in sex ratios, recruitment, and population estimates to determine hunting quotas.

Nevada has a mandatory hunter questionnaire used to determine harvest for both species. Questionnaire return rates are typically around 95 per cent for each species with about 98 per cent of returns submitted using the on-line system.

The two main factors affecting hunter opportunity are herd population size and the social influence of commissions and game boards. Bull elk hunting is primarily a trophy harvest management strategy. However, in recent years spike elk hunts have been introduced to reduce bull ratios.

Deer quotas are determined by post-hunt buck ratios with a statewide objective of 30 bucks per 100 does. Cow elk quotas are used to keep populations near objectives while still maintaining quality hunts. Rifle deer hunters have maintained a success rate of about 40 per cent statewide. The percentage of bucks with four points or better in the harvest has averaged 37per cent over the past three years.

Elk harvest continues to increase, especially for cows, as management goals are aimed at reducing total numbers to meet population objectives. Rifle bull hunters enjoy a hunter success rate of about 56 per cent with a statewide six point or better average of 68per cent. For both deer and elk there is greater emphasis placed on trophy harvest than opportunity.

Presenter and email: Cody Schroeder; cschroeder@ndow.org

NEW MEXICO DEER AND ELK STATUS UPDATE FOR 2015

NICOLE T QUINTANA, New Mexico Department of Game and Fish, 1 Wildlife Way, Santa Fe, NM 87507 USA

RYAN L DARR, New Mexico Department of Game and Fish, 1 Wildlife Way, Santa Fe, NM 87507 USA

Abstract: New Mexico is home to an estimated 65,000 mule deer and 12,500 white-tailed deer. While white-tailed deer numbers are stable, mule deer abundance has significantly declined in recent decades. Causes of mule deer declines may be related to habitat loss, drought, and predation. Declining deer numbers have reduced hunting opportunities and dropped average success to 25 per cent.

To increase success rates, the state has reduced deer licenses by 11.5 per cent statewide for the upcoming hunting season. New Mexico is implementing deer habitat management projects on hundreds of thousands of acres across the state. Biologists are also evaluating a modified deer survey technique to enhance abundance estimates and to help with defining focus areas for intensive management.

Additional work is being performed to evaluate the use of translocations to bolster populations in suitable habitat where deer have disappeared. Finally, predator management options are currently being examined through various research projects.

New Mexico's statewide elk population is largely stable with localized variation. Season frameworks and license numbers were recently modified to reflect these variations. Elk surveys are flown annually during autumn to obtain bull:cow:calf ratio data. This ratio data is used, along with mandatory hunter harvest information to obtain elk population estimates using the

population reconstruction method. Elk harvest is relatively stable across the state. Elk management is guided by objectives specific to individual herd units and bull:cow ratios. Managers struggle with opposing desires to have particular elk herds managed for antler quality or greater opportunity. In areas experiencing low calf:cow ratios, research studies are implemented to determine the causes of low ratios. Recently, elk have begun inhabiting some productive agricultural locations, exceeding landowner tolerance and resulting in localized management actions.

Presenter and email: Ryan L. Darr; ryan.darr@state.nm.us

STATUS OF DEER AND ELK POPULATIONS IN SOUTH DAKOTA, 2015

ANDREW LINDBLOOM, South Dakota Department of Game, Fish, and Parks, 20641 SD HWY 1806, Fort Pierre, SD 57532 USA

KEVIN ROBLING, South Dakota Department of Game, Fish, and Parks, 4130 Adventure Trail, Rapid City, SD 57702 USA

Abstract: Deer and elk populations in South Dakota have recently been depressed below management objectives due to liberalized antlerless harvest strategies, successive severe winters, record drought, epizootic hemorrhagic disease outbreaks, and predation.

Public discontent and controversy over low ungulate and high predator densities has prompted South Dakota Department of Game, Fish, and Parks (SDGFP) to further develop species-specific management plans. The first elk management plan was completed in early 2015, and the development of a statewide deer plan has begun.

SDGFP established an elk stakeholder group to advise the department on plan development, and conducted a public opinion survey to evaluate hunter and landowner desires for future elk management. Although the elk management plan does not satisfy all constituents, it offers transparent goals and strategies for managing elk over the next five years.

Deer and elk populations are monitored primarily using winter aerial sightability and fall herd composition surveys, survival data, and population model projections. Winter and spring captures and radio-collaring plans in 2015 include approximately 50 female elk, 150 female mule deer, 150 mule deer neonates, 150 female white-tailed deer, 70 male white-tailed deer, and 200 whitetail neonates.

Aerial surveys and population models project approximately 6,100 elk (95 per cent CI 5,800-7,100) currently wintering in the Black Hills management units, with populations predicted to be increasing. Herd composition surveys estimate fall recruitment at 49 calves per 100 cows.

Mule deer and white-tailed deer populations are also beginning to rebound following depressed densities in most management units. Population models estimate approximately 317,000 (220,000-414,000) white-tailed deer and 88,000 (59,000-116,000) mule deer on the prairie. Black Hills deer estimates are 41,000 (30,000-53,000) whitetails and 8,700 (5,700-11,800) mule deer. Deer harvest rates have been reduced substantially across the state, and while population models suggest increasing rates of change in most areas, habitat conversion to agricultural crops, predator densities, and unknown weather and disease events may impede deer recovery rates.

Presenter and email: Andrew Lindbloom; andy.lindbloom@state.sd.us

STATUS OF DEER AND ELK POPULATIONS IN TEXAS, 2005–2013

SHAWN S. GRAY, Texas Parks and Wildlife Department, 109 South Cockrell, Alpine, TX 79830 USA

ALAN CAIN, Texas Parks and Wildlife Department, P. O. Box 261, Pleasanton, TX 78064 USA

Abstract: 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. 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 62,268 mule deer estimated in 2013. In contrast, mule deer estimates have trended downward for the Trans-Pecos ecoregion, but are rebounding with a 2013 estimate of 156,566. Texas' white-tailed deer herd has been stable over the last 9 years and was estimated at over 3.8 million in 2013. Statewide deer harvest data is 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 8,400 and white-tailed deer harvest was estimated at approximately 625,500 during the 2013 hunting season. The Texas Legislature designated elk as an exotic species in 1997. Since the 1997 reclassification as an exotic by the state 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 game farms and high-fence 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; therefore, elk can be hunted/harvested 365 days a year with no annual or possession bag limits.

Presenter and email: Shawn Gray; shawn.gray@tpwd.texas.gov

STATUS OF DEER AND ELK IN UTAH 2000-2015

JUSTIN SHANNON, Utah Division of Wildlife Resources, 1594 West North Temple, Suite 2110 PO Box 146301 Salt Lake City, UT 84114.

Abstract: Utah's statewide deer population has increased over the past several years, but is still lower than historical highs. We estimate the statewide population to be about 355,600 deer (January 2015 estimate). The population has been around 300,000 since the late 1990's with weather driven fluctuations. Utah's elk population has steadily grown from about 62,500 in 2000 to a current estimate of about 81,000. Deer populations are estimated by computer model. Natural mortality inputs to the model are estimated using survival rates of collared does and fawns on 7 representative units. Ground classification and harvest data are also used as input to the model. Elk populations are estimated using hybrid approach that includes helicopter survey flights every 3 years and modeling in the non-flight years. Harvest trends for deer and elk are stable to increasing. Harvest is estimated using a combination of phone and internet based surveys. We used a combination of random sample and mandatory reply surveys, depending on

the hunt type. Utah tries to strike a balance between the demand for hunting opportunity and antler quality. We do this differently for deer and elk. For deer, we provide general season opportunity on the majority of the units statewide and set aside a few units limited entry units. For elk, we have opportunity and limited entry units, and we allow for spike harvest on units managed for older age class bulls. We base our buck deer permits on post season buck to doe ratios and our bull elk permits on average age of harvested bulls. Habitat quality and quantity continues to be the limiting factors for mule deer. Our elk populations are not limited by habitat in most cases since most of our population objectives are socially driven.

Presenter and email: Justin Shannon; justinshannon@utah.gov

STATUS OF DEER AND ELK POPULATIONS IN WASHINGTON, 2001-2013

BROCK HOENES, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501 USA

SARA HANSEN, Washington Department of Fish and Wildlife, 2315 North Discovery Place, Spokane Valley, WA 99216 USA

Abstract: Rocky Mountain (*Cervus elaphus nelsoni*) and Roosevelt (*C. e. roosevelti*) elk both occur in Washington State and the Washington Department of Fish and Wildlife (WDFW) formally recognizes and manages 10 elk herds. All 10 elk herds are either stable or increasing and the statewide post-hunt 2013 estimate was 49,000–58,000 elk, which is within the post-hunt population objective range of 53,000–65,000 elk. WDFW manages for a post-hunt population that has 12-20 bulls:100 cows and achieved this management objective in all herds during 2013, with observed ratios ranging 15-69 bulls:100 cows. Post-hunt surveys also indicate each elk herd had calf recruitment rates that would support population growth, with post-hunt calf:cow ratios ranging from 27–49 calves:100 cows. The statewide harvest estimate in 2013 was 7,246 elk, which is similar to the 2001–2013 mean of 7,477 elk. WDFW is responsible for managing mule deer (*Odocoileus hemionus*), black-tailed deer (*Odocoileus hemionus columbianus*), and white-tailed deer (*Odocoileus virginianus*). Available population metrics (relative abundance indices, age/sex ratios, survival estimates, and harvest trends) indicate all three species are stable or increasing across their range. Exceptions include mule deer in the south-central region of the state and coastal black-tailed deer herds on the Olympic Peninsula recovering from hair loss due to exotic lice. WDFW manages elk and deer harvest to maximize hunter opportunity and maintains general season, over-the-counter opportunities for all subspecies of deer and elk throughout the state. However, WDFW also offers quality hunts through a permit system. Habitat quality, land-use changes, and weather are likely the primary drivers of local deer and elk population fluctuations at this time. As wolves continue to colonize the state, however, efforts to improve monitoring of ungulate populations are underway.

Presenters: Brock Hoenes; Brock.Hoenes@dfw.wa.gov

WAFWA MULE DEER WORKING GROUP PRODUCTS AND PROGRESS

JAMES HEFFELFINGER, WAFWA Mule Deer Working Group. Arizona Game and Fish Department. 555 N. Greasewood Rd. Tucson, Arizona 85745 USA

Abstract: In 1997, the Western Association of Fish and Wildlife Agencies (WAFWA) established a Mule Deer Working Group (MDWG) consisting of a representative from each of the 23 member states and Canadian provinces. Since that time, the working group has been successfully addressing black-tailed and mule deer concerns shared among wildlife agencies in western North America. The many accomplishments of the MDWG include a book summarizing the current knowledge, challenges, and opportunities for the important issues identified by leading mule deer experts (Mule Deer Conservation: Issues and Management Strategies 2003), a popularized version of this book for easy reading by non-biologists (Mule Deer: Changing Landscapes, Changing Perspectives), the North American Mule Deer Conservation Plan, Mule Deer Habitat Guidelines for 7 North American ecoregions, Energy Development Guidelines for Mule Deer, Methods for Monitoring Mule Deer Populations, Range-wide Status of Black-tailed and Mule Deer, and a growing collection of 13 Fact Sheets addressing the most important issues facing mule deer today. This is an opportunity to learn what the MDWG has been up to and become familiar with the tools available to help you conserve the most important member of Cervidae. All these products are available at: www.muledeerworkinggroup.com.

Presenter and email: Jim Heffelfinger; jheffelfinger@azgfd.gov

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ABSTRACTS
PLENARY SESSION

MANAGING DEER AND ELK HARVESTS WITH ENVIRONMENTAL VARIABILITY

MARK S. BOYCE, Department of Biological Sciences, University of Alberta, AB, T6G 2E9, Canada

SIMONE CIUTI, Department of Biological Sciences, University of Alberta, AB, T6G 2E9, Canada

WILLIAM JENSEN, North Dakota Game and Fish Department, 100 N. Bismarck Expressway, Bismarck, ND 58501-5095, USA

Abstract: All deer and elk populations exist in variable environments, and all climate-change models predict that these environments are becoming more variable. Temporal variability in the environment causes perturbations in vital rates of survival and recruitment, and also affects the carrying capacity of habitats. We usually assume that this variation is stochastic, but recently we have found that the Pacific Oscillation has a significant influence on mule deer populations in North Dakota. In other ungulate populations the Pacific Decadal Oscillation and the North Atlantic Oscillation have predictable consequences for demography. These climate oscillations create a substantial degree of predictability in vital rates offering opportunity for adaptive adjustments of harvest quotas. We show how this predictability can be accommodated in an optimization model for mule deer harvests. Such adaptive approaches for harvest modelling will allow us to anticipate the consequences of climate change and to adjust our harvest policies accordingly.

Presenter and email: Mark S. Boyce; boyce@ualberta.ca

INFLUENCES OF ENVIRONMENTAL VARIATION ON NUTRITION AND BODY CONDITION OF ELK

JOHN G. COOK, National Council for Air and Stream Improvement, 1401 Gekeler Lane, La Grande, OR, 97850, USA

RACHEL C. COOK, National Council for Air and Stream Improvement, 1401 Gekeler Lane, La Grande, OR, 97850, USA

LARRY L. IRWIN, National Council for Air and Stream Improvement (retired), P.O. Box 68, Stevensville, MT, 59870, USA

Abstract: Nutritional mechanisms comprise a primary pathway through which environmental conditions influence body size and nutritional condition, reproduction, development of juveniles, and, ultimately, population dynamics. Yet, little is known about variation in nutritional condition and reproduction of large ungulate populations as a function biogeoclimatological variation in western North America, seasonality of nutritional influences, causes of nutritional limitations where they occur, and, therefore, how, when, and where habitat management can be effectively used to benefit large ungulate herds. We have addressed many of these issues in the western US by integrating studies of nutrition at fine scales using captive elk with studies of nutritional condition and reproduction on wild elk at coarse scales from 1995-2015. Controlled

experiments with the captive elk demonstrated marked effects of moderate deficiencies in digestible energy (DE) during summer on nutritional condition (e.g., body fat), pregnancy rates, timing of breeding, growth and maturation of juveniles, and winter survival potential of adults and juveniles, highlighting the potential of summer nutrition as a driver of fitness in elk. Surveys of nutritional condition and pregnancy rate of nearly 30 elk herds in 7 western states demonstrated 1) low condition and reduced pregnancy rates in many herds, 2) marked variation in both attributes among and within ecological settings, and 3) greater influences of nutrition in summer/autumn than in winter. Geographic patterns in fitness included latitudinal/elevational gradients in the rainforests of western Oregon and Washington and precipitation/elevational gradients across the broader western US. Studies using captive elk placed in wildland habitats indicate that variation in DE content of forage probably explains variation in fitness across ecological settings, but that causes of inadequate forage DE levels, and potential value and appropriate types of habitat management to improve nutritional resources on behalf of elk, depend on local ecological conditions.

Presenter and email: John Cook; cookjg.ncasi@gmail.com

PREDATION IN VARIABLE ENVIRONMENTS: POPULATION CONSEQUENCES

MARK HEBBLEWHITE, Wildlife Biology Program, Department of Ecosystem and Conservation Sciences, College of Forestry and Conservation, University of Montana, Missoula, MT, 59812, USA

Abstract: Wolf recovery in the lower 48 states has restored one of the most important ecological processes shaping ungulate population dynamics after an absence of 70-years. Unfortunately, ungulate population management may be ill-equipped to this new reality for several reasons. First, management objectives for many ungulate populations are based either on nutritional carrying capacity or the long-term population averages. For either of these approaches to work after wolf recolonization, wolf predation must be a weak limiting, but not regulating factor. If this is false, then it becomes a logical tautology to define the population objective based only on food in the post-wolf recovery era. A review of classical predator-prey theory suggests three alternate hypotheses to the food-only model, the predation-food hypothesis, the predator-pit hypothesis, and the predator regulation hypothesis. Focusing here on wolf-elk dynamics, evidence supports the predator regulation or predator-food hypothesis for elk, but growing evidence supports de-stabilizing ratio-dependent predation. This emphasizes that ungulate management goals may need to change following wolf recovery. However, there is also a critical role for bottom-up habitat quality to buffer the top-down effects of wolf regulation. Despite the insights from classic theory, however, most theory stems from single-prey single predator systems. Growing evidence demonstrates further ways multi-prey dynamics can obscure easy assessments of the underlying predator-prey dynamic. Finally, most underlying theory assumes stability in the face of dynamic environmental variation. For these reasons, I argue that predator-prey theory is ill-equipped to currently offer predictive models for ungulate managers working in predator-driven systems. Faced with this rather bleak review of theory and empiricism, I outline several options available for integrating predator-ungulate management under different

management paradigms. Regardless of which paradigm ungulate management operates under, however, maintenance of the status-quo for ungulate management following wolf recovery has the potential to increase conflicts between vying stakeholders interested in predator-prey management in the west.

Presenter and email: Mark Hebblewhite; mark.hebblewhite@umontana.edu

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CHALLENGES OF MANAGING DEER & ELK HERDS IN VARIABLE ENVIRONMENTS

N. THOMPSON HOBBS, Natural Resource Ecology Laboratory, Colorado State University, CO 80523 USA

Abstract: The most important challenge in managing natural resources is to choose among alternative actions to meet goals for an uncertain future. Science should inform those choices. Population models have been usefully applied to management of deer and elk populations throughout North America to help managers decide on appropriate levels and composition of harvest. The utility of these models could be improved by 1) including honest assessments of uncertainty, 2) objectively incorporating multiple sources of data, and 3) making forecasts that assess the probability a specified harvest regime will meet a specific goal for a population. Recent advances in statistical modeling make these three improvements feasible. Bayesian methods allow us to assimilate data typically collected by management agencies with traditional, age and sex structured demographic models. Hard-won findings from detailed research studies can be included in the same framework. Formal assimilation of population models with data allows true forecasts, that is, predictions accompanied by honest estimates of uncertainty arising from multiple sources. Forecasts, in turn, can be used to evaluate the probability that alternatives for harvest can meet future goals for the population. Sparing equations in favor of plain talk, I show how these models can be constructed with data on hand and with current technology. I show how they can be applied to improve the conversation among managers, researchers, and stakeholders seeking to make the best possible decisions on conservation of deer and elk populations using regulated harvest. Models like the ones I advocate form the foundation of adaptive management as it was originally proposed by Carl Walters. I show how they can be used to adaptively respond to variation in population performance over time.

Presenter and email: N. Thompson Hobbs; tom.hobbs@colostate.edu

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SPATIAL AND TEMPORAL HETEROGENEITY OF RESOURCES IN ARID LANDS: POPULATION CONSEQUENCES FOR MULE DEER

KELLEY M. STEWART, Department of Natural Resources and Environmental Science, University of Nevada Reno, Reno, NV 89557, USA
ANTHONY BUSH, Department of Natural Resources and Environmental Science, University of Nevada Reno, Reno, NV 89557, USA
VERNON C. BLEICH, California Department of Fish and Wildlife, Wildlife Investigations Laboratory, 1701 Nimbus Road, Rancho Cordova, CA 95670, USA
NEAL DARBY, National Park Service, 2701 Barstow Road, Barstow, CA 92311 USA

DEBRA HUGHSON, National Park Service, 2701 Barstow Road, Barstow, CA 92311 USA

Abstract: In arid environments, resources often are limited, and are widely or patchily distributed. Understanding the use of limited resources by large-bodied herbivores presents unusual challenges in arid ecosystems, because body size is related to both physiological needs and limits, resulting in broad spatial distributions of animals and resources. A key component in arid environments is availability of free-standing water; we hypothesized that distance to water would be important in patterns of resource selection especially during hot dry seasons and would be important in selection of birth sites. We also hypothesized that selected resources also would be important parameters in demographic models of survival. We used mule deer (*Odocoileus hemionus*), a medium-bodied ungulate with wide distributions across North America, as a model organism to investigate effects of limited and widely distributed resources on demographics, patterns of space use, and selection of resources. We also modeled selection of birth sites relative to survival of neonates. We used program MARK to evaluate survival of adults and young. Adult mule deer selected for high elevations and closer to sources of water in all seasons. Adult survival was highest during years of high precipitation and lowest during droughts. Neonate survival during years of elevated precipitation was highest with individual births occurring early than the median birth date - larger neonates at birth had higher survival than their smaller counterparts. Adult females selected birth sites with about 40-50% shrub cover and close to sources of water. Understanding how ungulates select and use limiting resources, especially with changing weather patterns and urban development in arid will likely be key components to maintaining viable populations of large mammals in arid environments.

Presenter and email: Kelley Stewart; kstewart@cabnr.unr.edu

ABSTRACTS
CWD SPECIAL SESSION

ENVIRONMENTAL CONTAMINATION: IS IT THE REAL ISSUE IN CWD MANAGEMENT?

JUDD M. AIKEN, Department of Agriculture, Forestry and Nutritional Sciences, University of Alberta, AB, T6G 2M8, Canada

Abstract: Both direct (animal to animal) and indirect (animal to environment to animal) play a role in the transmission of chronic wasting disease. Environmental sources of CWD infectivity result from infectious prions being shed or released from CWD infected animals (saliva, urine and feces as well as decomposing carcasses). This infectivity can persist in soils for years to decades providing a continuous source of CWD infectivity to cervids as well as other mammalian species. Our studies have examined soils and determined that soils can tightly bind infectious prions, binding that can enhance prion infectivity with some soils. Soils are complex and vary considerably in mineral composition as well as organic components. We have examined clay minerals as well as organic components of soils and found both can interact with prions. Although environmental sources and persistence of prions is well documented, the relative importance of direct vs indirect transmission route in the transmission of CWD is less clear and will be discussed.

Presenter and email: Judd Aiken; judd.aiken@ualberta.ca

CHANGING GENETICS AND THE FUTURE OF CWD

JULIE A. BLANCHONG, Department of Natural Resource Ecology and Management, Iowa State University, 339 Science II, Ames, Iowa 50011, USA

Abstract: Chronic wasting disease has proven to be invariably fatal in all cases to date and is associated with decreased survival and reduced abundance in free-ranging populations where the disease is at high prevalence. For these reasons, understanding relationships between genetics and the epidemiology of CWD and their potential relevance for disease management is of great interest. This talk will review the current state of knowledge from experimental studies on captive cervids and transgenic mice as well as data from free-ranging cervid populations regarding genes associated with CWD resistance and progression. Genetic variants at the prion protein gene, the locus that has received the most investigation, associated with CWD resistance and progression will be described as will findings from investigations of other gene regions. In addition, evidence for different strains of CWD and their epidemiological significance will be presented. Finally, data on potential population-level consequences of fitness differences of these genetic variants will be covered. Management implications of these findings for captive and free-ranging cervids will be discussed and future research needs will be addressed.

Presenter and email: Julie A. Blanchong; julieb@iastate.edu

WHAT DO WE KNOW ABOUT MECHANISMS OF TRANSMISSION TO HELP US MANAGE?

TRENT K. BOLLINGER, Canadian Wildlife Health Cooperative, Department of Veterinary Pathology, University of Saskatchewan, 52 Campus Dr., Saskatoon, SK, S7N 5B4 Canada

Abstract: CWD is a contagious disease with prions being shed in feces, urine, saliva, and likely all excretions and secretions to varying degrees. Transmission occurs through animal-to-animal contact and by contact with an environment contaminated with prions from infected individuals which shed prions during the long incubation period. Factors affecting the transmission of CWD are poorly understood but several patterns of infection have emerged. In areas were cervid species are sympatric, CWD prevalence is highest in mule deer, less in white-tailed deer and least in elk. Adult bucks tend to have a prevalence which is several times higher than adult does. Prevalence is highest in urban areas compared to rural areas and infection under captive conditions can develop relatively rapidly to involve the majority of animals. Under free-ranging conditions the prevalence can exceed 50% in focal areas whereas in other areas the prevalence remains low. These observations indicate social factors and how cervids use their environment are critical in the epidemiology of CWD and are likely to provide clues on how to manage the disease in free-ranging populations. Researchers have explored through computer simulation effects of various assumptions; such as: density and frequency dependent transmission, and selective (including predation) and non-selective culling (hunting), on prevalence and population effects of CWD. We and other researchers have investigated home range overlap and joint space use to identify areas where transmission is likely to occur. We have extended our studies and used trail cameras to investigate the relative frequency and intensity of use of focal areas of the environment and found frequency, intensity and contact with the environment is several times higher at anthropogenic sites (grain pile and salt blocks) as compared to natural sites (bed, trail, rub sites). Reducing contacts with environmental focal points should be part of any CWD management program.

Presenter and email: Trent K. Bollinger; trent.bollinger@usask.ca

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POPULATION DYNAMICS OF COLORADO MULE DEER WITH ENDEMIC CHRONIC WASTING DISEASE

NATHAN L. GALLOWAY, Department of Biology, Colorado State University, CO 80523 USA

CHRIS GEREMIA, National Park Service, Yellowstone National Park, WY 82190 USA

JENNIFER A. HOETING, Department of Statistics, Colorado State University, CO 80523 USA

N. THOMPSON HOBBS, Natural Resource Ecology Laboratory, Colorado State University, CO 80523 USA

MICHAEL F ANTOLIN, Department of Biology, Colorado State University, CO 80523 USA

Abstract: Chronic Wasting Disease (CWD) is a transmissible neurological disease that infects free-ranging populations of North American cervids (hereafter deer) and continues to spread to new areas. CWD is an inevitably fatal prion disease, which has been hypothesized to harm ecosystems through the demise of deer populations. Current understanding of CWD's effect on deer populations is limited to widely varying predictions from simulation models and a few empirical studies conducted on local geographic scales. We completed a five-year mark-

recapture study of northern Colorado mule deer in a population with a decades-old presence of CWD to understand how current disease dynamics affect population growth and assess whether the epidemic is increasing. Spatially localized infection, similar infection rates among ages, and slow disease progression muted the effects of CWD on population growth. Projections from the current state show a largely unchanging deer population, although decline was the more probable outcome. Furthermore, the weight of evidence suggests a decline in the CWD outbreak between historic observations (1997-2003) and our recent work (2010-2014). Infection is also localized spatially across sub-populations that experience heterogeneous disease pressure, and as a result show varying disease impacts. Disease also associates differentially with one common observed form of the prion precursor protein (225S; serine). Interestingly, the alternate form of the prion precursor occurs more often in healthy deer, but does not correlate spatially with disease. An evolutionary increase in the frequency of the prion precursor form associated with healthy animals may not be occurring at a substantial rate in our study population. Continued observations as this epidemic continues would allow researchers to better understand the long-term dynamics of the system in its own ecological context.

Presenter and email: Nathan Galloway; Nathan.galloway@colostate.edu

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MANAGEMENT FOR CWD: WHAT HAVE WE LEARNED?

NOHRA MATEUS-PINILLA, Wildlife Veterinary Epidemiology Laboratory, University of Illinois, Illinois Natural History Survey, 1207 W. Gregory Drive, Urbana, Illinois 61801, USA

Abstract: CWD was first found in northern Illinois in the fall of 2002. Since that time, more than 75,000 deer have been tested throughout the State. Temporal data serve as evidence based tool(s) to evaluate changes in CWD prevalence and distribution. To date, CWD is found in 14 northern Illinois counties where 467 positive cases have been identified. For CWD management the Illinois Department of Natural Resources (IDNR) uses hunter harvest surveillance supplemented by localized removal of deer from CWD infected areas. Since culling began in 2003 the CWD management efforts in Illinois were aimed at reducing CWD occurrence and reducing the likelihood of CWD becoming stablished in an area. Of additional consideration was to manage disease without causing severe reductions of deer populations throughout an entire county. Since then annual CWD prevalence rates have remained flat at about 1%. These results are positive indicators of the effectiveness of intervention. Yet, CWD is not distributed evenly on the landscape and slow disease dispersion is apparent. The surveillance program and landowner collaboration remain at the center of CWD management wild populations. Obstacles to CWD management include: 1) preliminary evidence that the frequency of long distance dispersal by deer is higher than previously reported. If this is the case, the risk for disease spread will increase; 2) the manpower required to meet surveillance and management needs; 3) the reality that hunter harvest alone is not intensive enough to effectively manage infected areas; 4) new disease foci in prime deer habitat where the success of CWD management is limited by poor stakeholder support. Ultimately, the attempts to manage CWD should recognize gaps in knowledge related to disease transmission and persistence, as well as the continuum of an ecological based approach where the pathogen can be maintained and from where infection can be transmitted to the population.

Presenter and email: Nohra Mateus-Pinilla; nohram@illinois.edu

SOCIAL AND ECONOMIC CHALLENGES FOR MANAGING CWD

ELLEN GODDARD, Department of Resource Economics and Environmental Sociology, University of Alberta, 515 General Services Building, Edmonton, AB T6G 2H1 Canada

AYE CHAN MYAE, Government of Alberta, Jobs, Skills, Training and Labour, 7th fl Commerce Place, 10155 - 102 Street, Edmonton, AB, T5J 4L1 Canada

Abstract: Part of managing any animal disease outbreak relates to the public and political desire for such management. From two large research projects focusing on the socio-economic aspects of CWD risk management, results in terms of preferences of hunters, of the public and of consumers of meat for different management strategies will be presented. Comparisons between similar groups in the US and Canada will be shown. The results suggest significant differences in risk perceptions, across groups and countries, are related to wide variation in preferences for public management of the risks of CWD. Certain types of public communication may be necessary to ensure the public is supportive of the optimal scientific disease management strategies.

Presenter and email: Ellen Goddard; egoddard@ualberta.ca

MODELING TRANSMISSION OF CHRONIC WASTING DISEASE IN WISCONSIN WHITE-TAILED DEER: MAKING MODELS USEFUL FOR MANAGEMENT

CHRISTOPHER S. JENNELLE, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison, WI USA

VIVIANE HENAUX, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison, WI USA

MICHAEL D. SAMUEL, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison, WI USA

BALA THIAGARAJAN, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison, WI USA

GIDEON WASSERBERG, Biology Department, University of North Carolina, Greensboro, NC USA

ROBERT E. ROLLEY, Wisconsin Department of Natural Resources, Madison, WI USA

Abstract: For managed wildlife, hunter harvest data is a useful source of information for understanding disease dynamics and possible mitigation efforts. We used such data collected from 2002 to 2013 to model transmission mode, estimate infection rate, and address how alternative harvest management strategies could affect chronic wasting disease (CWD) dynamics in a Wisconsin white-tailed deer population. Using maximum-likelihood methods to evaluate alternative multistate deterministic models of CWD transmission, harvest data strongly supported a frequency-dependent transmission structure with sex-specific infection rates that are two times higher in males than females. As transmissible spongiform encephalopathies are an important and difficult-to-study class of diseases with major economic and ecological implications, our work supports the hypothesis of frequency-dependent CWD transmission in wild deer at a broad spatial scale and indicates that effective harvest management can be implemented to mitigate CWD prevalence. Specifically, we show that a harvest strategy focused on the greater-affected sex (males) can result in stable population dynamics and control of CWD

within this century, given the constraints of the model. This potential control comes at a cost; consistently high levels of male harvest over the course of decades, resulting in fewer opportunities for hunter harvest of adult male deer. We also provide a quantitative estimate of geographic disease spread in southern Wisconsin, validating qualitative assessments that CWD spreads relatively slowly. We discuss the realistic implications of our results in the context of a challenging management environment that most (if not all) states experience.

Presenter and email: Christopher Jennelle; chris.jennelle@minnesota.dnr.gov

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OVERVIEW AND NEXT DIRECTIONS FOR CWD IN THE WILD

MICHAEL D. SAMUEL, U.S. Geological Survey, Wisconsin Cooperative Wildlife Research Unit, University of Wisconsin, 204 Russell Labs, 1630 Linden Drive, University of Wisconsin, Madison, WI 53706 USA

Abstract: Chronic wasting disease is an always fatal, contagious prion disease affecting members of the North American deer family. The disease has become widely distributed in the western, central, and eastern United States and in prairie Canada. Significant advances in CWD research have occurred during the past decade, many will be highlighted in this symposium. However, these advances have not translated into a cure for CWD or the development of effective management actions to control prevalence or stop disease spread. At the same time we've found that affected cervid population can be substantially impacted when CWD reaches or exceeds species-specific prevalence levels. Emerging science now suggests that new management and policy challenges may be on the horizon. This talk will highlight key scientific progress, identify important CWD knowledge gaps, consider potential management strategies, and speculate about emerging management and policy challenges. These challenges suggest that a multi-agency coordinated national and international effort will be required to successfully address the future threats of CWD.

Presenter and email: Michael D. Samuel; msamuel@usgs.gov

EFFECTS OF CHRONIC WASTING DISEASE ON ELK POPULATIONS: HAVE WE UNDERESTIMATED THE RISK?

MARGARET A. WILD, Biological Resources Division, National Park Service, Fort Collins, CO, 80525, USA

RYAN J. MONELLO, Biological Resources Division, National Park Service, Fort Collins, CO, 80525, USA

JENNY G. POWERS, Biological Resources Division, National Park Service, Fort Collins, CO, 80525, USA

Abstract: Chronic wasting disease (CWD), a fatal, contagious prion disease of cervids, can cause long-term population declines in deer (*Odocoileus* spp.); however, little data exist on the effects of CWD on free-ranging elk (*Cervus elaphus nelsoni*). Where CWD exists in elk, prevalence is frequently estimated to be <1% leading some to surmise that its population impact is minimal. In some geographically isolated areas of Colorado, Wyoming, and South Dakota however CWD prevalence in elk surpasses that in deer. Further, CWD contributed to decreased population growth rates in elk in Wind Cave National Park, South Dakota. To investigate the

population impacts of CWD, we studied an elk herd residing in and around Rocky Mountain National Park, Colorado, where CWD was first detected in 1981. Using immunohistochemical staining of rectal biopsies, we estimated CWD prevalence to be 12.9% (CL 8.0 - 19.1) in 2008-2009, although additional analyses using the highly sensitive serial protein misfolding cyclic amplification (sPMCA) assay predict prion infection to be higher (18.9%, CI 15.5 – 32.7%). We used survival rates of susceptible and infected elk to develop a projection matrix for a discrete time, female only model that estimated the intrinsic population growth rate (λ) of this elk herd to be 1.00 (BCI 0.93 - 1.05). Results of the projection matrix predict that even in the absence of hunting or other sources of mortality, CWD alone could induce population declines once prevalence exceeds 13% (BCI = 0, 35); however, this estimate was contingent on calf:cow ratios and harvest. To refine these estimates, we initiated a longer term survival study on this population in 2011. Preliminary results suggest that survival rates remain low and that CWD continues to be a leading cause of mortality. Clearly the population impacts of CWD on elk should not be dismissed without further investigation.

Presenter and email: Margaret Wild; Margaret_wild@nps.gov

ABSTRACTS OF CONTRIBUTED PAPERS: HARVEST

ADAPTING ELK HARVEST IN RESPONSE TO LAND USE CHANGE—A 40-YEAR CASE STUDY

TIM CULLINAN, Point No Point Treaty Council, 7999 NE Salish Lane Kingston, WA 98346 USA

Abstract: Over four decades, three major land use changes induced behavioral changes in an elk herd in the Olympic Mountain foothills near Sequim, Washington. Changes in elk home range and seasonal behavior subsequently necessitated adaptation of harvest strategies to reduce human-elk conflicts in an urbanizing agricultural landscape. Over time, the harvest management objective evolved from traditional subsistence and recreational harvest to a combination of recreation and crop depredation control, and eventually toward harvest motivated primarily by the need to reduce damage to crops and other property. Concurrent with land use changes, state and tribal co-managers also had to cope with changing agency policies regarding antlerless harvest and crop damage compensation, new local ordinances restricting use of firearms, construction of a freeway through the elk herd's home range, and with multiple vociferous user groups advocating a broad spectrum of incompatible objectives. By 2004, this elk herd comprised only one percent of the regional elk population, but annually consumed one-third of the state wildlife agency's regional elk management budget. In hindsight, state and tribal co-managers could have obviated many management challenges had they been better able to anticipate elk responses to land use changes, taken more timely and aggressive action in adjusting harvest, put less faith in wishful thinking, and acted more quickly to manage harvest on a finer-grained geographic scale. This paper provides a 40-year retrospective describing how land use changes and the law of unintended consequences challenged managers to adapt harvest strategies to accommodate the needs of a wide variety of stakeholders.

Presenter and email: Tim Cullinan; tcullinan@pnptc.org

DROUGHT IN SOUTH TEXAS: IMPLICATIONS FOR RECRUITMENT, AGE STRUCTURE, AND HARVEST OF WHITE-TAILED DEER

KORY GANN, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363 USA

DAVID HEWITT, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363 USA

ALFONSO ORTEGA-S, JR., East Wildlife Foundation, Kingsville, TX 78363 USA

TIMOTHY FULBRIGHT, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363 USA

ALFONSO ORTEGA-S, Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX 78363 USA

Abstract: Environmental variability may affect productivity of white-tailed deer in South Texas, thus influencing population age structure. Understanding the impacts of environmental variability on the productivity and age structure of unmanaged deer populations provides insight

into the challenge faced by deer managers in the region. From 2011–2014, we captured 1,599 adult deer (> 1 year old) on 2 properties where deer were unmanaged; one property along the Texas Gulf Coast and another 160 km inland. We classified drought conditions for 2010−2013 using the 5 month average Palmer Z-Index values for March−July. Above average rainfall in spring and summer 2010 led to high fawn recruitment. As a result, yearling deer composed 15–17% of females and 20–26% of males captured on both properties in 2011. Drought experienced from 2011−2013 decreased fawn recruitment on the inland property, where yearling deer composed 1–7% of females and 1–9% of males captured from 2012−2014. Effects of drought on recruitment were less evident on the coastal property, where yearling deer were 8–12% of females and 10–25% of males captured from 2012−2014. Deer 6+ years old composed 30–57% of the females and 16–43% of the males captured on both properties from 2011−2014, suggesting that survival of adults is high once they are recruited into these populations. Recruitment of deer in western South Texas may be limited by erratic precipitation, whereas recruitment may be more stable in coastal populations. Frequent drought ensures that unmanaged deer populations in western South Texas rarely achieve high densities, whereas the large number of mature deer act as a buffer to sustain the population through periods of low fawn recruitment and are available for fawn production during periods with adequate rainfall. Lowering adult survival through intense harvest may reduce the ability of white-tailed deer populations in this region to persist at moderate densities.

Presenter and email: Kory Gann; kory.gann@students.tamuk.edu

DEER AND ELK HUNTER SUCCESS

RYAN M. NIELSON, WEST, Inc., 415 West 17th, Ste. 200, Cheyenne, WY 82001, USA

SCOTT L. FINDHOLT, Oregon Department of Fish and Wildlife, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

MARY M. ROWLAND, Pacific Northwest Research Station, USDA Forest Service, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

MICHAEL J. WISDOM, Pacific Northwest Research Station, USDA Forest Service, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

BRUCE K. JOHNSON, Oregon Department of Fish and Wildlife, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

Abstract: What leads to a successful hunt? Is use of an all-terrain vehicle (ATV) typically associated with a greater success rate? Can time spent scouting before the hunt predict success, or time spent away from camp during the hunt, daily distance traveled while hunting, or spending more time away from roads and ATV trails? Can hunter success be predicted by a hunter's personal characteristics (e.g., gender and age) or by weather? We analyzed hunter survey data and global positioning system (GPS) locations from 374 hunters that participated in controlled archery bull elk, rifle buck deer, and rifle bull elk hunts during 2008 – 2013 at Starkey Experimental Forest and Range in northeast Oregon. Each hunting period was 5 days, with a 5-day scouting period available to the permitted hunters prior to the hunt. Hunters were required to carry GPS units that attempted to record their location every 5 minutes, and there were varying levels of motorized access within the study area. Results indicated that hunter success could be predicted by time spent in camp, distance traveled during the hunt, weather, and ATV use,

among other variables. Results from this study will provide managers of ungulate populations with better knowledge of how best to optimize hunting season designs, especially in relation to different types of access.

Presenter and email: Ryan Nielson; rnielson@west-inc.com

FACTORS AFFECTING SPATIAL DISTRIBUTION OF ARCHERY VS. RIFLE HUNTERS WITH VARYING LEVELS OF MOTORIZED ACCESS

MARY M. ROWLAND, Pacific Northwest Research Station, USDA Forest Service, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

RYAN M. NIELSON, WEST, Inc., 415 West 17th, Ste. 200, Cheyenne, WY 82001 USA

SCOTT L. FINDHOLT, Oregon Department of Fish and Wildlife, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

BRUCE K. JOHNSON, Oregon Department of Fish and Wildlife, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

MICHAEL J. WISDOM, Pacific Northwest Research Station, USDA Forest Service, Forestry & Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

Abstract: Land and wildlife managers face daunting challenges in adapting recreational opportunities to changing modes of access, such as the proliferation of all-terrain vehicle (ATV) use. Previous studies have reported movements of deer (*Odocoileus* spp.) and elk (*Cervus elaphus*) in response to human disturbance during hunting seasons, but movements and distributions of hunters have rarely been modeled, especially in relation to motorized vehicle use or hunt type. Moreover, few studies have addressed interactions of hunter movements, deer and elk movements, and hunter success in relation to motorized access. To address this need, we designed a manipulative experiment with controlled access and hunter densities from 2008-2013 at the Starkey Experimental Forest and Range in northeastern Oregon. ATV access for the hunts ranged from high (>3 km/km2) open road/trail densities to very limited (<1 km/km2) access, allowing hunters to select their desired hunting strategy. Hunters were required to carry Global Positioning System (GPS) units during 5-day scouting and 5-day hunting periods. GPS location frequency was set at 5 minutes to capture fine-scale temporal and spatial distributions of hunters. We estimated Brownian Bridge Movement Models for each hunter and then used individual utilization distributions (UDs) to estimate population level UDs for hunters from each of 3 hunt types, archery elk, rifle deer, and rifle elk, and from the 2 levels of ATV access. We also related a suite of environmental covariates to hunter UDs, including distance from nearest open road or ATV trail and distance from hunter camp. Here we report results of our initial comparisons across hunt types and level of ATV access, and correspondence of UDs to selected covariates. Our results can be used to inform state and provincial wildlife agencies about how hunters in these groups distribute themselves in landscapes and hunting scenarios similar to those at Starkey.

Presenter and email: Mary Rowland; mrowland@fs.fed.us

ABSTRACTS OF CONTRIBUTED PAPERS: MIGRATION

MIGRATION PATTERNS OF ADULT FEMALE MULE DEER IN RESPONSE TO ENERGY DEVELOPMENT

CHUCK ANDERSON, Mammals Research Section, Colorado Parks and Wildlife, 317 W. Prospect, Ft. Collins, CO 80526 USA

PATRICK LENDRUM, Department of Fish, Wildlife and Conservation Biology, Colorado State University, 1474 Campus Delivery, Fort Collins,CO 80523 USA

TERRY BOWYER, Department of Biological Sciences, Idaho State University, 921 S. 8th Ave., Pocatello, ID 83209 USA

KEVIN MONTEITH, Department of Biological Sciences, Idaho State University, 921 S. 8th Ave., Pocatello, ID 83209 USA

RYAN LONG, Department of Biological Sciences, Idaho State University, 921 S. 8th Ave., Pocatello, ID 83209 USA

JOHN KIE, Department of Biological Sciences, Idaho State University, 921 S. 8th Ave., Pocatello, ID 83209 USA

JOHN JENKS, Dept. of Natural Resource Management, South Dakota State University, Box 2140B, Brookings, SD 57007 USA

CHAD BISHOP, Colorado Parks and Wildlife, 6060 Broadway, Denver, CO 80216 USA

Abstract: The Piceance Basin of northwest Colorado contains the largest migratory mule deer (*Odocoileus hemionus*) population in the state and one of largest natural gas reserves in the country. Understanding how energy development activities influence migratory behavior of mule deer will enhance mule deer management and inform future energy development planning. We compared spring migration routes of adult female mule deer fitted with GPS collars (n = 205) among four study areas that had varying degrees of natural-gas development from 2008 to 2010. Environmental factors influencing migration included snow depth, temperature and green-up on winter and summer range; increasing temperatures, snow melt and emerging vegetation dictated timing of winter range departure and summer range arrival. Duration of Piceance mule deer migration was relatively short averaging 4 to 8 days among the 4 areas examined (straight line distance between seasonal ranges averaged 33 - 45 km). Deer in poor condition migrated later than deer in good condition, but condition was similar among areas regardless of development status. Migrating deer did not avoid development activity, but used higher canopy cover, departed later, arrived earlier and migrated more quickly than deer from undeveloped areas. Large changes in timing of migration could have nutritional consequences negatively influencing reproduction/neonate survival, but the relatively minor shift of a couple/few days we observed should not result in long-term fitness consequences. Piceance Basin mule deer appear to avoid negative effects of energy development through behavioral shifts in timing and rate of migration. Identification, protection and maintenance of suitable migratory paths should be incorporated into land use planning. Comparisons from the Piceance Basin and south-central Wyoming will be presented to further address mule deer migration behavior in relation to energy development activities.

Presenter and email: Chuck Anderson; chuck.anderson@state.co.us

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MULE DEER MIGRATION CORRIDORS AND DEER-VEHICLE COLLISIONS IN OREGON

PRISCILLA K. COE, Oregon Department of Fish and Wildlife, 1401 Gekeler Lane, La Grande, OR 97850 USA

RYAN M. NIELSON, WEST, Environmental & Statistical Consultants, 415 W 17th, Ste. 200, Cheyenne, WY 82001 USA

DEWAINE H. JACKSON, Oregon Department of Fish and Wildlife, 4192 North Umpqua Hwy, Roseburg, OR 97470, USA

JACQUELINE B. CUPPLES, Oregon Department of Fish and Wildlife, 1401 Gekeler Lane, La Grande, OR, 97850, USA

NIGEL E. SEIDEL, Oregon Department of Fish and Wildlife, 1401 Gekeler Lane, La Grande, OR. 11. 97850, USA

Abstract: We simultaneously documented mule deer (*Odocoileus hemionus*) migration corridors and mule deer-vehicle collisions (DVCs) in south central Oregon over 6 years. We calculated Brownian Bridge Movement Models for 359 migrating mule deer equipped with Global Positioning System (GPS) technology. We modeled DVC counts as functions of probability of use during migration, annual average daily traffic (AADT), and habitat characteristics. Probability of use during migration was the strongest predictor of where DVCs occurred (r = 0.93). Predicted DVCs also increased with AADT but peaked at about ~8000 and then decreased. Where AADT was above ~8,000, fewer deer attempted to cross the highway and DVCs decreased because over time, deer either abandoned the migration route or were killed trying to cross this busy highway. Our results suggest that managers should focus on migration corridors or high density DVC locations to identify where fencing and under/over-passes could be most effective for maintaining migratory corridors when confronting increasing traffic and development that bisect seasonal ranges of mule deer.

Presenter and email: Priscilla Coe; Priscilla.k.coe@state.or.us

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BEHAVIORAL FLEXIBILITY IN MIGRATORY BEHAVIOR IN A LONG-LIVED LARGE HERBIVORE

SCOTT L. EGGEMAN, Wildlife Biology Program, Department of Ecosystem and Conservation Science, College of Forestry and Conservation, University of Montana, Missoula, MT USA

MARK HEBBLEWHITE, Wildlife Biology Program, Department of Ecosystem and Conservation Science, College of Forestry and Conservation, University of Montana, Missoula, MT USA

HOLGER SPAEDTKE, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

EVELYN H. MERRILL, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

Abstract: Migratory large herbivores are predicted to enhance lifetime fitness through higher quality forage and reduced predation risk compared to non-migratory conspecifics. While the overall understanding of population-level migratory behavior is generally understood; few studies have tested individual-level flexibility in ungulates using long-term monitoring of marked individuals. We tested variability of individual migratory behavior using a ten-year telemetry dataset of 223 adult female elk (*Cervus elaphus*) in the declining partially migratory Ya Ha Tinda population in Alberta, Canada. We then used generalized binomial mixed-models to test how extrinsic (climate) and intrinsic (elk density, age) factors affected both the proportion of migrants in the population, and, the decision to switch between migratory strategies. Individuals switched between migrant and resident strategies at a mean rate of 15%/year. The probability of an elk migrating increased with dry summers and winter severity preceding migration, and increased at higher elk abundances and with increasing age. At an individual level, we found evidence that switching was density-dependent, and migrants switched more at lower elk abundance, whereas residents switched more at higher abundance. Migrant elk did not switch in response to previous summer precipitation, but residents did show a slightly higher probability of switching following wet summers. Older migrant elk however rarely switched, whereas resident elk switched more frequently at older ages. Our results show migratory behavior in ungulates is an individually variable trait that can respond to environmental and density-dependent forces. Given previous support for similar demography between migrant and resident elk in our population, this suggests individual elk are able to balance demographic fitness via migratory flexibility, providing the mechanism for the maintenance of partial migration in this, and other, populations.

Presenter and email: Scott Eggeman; seggeman@mt.gov

HABITAT QUALITY INFLUENCES MIGRATORY STRATEGY OF FEMALE WHITE-TAILED DEER

CHARLES R. HENDERSON JR., Montana Cooperative Wildlife Research Unit, University of Montana Missoula, MT 59812 USA

MICHAEL S. MITCHELL, U.S. Geological Survey, Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, MT 59812 USA

WOODROW L. MYERS, Washington Department of Fish and Wildlife, Spokane Valley, WA 99216 USA

PAUL M. LUKACS, Wildlife Biology Program, University of Montana, Missoula, MT 59812 USA

GERALD P. NELSON, Washington Department of Fish and Wildlife, Olympia, WA 98501 USA

Abstract: Partial migration is a life history strategy that is common for ungulate species living in seasonal environments. One factor that influences the decision to migrate by ungulates is access to high quality habitat. We evaluated the influence of access to winter habitat of high quality on the probability of an individual migrating, seasonal habitat use between and within migratory and resident classes of deer, and the effects of this decision on the survival of female white-tailed deer. We radio-collared 67 female white-tailed deer (*Odocoileus virginianus*) in 2012 and 2013. The odds of being a migrant increased as home range size increased and decreased as proportion

of cropland within home range in winter increased. The habitat with the highest relative probability of use in winter for residents was pasture (1.00, SD = 0.01) and for migrants was riparian (0.73, SD = 0.39). In summer both groups had the highest relative probability of using pasture (resident = 0.96, SD = 0.15; migrant = 0.99, SD = 0.08). We integrated the migration probability and survival models to estimate annual and seasonal survival rates of migrants and residents. We found no difference between the annual and seasonal rates of survival for the different migration strategies. Our results indicate that access to habitat of high quality may be a strong influence on a female white-tailed deer's decision to migrate. We suggest the presence of partial migration in a population may be a response to competition for high quality habitat.

Presenter and email: Charles Henderson; charles1.henderson@umontana.edu

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MULE DEER MIGRATION CORRIDORS: EFFECTS OF HUMAN DISTURBANCE ON BEHAVIOR AND POPULATION DYNAMICS

CODY SCHROEDER, Nevada Department of Wildlife, 1100 Valley Rd, Reno, NV 89512 USA

MARCUS BLUM, University of Nevada, Reno; 1664 N. Virginia St, MS 186, Reno, NV, 89557 USA

CALEB MCADOO, Nevada Department of Wildlife, 60 Youth Center Road, Elko, Nevada 89801 USA

KELLEY STEWART, University of Nevada, Reno: 1664 N. Virginia St, MS 186, Reno, NV, 89557 USA

Abstract: Many large ungulates, including mule deer, are faced with difficult challenges with respect to intact and healthy habitats. Migration corridors that connect seasonal ranges have been impacted by roads, fences, human developments and other human disturbances. The effects of these impacts have been well studied in some systems; however, few have quantified the population level responses from potential impacts. We present an overview of the issues regarding human impacts to mule deer migration corridors in Nevada. Specifically, we will present a summary of potential impacts to migration corridors by urban development, road impacts, and mining developments. We compared three different study areas with varying degree of impacts to assess the potential for impacts on adult survival of mule deer. In general, landscape variables, precipitation, and body condition were explanatory variables in known-fate survival estimates across regions. The population level inferences of these survival estimates are discussed in the context of mule deer management and habitat considerations.

Presenter and email: Cody Schroeder; cschroeder@ndow.org

ABSTRACTS, CONTRIBUTED PAPERS: MONITORING

USE OF VAGINAL IMPLANT TRANSMITTERS IN DETERMINATION OF ELK CALF BIRTH SITES AND AGE AT CAPTURE

JODI BERG, Department of Biological Sciences, University of Alberta, Edmonton, AB T6G 2E9 Canada

JODY REIMER, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

EVELYN MERRILL, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

MARK HEBBLEWHITE, Wildlife Biology Program, Department of Ecosystem and Conservation Science, College of Forestry and Conservation, University of Montana, Missoula, MT USA

Abstract: Annual variation in ungulate population growth rates is driven by low, variable juvenile survival, in comparison to relatively high, constant adult survival. Accurate information on date of birth of juvenile ungulates is critical to understanding age-dependent patterns of survival and cause-specific mortality, and variability in estimates of age-at-capture arising from inconsistent or untested aging methods can affect estimates of survival. To age elk calves upon capture, most studies rely on a paper by D. E. Johnson, written in 1951, which allows calves to be assigned to an age class by comparing body measurements (new-hoof growth, incisor eruption, hind leg length) to measurements Johnson obtained from calves caught in the field. However, Johnson did not know precise time of birth for the calves captured, and to our knowledge, these measurements have not been strictly tested. We compare calf ages assigned using Johnson's classification with known ages through use of precise event timers (PETs) on vaginal implant transmitters (VITs). We then illustrate a novel method that uses GPS locations of cow elk to identify birth sites of elk calves through a clustering analysis, tested with birth sites located through VITs. Our results can be applied to past and current data on other elk studies, particularly when objectives include estimates of calf survival or parturition site selection.

Presenter and email: Jodi Berg; jberg@ualberta.ca

WHITE-TAILED DEER OCCUPANCY DYNAMICS AND HABITAT SELECTION IN ALBERTA'S BOREAL FOREST

JASON T FISHER, Alberta Innovates - Technology Futures, Bag 4000 Vegreville, AB, T9C 1T4, Canada

COLE BURTON, Alberta Innovates - Technology Futures, Bag 4000 Vegreville, AB, T9C 1T4, Canada

MICHELLE HILTZ, Alberta Innovates - Technology Futures, Bag 4000 Vegreville, AB, T9C 1T4, Canada

LUKE NOLAN, Alberta Innovates - Technology Futures, Bag 4000 Vegreville, AB, T9C 1T4, Canada

LAURENCE D. ROY, Alberta Innovates - Technology Futures, Bag 4000 Vegreville, AB, T9C 1T4, Canada

Abstract: White-tailed deer are increasing in numbers and range in Alberta's northeast boreal forest, changing predator-prey dynamics in the region. Previous modelling suggested climate change is influencing expansion, but to date there has been limited empirical data on the relative roles of severe winters and landscape disturbance on deer distribution dynamics. We are using a combination of satellite collars and remote cameras to estimate deer density, and test hypotheses about factors affecting distribution. We hypothesized (1) deer occupancy remains annually

stable, despite winter declines; and (2) deer expansion is facilitated by anthropogenic disturbance, which we assess by testing for positive association between deer distribution and industrial footprints. We used camera data and multi-season hierarchical occupancy models to estimate site occupancy, site colonization, and site extinction across the study area over three years. All occupancy parameters varied among seasons. Severe winters had greater negative impact on deer occupancy than did milder winters, but empty sites were quickly recolonized in spring. We used generalised linear models in an information-theoretic approach to test hypotheses about deer occurrence and landscape features. A combination of upland deciduous cover and the amount of anthropogenic disturbance in the landscape explained white-tailed deer distribution over the three years. Our research suggests white-tailed deer persist in the Alberta boreal forest - despite annual fluctuations induced by winter conditions. Landscape disturbance plays a significant role, potentially requiring habitat management as well as population management to minimize the effects of deer expansion on other species, such as woodland caribou.

Presenter and email: Jason Fisher; jason.fisher@albertainnovates.ca

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THE USE OF DISTANCE SAMPLING FOR DEER AND ELK SURVEYS WITH EXAMPLES FROM NORTHERN ALBERTA

MIKE RUSSELL ESRD Provincial Building, Main Floor 10320 - 99 Street Grande Prairie, AB, T8V 6J4, Canada

HANNAH MCKENZIE ESRD Great West Life Building, Second Floor 9920 - 108 Street Edmonton, AB, T5K 2M4, Canada

CURTIS STAMBAUGH ESRD Provincial Building, Main Floor 5020 - 52 Avenue Whitecourt, AB, T7S 1N2, Canada

Abstract: Obtaining reliable and precise estimates of population abundance is one of the most important, but also challenging, components of wildlife management. There are a variety of survey methods available to estimate abundance. In this talk we review the distance sampling method, with a focus on the challenges of applying it to deer and elk. Two common characteristics of deer and elk are patchy distribution of animals and large variability in group size. These factors often lead to abundance estimates with low precision. We highlight possible design and analysis strategies which can assist in reducing variability in abundance estimates. We will show examples of how we have used these strategies in distance surveys of deer and elk in northern Alberta, and share our current ideas about using distance sampling for these species moving forward.

Presenter and email: Nils Anderson; hannah.mckenzie@gov.ab.ca

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A SYSTEM FOR REMOTELY MONITORING VAGINAL IMPLANT TRANSMITTERS AND FAWN SURVIVAL

CLIFFORD G. RICE, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501, USA

Abstract: Vaginal implant transmitters (VITs) are commonly used to determine the time of birth for ungulates to enable the capture and marking of their offspring. However, the use of VITs

requires frequent monitoring and hence, high manpower and/or aviation costs. Similarly, offspring equipped with traditional telemetry necessitate large efforts for effective monitoring. The alternative described here uses communication between the VIT or offspring's transmitter and the parent's collar to monitor the status of the VIT or offspring's transmitter (Vectronic Aerospace, Berlin, Germany). The parent's collar uses its satellite communication capabilities to forward this information to the investigator when appropriate. I describe the development and successful deployment of this system in a study of black-tailed deer (*Odocoileus hemionus columbianus*).

Presenter and email: Clifford Rice; cliff.rice@dfw.wa.gov

ABSTRACTS OF CONTRIBUTED PAPERS: POPULATION

ELK CALF SURVIVAL AND ELK POPULATION DYNAMICS IN THE SOUTHERN BITTERROOT VALLEY

DANIEL EACKER, Wildlife Biology Program, University of Montana, Missoula, MT 59812 USA

KELLY PROFFITT, Montana Fish, Wildlife, and Parks, Region 3 Headquarters, Bozeman, MT 59718 USA

MARK HEBBLEWHITE, Wildlife Biology Program, University of Montana, Missoula, MT 59812 USA

BEN JIMENEZ, Montana Fish, Wildlife, and Parks, Region 2 Headquarters, Missoula, MT 59804 USA

JUSTIN GUDE, Montana Fish, Wildlife, and Parks, FWP Headquarters, Helena, MT 59620 USA

MIKE THOMPSON, Montana Fish, Wildlife, and Parks, Region 2 Headquarters, Missoula, MT 59804 USA

Abstract: In response to declining elk calf recruitment in the southern Bitterroot Valley of Montana, we initiated a 3-year study to determine the importance of bottom-up and top-down factors for elk calf survival and elk population dynamics. We monitored the survival of 286 elk calves during 2011-2014 in order to estimate cause-specific mortality and calf survival to age 1.We used continuous-time survival modeling to evaluate the effect of risk covariates and estimate calf survival and cause-specific mortality rates. Annual elk calf survival was 0.32 in 2011, 0.43 in 2012, and 0.45 in 2013. We found that mountain lions (20%) were the most important mortality source for elk calves, followed by unknown causes (17%), unknown predation (9%), bear predation (5%), natural, non-predation (4%), wolf predation (3%), and human-related mortality (1%). Male elk calves were at 63% higher risk of mortality than females ($P = 0.01$), and elk calves in the West Fork area were at 42% higher risk of mortality compared to the East Fork ($P = 0.07$) during their first year. Also, we detected a significant positive effect of estimated birth date on summer mortality risk for elk calves ($P = 0.07$). We will use integrated population modeling to combine elk calf and adult female survival, nutrition, and carnivore population data, allowing us to forecast the effect of habitat and carnivore densities on elk

population trends. These tools may help managers balance carnivore and ungulate population objectives and is applicable to all areas experiencing carnivore recovery.

Presenter and email: Daniel Eaker; daneacker@hotmail.com

ECOLOGICAL DRIVERS OF ELK SURVIVAL IN IDAHO

JON S HORNE, Idaho Department of Fish and Game, Lewiston, ID 83501 USA

SCOTT BERGEN, Idaho Department of Fish and Game, Pocatello, ID 83204 USA

MARK HURLEY, Idaho Department of Fish and Game, Boise, ID 83712 USA

PETE ZAGER, Idaho Department of Fish and Game, Lewiston, ID 83501 USA

Abstract: In 2008, Idaho Fish and Game focused research in two study areas to evaluate wolf predation on elk populations. Ultimately, the goal of this research was to develop a predictive model that could be used broadly across elk range to estimate non-human caused mortality rates as a function of elk and wolf distribution and abundance, habitat conditions, and weather. A total of 185 adult (68 bulls and 117 cows) and 157 calves (~6 months old) were captured and fitted with GPS radio-collars from the winter of 2008 – winter 2014. Non-human caused mortality rates were highest during the winter months (February 1 – May 1) and timing of mortality risk was similar between study areas. In general, adult annual survival rates were similar between study areas (mean = ~0.85), however, calf survival rates from January – May were highly variable spatially and temporally ranging 0.03 – 0.88. For adult elk, covariates related to age, snow depth and wolf presence best predicted winter survival. For calves, body size, snow depth, and wolf harvest best predicted survival. Due to strong correlations among predictor variables, we were unable to distinguish between the effects of important drivers of elk survival (i.e., wolf presence versus snow conditions). Accordingly, we offer suggestions for future research to help disentangle these important processes.

Presenter and email: Jon Horne; jon.horne@idfg.idaho.gov

GENERALITY AND PRECISION OF REGIONAL SCALE SURVIVAL MODELS FOR MULE DEER FAWNS

MARK A. HURLEY, Idaho Department of Fish and Game, 600 S. Walnut St., Boise, ID 83712 USA

MARK HEBBLEWHITE, Wildlife Biology Program, College of Forestry and Conservation, University of Montana, Missoula, MT 59812 USA

PAUL LUKACS, Wildlife Biology Program, College of Forestry and Conservation, University of Montana, Missoula, MT 59812, USA

CHRISTOPHE BONENFANT, Laboratoire Biometrie & Biologie Evolution, CNRS-UMR-5558, University C. Bernard - Lyon I Villeurbanne, France

SCOTT BERGEN, Idaho Department of Fish and Game, 1345 Barton Road, Pocatello, ID 83204 USA

Abstract: Survival of fawns during winter is one of the most important components of mule deer population dynamics, but this vital rate is highly variable and difficult to estimate with traditional

survey methods. Wildlife managers require this important vital rate to estimate population dynamics for harvest management. Unfortunately, estimation of survival with marked animals is expensive and inference to other population is limited due to varying winter weather and summer nutritional quality. Our objective was to predict winter survival of mule deer fawns across large gradients in weather and predation regimes across southern and central Idaho. We modeled survival of 3025 fawns within 11 Population Management Units in southern Idaho, 2001-2013. We used remote sensed and modeled measures of summer plant productivity (NDVI) and winter snow conditions (MODIS Snow and SNODAS) to eliminate some of the bias associated with standard surrogates, such as precipitation and temperature. A functional analysis was then used to characterize the plant phenology and primary production along the growing season. We used the first two principal component scores (of the NDVI curves) which accounted for 74% of the variance, providing to provide numerical scores of annual fall (post NDVI peak) and spring plant growth. We used Bayesian hierarchical models to estimate survival, including covariates at the appropriate spatial and temporal resolution for each level: individual, capture site, Population Management Unit, and ecotype scales. We evaluated the predictive capacity of models and within an integrated population model and with out-of-sample validation procedures. Finally, we evaluated the generality vs. precision tradeoff across ecotype and spatial scales to understand the extent models may be applied to different landscapes with varied predator complexes, climate, and plant nutrition.

Presenter and email: Mark Hurley; mark.hurley@idfg.idaho.gov

POTENTIAL EFFECTS OF NATURAL GAS DEVELOPMENT ON NEONATAL MULE DEER SURVIVAL

MARK E. PETERSON, Colorado State University, Department of Fish, Wildlife, and Conservation Biology, 1474 Campus Delivery, Fort Collins, CO 80523 USA

CHARLES R. ANDERSON, JR., Colorado Parks and Wildlife, Mammals Research Section, 317 W. Prospect Road, Fort Collins, CO 80526 USA

PAUL F. DOHERTY, JR., Colorado State University, Department of Fish, Wildlife, and Conservation Biology, 1474 Campus Delivery, Fort Collins, CO 80523 USA

Abstract: Extensive natural gas development on public lands has elevated concern among stakeholders, wildlife managers, and researchers about the impacts on mule deer (*Odocoileus hemionus*) populations and their habitat. Understanding neonatal mule deer survival and cause-specific mortality is helpful to comprehend mule deer population dynamics, especially where natural gas development disturbances are occurring. The intensity of disturbance from development may be directly negatively correlated with neonate survival, or indirectly correlated through changes to habitat. However, no published studies have quantified the effects of natural gas development disturbances and consequent habitat conversion on neonatal mule deer survival and cause-specific mortality. Estimates of survival and cause-specific mortality were derived from a sample of neonates captured and radio-collared in 2012, 2013, and 2014 using vaginal implant transmitters inserted in adult females. Estimates of survival and cause-specific mortality were determined in energy developed and undeveloped areas in the Piceance Basin, Meeker, CO. In 2012, 2013, and 2014 survival estimates in the developed area were 0.35 (SE = 0.06), 0.29 (SE = 0.08), and 0.60 (SE = 0.07), respectively. In 2012, 2013, and 2014 survival estimates in the undeveloped area were 0.50 (SE = 0.10), 0.45 (SE = 0.08), and 0.67 (SE = 0.19),

respectively. In 2012 - 2014, predation was the leading cause of mortality and accounted for 0.43 (SD = 0.14) of mortalities in the developed area and 0.37 (SD = 0.16) in the undeveloped area. Overall, our goal IS to provide results promoting improved energy development mitigation and wildlife management practices.

Presenter and email: Mark Peterson; mark.peterson313@gmail.com

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SURVIVAL, SPACE USE, AND SITE FIDELITY OF TRANSLOCATED MULE DEER

DAVID C. SMEDLEY, Department of Plant and Wildlife Sciences, Brigham Young University, 4105 LSB, Provo, UT 84606 USA

RANDY T. LARSEN, Department of Plant and Wildlife Sciences, Brigham Young University, 4105 LSB, Provo, UT 84606 USA

KENT R. HERSEY, Utah Division of Wildlife Resources, 1594 W North Temple, Suite 2110, Salt Lake City, UT 84114 USA

JUSTIN M. SHANNON, Utah Division of Wildlife Resources, 1594 W North Temple, Suite 2110, Salt Lake City, UT 84114 USA

BROCK R. MCMILLAN, Department of Plant and Wildlife Sciences, Brigham Young University, 4105 LSB, Provo, UT 84606 USA

Abstract: Translocation of wildlife is common practice for a variety of big game species. Mule deer (*Odocoileus hemionus*) are a species of great interest in western North America and translocation has been used, although infrequently, to manage some populations. Little is known, however, about the response of mule deer to translocation. Our objectives were to 1) compare survival between translocated and resident mule deer, 2) evaluate the influence of release timing (early vs late winter) on survival and space use, and 3) estimate the home range size, movements, and site fidelity of translocated mule deer. We monitored 197 mule deer that were translocated from southern to central Utah (approximately 145 kilometers) during 2013-2014 and 70 resident deer as a reference. Annual survival was greater for resident deer (0.86; 95% CI = 0.75 – 0.93) than translocated animals (January release 0.53; 95% CI = 0.40 – 0.65, March release 0.48; 95% CI = 0.35 – 0.62) in 2013. Estimates of annual survival for deer translocated in 2014, however, showed more variation (range 0.58 - 0.76), and was comparable to residents (0.76; 95% CI = 0.65 – 0.87) for deer released in January. Translocated animals in their second year post release demonstrated higher survival (0.83; 95% CI = 0.73 – 0.94) that was not different from resident deer (2014 estimate 0.76; 95% CI = 0.65 – 0.87). Translocated deer had larger annual home range sizes (primarily due to summer movements) than resident deer (56 km2) during year one and year two ($p < .05$), but average size decreased from 516 km2 in year one to 344 km2 in year two. Almost all (95%) surviving translocated deer returned to the release sites during the subsequent winter following release. Given high fidelity to release locations, translocation of mule deer could help establish use of currently underutilized winter ranges.

Presenter and email: David Smedley; davidsmedley28@yahoo.com

ABSTRACTS OF CONTRIBUTED PAPERS: HABITAT

ARE THERE GREEN WAVES IN IDAHO? HABITAT TYPE, VEGETATION CONDITION, WINTER SEVERITY AND PREDATION COVARIATES AND THERE INFLUENCE ON SEASONAL AND INTER-ANNUAL RANGE SELECTION.

SCOTT BERGEN, Idaho Department of Fish and Game, 1345 Barton Road Pocatello, ID 83204 USA

ANNA MOELLER, University of Montana, Missoula, MT 58912 USA

JON HORNE, Idaho Department of Fish and Game, 3316 16th Street Lewiston, ID 83501 USA

MARK HURLEY, Idaho Department of Fish and Game, 600 s. Walnut Street Boise, ID 83707 USA

Abstract: Elk have long been recognized as ungulate species that seasonally migrate in south central Idaho. We analyze movement patterns of 175 elk fitted with GPS collars in the South Fork of the Payette River Valley from 2008 – 2013. Seasonal, annual, and inter-annual movement patterns were quantified using the net-squared displacement metric (NSD) as an unbiased means of identifying the timing and extent of these movements (Bunnefeld et al. 2011). From the NSD analysis, we report on the proportion of the population that exhibited non migratory home-range, seasonal migration, mixed migration, dispersal, and nomadism spatial movement behaviors as well as the timing and synchronicity of these movements. Results from the NSD analysis were then applied to spatiotemporally explicit analysis that identified seasonal migration corridors and seven other 'extra-regional' dispersal paths to other winter ranges. Elk that dispersed to novel winter ranges were evaluated to quantify the differences in the environmental covariates of habitat type, vegetation-forage production, winter severity, and predation pressure that were encountered between their natal and new winter ranges. We find that there are some dispersal movements that appear to be consistent with the Green Wave hypothesis where individuals found better forage and less predation pressure associated with agricultural subsidy but there are also a greater variety of dispersal events that are not consistent with this developing paradigm. The variety movement patterns are likely occurring at local to region scales, which means that their application to resource management beyond the study area need to be evaluated with caution since larger scale extra-regional movements are not apparent in sister studies occurring in other regions in Idaho.

Presenter and email: Scott Bergen; scott.bergen@idfg.idaho.gov

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FEEDING VS. FLEEING: THE FORAGING COST OF WOLF PREDATION RISK FOR DEER

APRYLE D. CRAIG University of Washington Winkenwerder 110 4000 15th Avenue NE Seattle, WA 98195-2100 USA

AARON J. WIRSING University of Washington Box 352100 Seattle, WA 98195 USA

Abstract: In weighing foraging options, animals tradeoff food and safety. This tradeoff can be explored using giving up density (GUD), or the amount of food remaining in a depletable patch at the end of a foraging bout, with higher GUDs indicating a greater perceived predation risk. In

northeast Washington, deer may be trading off food and safety due to increased risk of predation from naturally recolonizing gray wolves. To test this hypothesis, I will use feeding trays to quantify and contrast GUDs of mule and white-tailed deer in wolf-impacted and wolf-free areas. I will present the results of my first field season (February-March 2015), which will give insight into the effects of predation risk on deer behavior and ecosystem dynamics. Increased wolf predation risk, for example, could drive changes in deer habitat use and plant communities as a result of vegetation released from grazing pressure in high risk areas.

Presenter and email: Apryle Craig; apryle@uw.edu

MULE DEER USE OF JUNIPER HABITATS DURING WINTER IN SOUTH-CENTRAL OREGON

SARA GREGORY, Oregon Department of Fish and Wildlife, 1401 Gekeler Lane La Grande, OR 11. 97850 USA

BRUCE JOHNSON, Oregon Department of Fish and Wildlife, 1401 Gekeler Lane, La Grande, OR. 11. 97850 USA

PRISCILLA COE, Oregon Department of Fish and Wildlife, 1401 Gekeler Lane, La Grande, OR. 11. 97850 USA

RYAN NIELSON, WEST, Environmental & Statistical Consultants, 415 W 17th, Ste. 200, Cheyenne, WY 82001 USA

DEWAINE JACKSON, Oregon Department of Fish and Wildlife, 4192 North Umpqua Hwy, Roseburg, OR 97470 USA

Abstract: Throughout the western United States, managers of sagebrush ecosystems have increased the removal of encroaching juniper with the intention of improving grass and forb production and habitat for sage grouse (*Centrocercus urophasianus*) and other sagebrush obligate species. These management practices frequently occur in areas that are important for wintering mule deer (*Odocoileus hemionus*). We calculated resource selection functions for mule deer to investigate the effects of vegetation, topographic, abiotic, and human disturbance characteristics during 8 winters in south-central Oregon. We estimated probability of use with locations collected from 418 deer fitted with Global Positioning System (GPS) collars (n = 241,268 locations). During January 1 – March 31, deer use encompassed 9 localized winter ranges (minimum convex polygons) totaling 839,000 ha. Across these winter ranges, proportion of juniper was an important covariate in all top models, with deer strongly preferring areas where the juniper/sagebrush ratio was approximately even. We further investigated the relationships between environmental predictors of juniper and mule deer resource selection.

Presenter and email: Sara Gregory; sara.c.gregory@state.or.us

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BOTTOM-UP HABITAT CHANGES AND EFFECTS ON ELK NUTRITION IN THE BITTERROOT VALLEY, MONTANA

KELLY M. PROFFITT, Montana Fish, Wildlife and Parks, 1400 South 19th Street, Bozeman, MT 59718 USA

MARK HEBBLEWHITE, Wildlife Biology Program, University of Montana, Missoula, MT 59812 USA

DAN EACKER, Wildlife Biology Program, University of Montana, Missoula, MT 59812 USA

Abstract: In the Bitterroot valley of western Montana, declines in elk numbers and recruitment has occurred at the same time as wolf recovery leading casual observers to conclude that wolf predation is the leading cause of elk declines. This top-down interpretation ignores the many complex causative factors that drive ungulate population dynamics, including winter severity, other predators, human harvest, and habitat changes. Many areas in western Montana have undergone significant habitat changes in the last several decades, for example in declining forestry, changes in fire, and increasing forest succession and shrub encroachment. What is unknown in the recent controversies about elk declines is the effect that these habitat changes have had on elk populations. As part of a 3-year intensive elk study in the Bitterroot Valley, we investigated both top-down effects of predation and bottom-up effects of habitat on elk populations. Here, we evaluate the bottom-up effects of habitat on elk in a comparison between two areas of varying habitat quality, the East Fork and West Fork of the Bitterroot. First, we describe methods used to evaluate elk forage biomass, diet and nutrition between the two study areas. We also link these bottom-up effects of habitat and nutrition on elk body condition, pregnancy rate, and potential impacts on population dynamics with integrated population models. We sampled vegetation at 236 sites. We measured body condition and pregnancy of 116 adult female elk. Our results show that habitat quality, from a plant species, biomass, and quality perspective was lower in the WF than the EF. Poor quality habitat effects were carried through to lower pregnancy rates, body condition of females, and, ultimately, population dynamics. Despite the importance of predation, we show persistent bottom-up influences of habitat that may have population-level impacts on elk population dynamics in some systems.

Presenter and email: Kelly Proffitt; kproffitt@mt.gov

ORDERS OF HABITAT SELECTION BY ELK ON DISTURBED HETEROGENEOUS LANDSCAPES

CHRISTINA M. PROKOPENKO, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

MARK S. BOYCE, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

Abstract: Road networks are a pervasive form of human use that has a strong, and often negative, influence on wildlife. The response by prey to human disturbance often is comparable to that of natural predators and perceived predation risk. Animals can shift their distribution on the landscape away from the disturbance, change habitat use patterns to avoid these areas, or change their behaviour when close to roads. Elk are energy limited and movement is restricted by snow in the winter; vehicle disturbance may place an additional constraint on elk during this time. Our study area in southwestern Alberta is composed primarily of private land, public Crown land, and Waterton Lakes National Park. Types of human use include agriculture, recreational activities, and natural gas extraction. In this area there regulations have been set to minimize disturbance associated with vehicle and industrial development on elk winter range. GPS relocation data from 170 elk collected from 2007 to 2013 have been used to study winter range selection by individuals at multiple orders. We have evidence of road avoidance at the herd

level, but the temporal and spatial variability in the area necessitates a more complex approach. For each individual elk, we will explain detailed patterns of second- and third-order selection for characteristics of winter range areas. Findings from this research can inform management decisions and allow us to conserve elk current winter range habitats, which will help to maintain a viable elk population on Alberta's rapidly changing landscapes.

Presenter and email: Christina Prokopenko; prokopen@ualberta.ca

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VARIED TASTES: HOME RANGE IMPLICATIONS OF FORAGING-PATCH SELECTION

DANA P. SEIDEL, Department of Environmental Science and Management, University of California, Berkeley, Berkeley, CA, 94720 USA

MARK S. BOYCE, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

Abstract: Mechanistic home-range models offer potential to explore animal space use beyond traditional home-range estimators. Van Moorter et al.'s (2009) model of home-range development for a generic forager shows promise for understanding the home ranges of elk and other large-bodied ungulates. Using data from two populations of elk, we explore the empirical support for two of the underlying assumptions of the model. Using GPS relocation data, we identified and sampled foraging patches used by elk. Points along elk paths not used for foraging were sampled identically for comparison. We contrasted "patch" and "nonpatch" data points, to identify foraging selection differences across herd, sex, and season using a combination of directly sampled and remotely sensed covariates. Generally elk selected patches with higher biomass, cover, slope, and lower traffic on the nearest road. Our patch-selection results speak directly to differences between foraging areas and other areas used by elk and display that both physiographic and anthropocentric features influence these choices. Our results provide empirical support for two of the primary assumptions behind Van Moorter et al.'s (2009) home-range model and offer insight as to what defines a valuable foraging patch and how these patches might influence the development and structure of home ranges in a free-ranging ungulate.

Presenter and email: Dana Seidel; dana.seidel@gmail.com

EFFECTS OF SUCCESSION AND FORAGE PLANTINGS ON NUTRITIONAL CARRYING CAPACITY AND HABITAT

LISA A. SHIPLEY, School of the Environment, Washington State University, Pullman, WA 99164-2812 USA

KATIE WAT, School of the Environment, Washington State University, Pullman, WA 99164-2812 USA

ELVIA LÒPEZ-PÈREZ, Departamento de Zootecnia, Universidad Autónoma Chapingo,Chapingo, C.P. 56230 México USA

Abstract: Low productivity in Roosevelt elk (*Cervus elaphus roosevelti*) populations on the Olympic Peninsula has been linked to low forage quality and loss of forage resources. Northwestern forests have experienced intensive timber management, recreation, and farming activities that may influence the quality and quantity of available forage. As a response,

managers have attempted to increase the quality and quantity of forage through managing succession and planting forage fields. We compared the diet composition and relative nutritional carrying capacities (NCC) for Roosevelt elk among forest successional stages, habitat types, and planted forage fields across the seasons. In addition, we examined whether female elk responded to nutritional carrying capacity of forest stands when selecting habitat. We measured forage biomass across seasons by clipping, drying and weighing understory vegetation on plots within conifer forest stands ranging in successional stage, riparian areas, and planted forage fields. We determined the digestible energy and protein of major forages, calculated NCC from the Fresh-Deer model, and determined seasonal diet composition from plant fragments in feces. Finally, we created Resource Selection Function models from radiolocations of 30 female elk over 2 years. We found that NCC was highest in conifer stands 4-15 years old, planted forage fields, and riparian areas. Within their fall-spring home ranges, female elk selected habitats with higher NCC, closer to forage/forest edges, and with lower slopes. Our results suggest that stands providing abundant, high-quality forages, whether in early successional forests, riparian areas or planted forage fields, are beneficial to Roosevelt elk.

Presenter and email: Lisa Shipley; shipley@wsu.edu

ECOLOGY OF ADULT FEMALE ROCKY MOUNTAIN MULE DEER FOLLOWING HABITAT ENHANCEMENTS IN NORTH-CENTRAL NEW MEXICO

GRANT E. SORENSEN, Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 USA

PHILIP S. GIPSON, Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 USA

MARK C. WALLACE, Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 USA

ROBERT D. COX, Department of Natural Resources Management, Texas Tech University, Lubbock, TX 79409 USA

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

Abstract: Rocky Mountain mule deer (*Odocoileus hemionus hemionus*) population declines in their southeastern distribution, in particular north-central New Mexico, have been attributed to malnourishment. Deer survival and performance was suggested to be limited by poor body condition due to low-quality diet resulting from degraded habitats. To test the hypothesis of malnutrition, we monitored 48 adult female mule deer and quality of key browse species from 2011 to 2013 after habitat enhancements were initiated. Habitat treatments included hydro-axing and mulching of pinyon-juniper (*Pinus edulis* – Juniperus spp.) and old-growth brush (*Quercus gambelii* - *Cercocarpus montanus*) with the goal of establishing high quality browse. Mulching increased the crude protein content of brush over non-mulched brush two years post-mulch, but this effect was not detected after 2.5 years. There was a strong selection for treated brush across all seasons and years. In no case, did deer that selected for treated brush have diets with greater fecal nitrogen. Adult female mule deer study period survival was 0.88 (SE=0.027). Survival was only minimally explained by selection for treated brush (β = 6.4E-06). Predation accounted for

81% of known mortalities (22/27) with mountain lion (*Felis concolor*) predation accounting for 60% of mortalities (16/27). Femur marrow fat levels indicated that only one individual was in poor condition (<12%) at time of death. Reproductive performance was high with 96% pregnancy rate and 88% twinning rate. Despite persistent drought conditions, adult female mule deer survival was high and similar to other estimates found in the region. Mulching did not improve deer diet quality. There was minimal evidence in our study to suggest that adult female mule deer populations were limited by malnutrition. High nutrient availability, femur marrow fat levels, and cause-specific mortality results point to a stronger role of predation over nutrition in limiting mule deer populations in north-central New Mexico.

Presenter and email: Grant Sorensen; grant.sorensen@ttu.edu

A COMPARATIVE ANALYSIS OF ELK HABITAT SELECTION AND USE AT MOUNT ST. HELENS

SHANTEL N. SPARKES, Department of Biological Sciences, University of Alberta, AB, T6G 2E9, Canada

EVELYN H. MERRILL, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

ANDREW B. GEARY, Department of Biological Sciences, University of Alberta, Edmonton, AB, T6G 2E9, Canada

SCOTT M. MCCORQUODALE, Washington Dept Fish & Wildlife, 1701 South 24th Ave, Yakima, WA 98942 USA

MARY M. ROWLAND, U. S. Forest Service, Forestry & Range Sciences Lab, 1401 Gekeler Lane, La Grande, OR 97850 USA

Abstract: Developing habitat relationships for assessing impacts of forest management on elk populations have a long history. Two recent statistical approaches using elk telemetry data have gained popularity are resource selection probability functions (RSPF) and resource utilization functions (RUF). The RUF predicts the probability of use of a land unit whereas the RSPF predicts the probability of selection given its encounter. The US Forest Service is using the Westside Elk Habitat Model (WEHM) based on an RUF approach that was developed using elk telemetry data from many populations across the region and covariates of human disturbance, physiographic attributes, forage quality, and vegetation types. To assess how the 2 statistical approaches compare, we used the same telemetry data from 23 GPS-collared elk at Mount St. Helens, WA for the period of 2009-2011 and the same covariates as used in WEHM to derive RUFs and RSPFs for the same study area. We compared the model outputs of the RUF to the RSPF approach based on (1) relative importance of the covariates, (2) correlation of the predicted values of 620-m2 cells, and (3) predictions of the relative probability of use derived from selection and habitat availability to the relative probability of use measured directly. We found probability of use was more sensitive to habitat availability than differences in selection among animals. We discuss how the outputs and whether one approach may be most appropriate under different conditions to aid managers in their application of these models in management.

Presenter and email: Shantel Sparkes; ssparkes@ualberta.ca

EFFECTS OF SILVICULTURAL HERBICIDES ON THE NUTRITIONAL ECOLOGY OF COLUMBIAN BLACK-TAILED DEER

AMY ULAPPA, School of the Environment, Washington State University, Pullman, WA 99164 US

LISA SHIPLEY, School of the Environment, Washington State University, Pullman, WA 99164 USA

RACHEL C. COOK, National Council for Air and Stream Improvement, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

JOHN COOK, National Council for Air and Stream Improvement, Forestry and Range Sciences Laboratory, 1401 Gekeler Lane, La Grande, OR 97850 USA

MARK SWANSON, School of the Environment, Washington State University, Pullman, WA 99164 USA

Abstract: Black-tailed deer (*Odocoileus hemionus columbianus*) and other forest herbivores depend on abundant and nutritious understory vegetation found in open-canopy and young, early-seral forests. Some biologists and managers are concerned that increasing intensity of forestry practices, such as herbicide use, may affect the nutritional ecology of black-tailed deer in forests of the Pacific Northwest. In general, herbicides are applied before planting seedlings to decrease the competition from forbs and shrubs during the first few years. Because early successional forbs and shrubs provide forage for deer, changes in the abundance and composition of these forage species may affect the quality of diets selected by black-tailed deer and their nutrient intake. We compared nutrient intake of black-tailed deer between stands that received herbicide treatments paired with those that did not, and investigated how these responses change as forests age from early seral stages (≥2 years post-harvest) to canopy closure (≤20 years post-harvest). Using hand-raised tractable black-tailed deer, bite count methods and behavioral observations, we measured diet composition, quality and nutrient intake within each paired stand. Additionally, we measured vegetation biomass and overstory characteristics for each stand. In two summers we sampled 28 pairs of pens in treated and untreated stands (2-20 yrs post harvest) with black-tailed deer and 11 pairs with vegetation/overstory sampling only (total: 39 pairs 2-20 yrs). We also sampled 18 mid-seral tree stands (35-90 yrs) as a comparison to early seral stands. We report results comparing sprayed and non-sprayed treatments across age classes including; daily nutrient intake, forage selected, and abundance of selected forages between treatments and among seral stages.

Presenter and email: Amy Ulappa; amy.ulappa@email.wsu.edu

ABSTRACTS OF CONTRIBUTED PAPERS: MANAGEMENT

MITIGATING ELK AND WHITE-TAILED DEER CONFLICTS WITH AGRICULTURE USING A COMBINED SOCIAL-ECOLOGICAL APPROACH

RYAN K. BROOK, College of Agriculture and Bioresources, University of Saskatchewan, Saskatoon, SK, S7J 3X8 Canada

Abstract: Elk and white-tailed deer make extensive use of agricultural landscapes in North America and there is considerable overlap in areas used by the two species. Farmland provides extremely high quality crops that typically greatly exceed the forage values for native vegetation as well forest cover. Many people in these rural landscapes value seeing elk and white-tailed deer and they are an important hunted resource, however they are also associated with significant conflicts and economic costs due to crop damage and disease transmission to livestock. Important failures in managing these issues have often been caused by viewing these problems as simple ecological issues. I present an approach that views the management of these complex agriculture-dominated landscapes as social-ecological systems that incorporate both ecological and social research methods in Manitoba and Saskatchewan. I will specifically examine two associated issues of great socio-economic importance, crop damage and bovine tuberculosis transmission between cattle and cervids. Ecological science is used to characterize movement patterns, resource selection, and seasonal use of agricultural crops and interactions between cervids and livestock. Social science provides critical opportunities to quantify the perceptions of risk, support or opposition to management options, and evaluate the success or failure of management options. These approaches are then integrated into a multi-scale on-farm risk assessment model that can be used to evaluate, prioritize, and evaluate a suite of mitigation options such as hay yard barrier fencing, livestock guardian dogs, hunting, and disease monitoring.

Presenter and email: Ryan Brook; ryan.brook@usask.ca

APPS FOR WILDLIFE MANAGEMENT? HOW CUSTOMIZED SOFTWARE CAN UP YOUR GAME

J. JOSHUA NOWAK, University of Montana, Wildlife Biology Program, Missoula, MT 59801 USA

PAUL M. LUKACS, University of Montana, Wildlife Biology Program, Missoula, MT 59801 USA

JUSTIN GUDE, Montana Fish, Wildlife & Parks, Helena, MT 59620 USA

MARK HURLEY, Idaho Fish & Game, Boise, ID 83712 USA

CHELSEA KRAUSE, South Dakota Department of Game, Fish & Parks, Pierre, SD 57501 USA

ANDY LINDBLOOM, South Dakota Department of Game, Fish & Parks, Fort Pierre, SD 57532 USA

HUGH ROBINSON, Panthera, New York, NY 10018 USA

KEVIN ROBLING, South Dakota Department of Game, Fish & Parks, Rapid City, SD 57702 USA

Abstract: What if the analyses needed to support allocation of deer and elk harvest were as simple as a Google search? Google's approach to searching the internet provides a useful heuristic for merging innovative statistical research with wildlife management. Not unlike an internet search, the technical side of wildlife management requires the synthesis of multiple sources of information, routine accomplishment of key tasks and extraction of useful information from noisy data. Modern statistical procedures can often provide the information managers seek, but the associated complexity is an unwanted annoyance. By leveraging the power of customized software we can automate these procedures and generate reports, essentially giving managers the ability to just 'Google it'. Collaborating with the states of Idaho, Montana, and South Dakota we have developed software solutions that make available a suite of Bayesian Integrated Population Models, demographic models, data exploration tools and report generating algorithms. Model outputs provide a comprehensive representation of the historic and future trajectory of populations. Typical model outputs include estimates of abundance, density, survival, recruitment, population growth rate and mean growth rate, all with associated measures of precision. The models handle missing data, disparate scales of data collection and sparse data. In addition, managers gain the ability to play conditional what if games that evaluate the consequences of management actions before implementation. Not unlike Google's search engine, the software provides an easy-to-use interface that allows users to run models and generate reports with some simple "clicks." The software and underlying statistical machinery aim to provide a unified consideration of all available data in generating relevant estimates of population characteristics while promoting defensible and proactive decision-making. In the short-term, these tools promise more and better information for decision-making, while we expect long-term application to lead to learning and increased efficiency.

Presenter and email: J. Joshua Nowak; joshnwk@yahoo.com

WHITETAIL DEER EXPANSION AND ABUNDANCE: ECOLOGICAL IMPLICATIONS AND MANAGEMENT CONCERNS IN ALBERTA

CURTIS STAMBAUGH, Alberta Environment and Sustainable Resource Development, Resource Management, 5020-52 Ave., Whitecourt, AB, T7S 1N2, Canada

ROB CORRIGAN, Alberta Environment and Sustainable Resource Development, Fish and Wildlife Policy, 9920 – 108 St, Edmonton, AB, T5K 2M4, Canada

ANNE HUBBS, Alberta Environment and Sustainable Resource Development, Resource Management, 4919-51 St., Rocky Mountain House, AB, T4T 1B3, Canada

Abstract: The evidence of expanding Whitetail Deer (*Odocoileus virginianus*) distribution into northern latitudes has become well documented. A combination of climatic factors and landscape changes are two broad variables used to help describe this progression northward. There may still be debate of which has greater influence, however, there is growing consensus on the ecological implications over this shift in species dominance. Today Alberta faces some difficult realities in managing a multi-prey and multi-predator environment. Apparent-competition has been well documented in the numerical response of wolves (*Canis lupus*) and density-independent mortality of woodland caribou (*Rangifer tarandus*), a threatened species in Alberta. Although not empirically tested in Alberta, a numerical response to cougars (*Puma concolor*)

and density-independent mortality of mule deer (*Odocoileus hemionus*) are suspected in certain regions; these same conditions are quite probable of occurring in localized moose (*Alces alces*) and elk (*Cervus elaphus*) populations following high over winter mortality of whitetail deer. Alberta is also the leading edge of the north and westward expansion of Chronic Wasting Disease (CWD). The ever present pulse of whitetail deer increases the risk of transmission and compromises our ability to manage the spread. Since this prion disease has been found in moose and elk, and potentially transmittable to caribou, what would the repercussions of this disease be reaching the boreal forest? Alberta is currently challenged with some very complex ecological issues while trying to balance the needs and wants of a hunting public.

Presenter and email: Curtis Stambaugh; curtis.stambaugh@gov.ab.ca

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DEVELOPMENT OF A REGIONAL MANAGEMENT PLAN FOR MULE DEER

PATRICK STENT, Fish and Wildlife Branch, Ministry of Forests, Lands and Natural Resource Operations, 205 Industrial Road G, Cranbrook BC, V1C 7G5, Canada

Abstract: Hunter concerns with declining mule deer populations and dissatisfaction with current hunting opportunities led wildlife staff in Southeastern BC to develop a 5-year regional management plan. With extensive stakeholder consultation, we used a structured decision making process to evaluate hunting regulation options, identify knowledge gaps and identify management actions that may increase mule deer abundance. We collected input from hunters through workshops, mail-out surveys and web-based surveys. A summary of the latest mule deer science was provided to hunters prior to meetings and used to evaluate likelihood that management actions would increase abundance. Hunting regulation recommendations in the plan were supported by regional wildlife clubs and guide-outfitters. Numerous actions to increase mule deer abundance in key areas were also identified. Since implementation of the plan, we have secured funding for habitat restoration, population monitoring and research to understand factors limiting population growth in different areas. I will highlight the process for development of a regional management plan and identify associated successes and challenges.

Presenter and email: Patrick Stent; patrick.stent@gov.bc.ca

KOOTENAY ELK MANAGEMENT PLAN PUBLIC SURVEY

TARA SZKORUPA, Government of British Columbia, 205 Industrial Road G, Cranbrook, BC, V1C 7G5, Canada

Abstract: Wildlife staff in the Kootenay Region are currently updating the regional Elk Management Plan for 2015-19. This plan will review and revise current elk management objectives, and identify actions to address key issues in the region. To better understand the interests, experiences and opinions of First Nations, elk hunters, agricultural producers and the general public, we conducted an on-line survey in November and December, 2014. A link to the survey was e-mailed to contacts, who were asked to forward the survey to others interested in elk management in the region. The survey was also advertised on the BC Government's Hunting News website, and people who are signed up for the RSS feed received a notification. The survey contained a mix of multiple choice, dropdown, matrix/rating scale, ranking and open-ended questions. We asked questions about the value of wildlife in the Kootenay Region, and the relative importance of different elk management objectives, issues, and actions. One section of

the survey was restricted to elk hunters. This section asked about reasons for hunting elk, factors influencing where to hunt, dollars spent on elk hunting, quality of recent elk hunting experiences, and satisfaction with hunting regulations. Another section of the survey was restricted to agricultural producers. This section asked about experiences with elk and elk hunters, and mitigation or compensation for crop losses. Over 1200 people from across the province and outside of BC responded to the questionnaire. Most respondents self-identified as BC resident hunters (93%), although there was also input from First Nations, guide-outfitters, agricultural producers and public servants. In this presentation I will summarize survey results, lessons learned from conducting this survey, and implications for our regional Elk Management Plan.

Presenter and email: Tara Szkorupa; tara.szkorupa@gov.bc.ca

ABSTRACTS OF CONTRIBUTED PAPERS: PREDATION

BLACK BEAR CARNIVORY OF UNGULATES: GLOBAL POSITIONING SYSTEM CLUSTER ANALYSIS AS A TOOL FOR ESTIMATION

SARAH KINDSCHUH, New Mexico State University, Department of Fish, Wildlife, and Conservation Ecology, Las Cruces, New Mexico 88003 USA

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

Abstract: GPS cluster analysis has been used to estimate predation rates and to describe prey composition of many large carnivores but has not yet been tested for American black bears (*Ursus americanus*). As omnivores, black bears exhibit different movement patterns than other large carnivores, therefore it is unclear whether this method is suitable for describing black bear carnivory. We are evaluating the use GPS cluster analysis in the Jemez Mountains of northern New Mexico to locate sites of black bear predation and scavenging of mule deer (*Odocoileus hemionus*), elk (*Cervus canadensis*), and cattle. We will test a range of cluster characteristics as predictor variables in logistic regression analysis to determine whether GPS data can be used to remotely locate black bear carnivory events. We captured 25 bears between 2012 and 2014 to deploy GPS collars that transmit location data via satellite. We investigated clusters of GPS locations in the field to determine whether each site was used for feeding on ungulate prey or carrion. We visited over 775 clusters and identified 59 ungulate carnivory events, of which 39 were neonate or young of year elk. We are conducting analyses this winter with project completion expected in May 2015. If our GPS cluster analysis model proves accurate for black bear movement data, this new technique could provide researchers with an efficient tool for quantifying both the impacts black bear predation can have on ungulate populations and how ungulates as a food resource impact black bear population fitness.

Presenter and email: Sarah Kindschuh; skindsch@nmsu.edu

USING UNGULATE BIOMASS TO ESTIMATE ABUNDANCE OF WOLVES IN BRITISH COLUMBIA

GERALD KUZYK, Ministry of Forests, Lands and Natural Resource Operations, 2975 Jutland Road, Victoria, BC, V8W 9M8, Canada

IAN HATTER, Ministry of Forests, Lands and Natural Resource Operations, 2975 Jutland Road, Victoria, BC, V8W 9M8, Canada

Abstract: Wolves are a primary predator of deer and elk and the abundance of wolves is an important consideration in managing these ungulates. In British Columbia, wolves are managed on a regional scale (38,557–252,776 km2) yet there is no standardized and cost-effective methodology for providing reliable estimates of wolf abundance at this scale. Therefore, we used an ungulate biomass regression model and estimated wolf abundance at a regional and provincial scale (900,402 km2). Ungulate biomass was derived from periodic population estimates of 10 ungulate species/subspecies gathered over a 12-year period (2000–2011) by regional biologists and compiled for provincial totals. In 2011, the proportion of deer and elk in the total ungulate biomass was 27% provincially and ranged from 45-96% in southern regions and 3-17% in northern regions where moose are the most common ungulate. In 2011, we estimated there were 8,688 (95% CI= 5,898–11,760) wolves in British Columbia with regional estimates ranging from 149 (95% CI=100–205) to 2,693 (95% CI=1,818–3,608) wolves, having regional differences being related to spatial scale (km2) and not wolf density. We suggest an ungulate biomass regression model is an adequate tool to estimate wolf abundance for management purposes when precise estimates are not required and wolves are not heavily exploited or recovering.

Presenter and email: Gerry Kuzyk; gerald.kuzyk@gov.bc.ca

SURVIVAL AND CAUSE-SPECIFIC MORTALITY OF NEONATE ELK IN A UNIQUE PREDATOR ENVIRONMENT IN THE BLACK HILLS OF SOUTH DAKOTA AND WYOMING, USA

BENJAMIN D. SIMPSON, Department of Natural Resource Management, South Dakota State University, Brookings, SD 57007 USA

JONATHAN A. JENKS, Department of Natural Resource Management, South Dakota State University, Brookings, SD 57007 USA

Abstract: We conducted a 2-year study of survival and cause-specific mortality of elk calves to determine the current status of elk occupying the southwestern region of the Black Hills. We captured and fit 71 neonates < 10 days of age with expandable radiocollars during summer 2012 (n = 37) and 2013 (n = 34). Predation accounted for 87.5% of mortalities; remaining mortalities were from starvation (6.3%) and unknown (6. 3%). Cougars (*Puma concolor*) accounted for all predation mortalities. We used known-fate analysis in Program MARK to estimate summer (15 May-25 September) and annual (12 month) survival for elk calves. Based on the lowest AICc (Akaike's Information Criterion corrected for small sample size) value, the top model for summer survival was {S1–2wks,>2wks} indicating that mortality during 1-2 weeks of age and 3-20 weeks of age was the best estimated survival; overall probability surviving 20 weeks was 0.79 (95% CI = 0.68-0.88). For annual (12 month) survival, model {Sbirthweight} had the lowest AICc value indicating that birth weight of elk calves best explained survival. The overall probability that a calf survived to 12 months of age was 0.75 (95% CI = 0.61–0.84). Our results

document high survival for neonate elk likely due to an ecosystem-specific predator guild and high alternative prey.

Presenter and email: Benjamin Simpson; bensimpson19@gmail.com

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SPATIAL INTERACTIONS AND PREDATION RISK IN MULTIPLE CARNIVORE COMMUNITIES IN THE UPPER RED DEER RIVER OF ALBERTA

ERIC SPILKER, University of Alberta, CW405 Department of Biological Sciences, Edmonton, AB, T6G 2E9, Canada

EVELYN MERRILL, University of Alberta, CW405 Department of Biological Sciences, Edmonton, AB, T6G 2E9, Canada

JODI BERG, University of Alberta, CW405 Department of Biological Sciences, Edmonton, AB T6G 2E9, Canada

Abstract: Understanding how bears and other large carnivores individually select resources as well as interact with one another is essential for understanding how they collectively pose risk to their prey. Most research on predation risk focuses on one predator species, but prey respond to multiple predators and interactions among predators affect predator distribution. We illustrate an approach to quantifying multi-carnivore predation risk to elk in summer in and adjacent to the Ya Ha Tinda in the upper Red Deer River watershed of Alberta. In summer 2014, we collected scats of grizzly bears, black bears, wolves, coyotes, and cougars along 464-km of transects distributed throughout 48 5x5-km grid cells. We develop resource selection probability functions (RSPF) for black bears and grizzly bears based on scat locations using characteristics of landscape features and co-occurrence of scats of other carnivores. We compare black bear and grizzly bear distribution and produce maps representing the risk of predation for elk posed by ursids. Further, we compare predation risk from bears using kill sites of adult and calf elk killed by bears. Results from this study can be used in management of bears and other carnivore species and in the conservation of the Ya Ha Tinda elk herd.

Presenter and email: Eric Spilker; spilker@ualberta.ca

A LONG-TERM STUDY OF ELK-COUGAR RELATIONSHIPS IN WESTERN WASHINGTON: REMOVAL CAN RECOVER SMALL HERDS

DAVID J. VALES, Wildlife Program, Muckleshoot Indian Tribe, 39015 172nd Ave SE, Auburn, WA 98092 USA

MICHAEL P. MIDDLETON, Wildlife Program, Muckleshoot Indian Tribe, 39015 172nd Ave SE, Auburn, WA 98092 USA

MIKE T. MCDANIEL, Wildlife Program, Muckleshoot Indian Tribe, 39015 172nd Ave SE, Auburn, WA 98092 USA

Abstract: We have studied cow and calf elk survival since 1998 in two watersheds on the west slope of the Washington Cascades. Elk numbers have ranged from ≈130 to >600 in the Green River, and ≈600 to >1,700 in the White River. The Muckleshoot Tribe began removing cougar to help restore elk numbers after collecting cow and calf survival data showing that cougar were the main cause of mortality, and at the low point in herd sizes. Cougar numbers were initially

estimated to be at least 35 based on fecal DNA and other evidence in the two watersheds totaling approximately 1,600 km2. Between 2000-2006, the Tribe removed 57 cougars (9.5 /year) and documented another 9 mortalities, 54 adult, 4 subadult, and 8 kitten. With immigration and kitten production, we estimated the number of individual cougars ≥1year old to be at least 80 over that same time. Annual calf survival improved from <0.25 to >0.60 during the six-year period. Annual calf mortality due to cougar dropped from >0.40 to <0.25. Annual cow mortality in the Green River due to cougar went from 0.15 pre-removal to 0.05 post-removal. Cougar still dominated calf and cow elk mortalities but lower predation allowed elk to escape the predator pit they were in. Cow elk survival improved more in the Green where public access was limited and cougar dominated mortality. We also present data on predation rates of radio-marked cougars that demonstrate how easily elk were limited by predation. We also present data on sex and age of cougars removed and collared as a potential indicator of harvest intensity. Our data show that cougar predation in our study area was mostly additive, although some mortality was compensatory. Elk herds have grown and are now at or above objective, and we have allowed cougar numbers to increase.

Presenter and email: David Vales; david.vales@muckleshoot.nsn.us

ABSTRACTS OF POSTERS

HABITAT SELECTION BY MULE DEER WITHIN MIGRATION CORRIDORS IN NEVADA

MARCUS E. BLUM, Department of Natural Resources and Environmental Science, University of Nevada Reno, Reno, NV 89557 USA

KELLEY M. STEWART, Department of Natural Resources and Environmental Science, University of Nevada Reno, Reno, NV 89557 USA

THOMAS DILTS, Department of Natural Resources and Environmental Science, University of Nevada Reno, Reno, NV 89557 USA

CODY SCHROEDER, Nevada Department of Wildlife, 1100 Valley Rd, Reno, NV 89512 USA

Abstract: Migration is an important ecological phenomenon that allows ungulates to increase their exposure to high quality nutrients throughout the year. However, there is a limited amount of literature describing the habitat selection process by ungulates along their migration routes. It is critical that managers gain a better understanding of how species are selecting habitat within their migration corridors so that they can increase the effectiveness of habitat improvement along known migration routes. To address this we examined movement patterns and resource selection along migration routes to understand the effects of environmental stochasticity on corridor selection and the habitat preferences within the migration corridors of female mule deer, *Odocoileus hemionus*. We captured and applied radio collars to female mule deer (n=66) on the migratory pathway in the Pequop Mountains of eastern Nevada. We used Brownian Bridge Movement Models to delineate stopover sites for each individual during both the autumn and spring migrations. We used resource selection functions to determine which climatic and environmental variables individuals selected across seasons in stopover locations and along movement paths within the migration corridors. We also compared corridors annually to determine the differences that existed due to environmental stochasticity and if migration corridors shifted in response to these environmental changes. Our research will benefit wildlife biologists by describing mule deer habitat selection within different parts of migration corridors which will allow them to identify high priority zones along migration routes where no collar information is available. It will also give managers a better understanding of environmental impacts on migration corridor selection as well as how corridors change in these conditions.

Presenter and email: Marcus Blum; m.blum1107@yahoo.com

AN ASSESSMENT OF FORWARD-LOOKING INFRARED TECHNOLOGY TO SURVEY BIG GAME POPULATIONS IN NORTHEASTERN, ALBERTA

SCOTT DONKER, Alberta Environment and Sustainable Resource Development, 11450 - 79 Avenue N.W., Edmonton, AB T6G 0P6 Canada

GRANT CHAPMAN, Alberta Environment and Sustainable Resource Development, 2nd Floor Provincial Building, 9503 Beaverhill Road, Lac La Biche, AB T0A 2C0 Canada

SIMON SLATER, Alberta Environment and Sustainable Resource Development, 111, 4999 - 98 Avenue, Edmonton, AB T6B 2X3 Canada

Abstract: Determining big game population abundance and distribution is typically accomplished with the use of a variety of aerial survey designs. Detection of white-tailed deer (*Odocoileus virginianus)* and moose *(Alces alces)* is negatively affected by many factors and can be severely limited in moderate to densely forested habitat types. Reduced detectability of animals can necessitate increased survey flight requirements to achieve a desired confidence of the population estimate. Forward-looking infrared (FLIR) is a technology that uses an infrared thermal sensing system to detect differences in amounts of infrared radiation emitted from objects. FLIR technology and sensor operator experience have improved in recent years to enable an aerial habitat scanning technique to detect many wildlife species. In this study, we assessed the use of a FLIR system, mounted on Cessna 206 aircraft, operated by Vision Air Research, to assess populations of moose and deer in Wildlife Management Unit 503 in north eastern Alberta. We are able to compare these results to a helicopter distance sampling survey flown 3 weeks prior using the same transect array.

Presenter and email: Grant Chapman; grant.chapman@gov.ab.ca

IMPACTS OF COYOTE REMOVAL ON THE SURVIVAL OF MULE DEER FAWNS

JACOB HALL, Plant and Wildlife Science Department, Brigham Young University, Provo, UT 84602 USA

ERIC D. FREEMAN, Idaho Department of Fish and Game, 324 S. 417 E., Suite #1 Jerome, ID 83338 USA

RANDY T. LARSEN, Plant and Wildlife Science Department, Brigham Young University, Provo, UT 84602 USA

KENT R. HERSEY, Justin M. Shannon Utah Division of Wildlife Resources, Salt Lake City, UT 84114 USA

BROCK R. MCMILLAN, Plant and Wildlife Science Department, Brigham Young University, Provo, UT 84602 USA

Abstract: Mule deer (*Odocoileus hemionus*) populations across much of the western U.S. have been declining for the past several decades. Low fawn survival and subsequent low population recruitment may be the preeminent cause of population declines in many areas. Predation has been identified as a factor influencing adult deer survival and juvenile recruitment, but its role relative to other factors remains unclear. To better understand how predation affects mule deer, we implemented a four-year study of mule deer response to coyote removals in southern Utah. Our objective was to test the hypothesis that mule deer fawn survival was higher in coyote removal areas than non-removal areas. We documented fawn survival/recruitment from 0 to 6 months of age in areas where coyotes were removed and where they were not. We have completed the first three years of the study. During June 2012–14, we captured 200 neonate fawns and fitted them with VHF-radio collars to monitor their survival. We located deceased fawns and determined a probable cause of death based on evidence found at that location. We analyzed fawn survival in the coyote removal and non-removal study sites. Fawn survival was higher in the coyote removal area than in the non-removal area in 2013, but there was no significant difference in survival in 2012 or 2014. However, the treatment effect was significant when the data from all three years were pooled, with higher fawn survival in the removal area.

Our preliminary findings indicate a need to collect all four years of data before making final inferences regarding the effects of coyote predation and coyote removal on fawn survival.

Presenter and email: Jacob Hall; halljacobt@gmail.com

ASSESSING THE POTENTIAL EFFECTS OF TREPONEME-ASSOCIATED HOOF DISEASE ON ELK POPULATION DYNAMICS IN SOUTHWEST WASHINGTON

BROCK HOENES, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501 USA

KRISTIN MANSFIELD, Washington Department of Fish and Wildlife, 2315 North Discovery Place, Spokane Valley, WA 99216 USA

ILAI KEREN, Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, WA 98501 USA

Abstract: The Washington Department of Fish and Wildlife (WDFW) began receiving reports of lame elk with deformed hooves during the 1990s, but the number and geographical distribution of reports increased sharply by 2008 and have continued to increase in frequency and extent. The emergence of a new hoof disease in southwest Washington elk herds 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. The severity of clinical signs of treponeme-associated hoof disease (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. In response to these concerns, WDFW is working with several specialists from around the world to understand the etiology of TAHD. The number of elk that have TAHD and the effects of TAHD on elk vital rates, collectively, will determine what the long-term implications of TAHD are for the viability, and subsequent management, of impacted elk herds. WDFW initiated an effort in fall 2014 using citizen-scientists to estimate prevalence and distribution of TAHD within the range of the Willapa Hills and Mount St. Helens elk herds. WDFW also initiated a parallel study in February 2015 that aims to quantify how TAHD affects the survival, pregnancy rates, productivity, and nutritional condition of adult female elk. WDFW will use the findings from these two studies to develop management strategies that are informed by sound, objective science.

Presenter and email: Brock Hoenes; brock.hoenes@dfw.wa.gov

HYPOTHETICAL EFFECTS OF AN ABANDONED WIND PROJECT ON DEER AND ELK IN NEVADA

CODY MCKEE, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512 USA

CODY SCHROEDER, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512 USA

MIKE COX, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512 USA

MIKE SCOTT, Nevada Department of Wildlife, 1100 Valley Road, Reno, NV 89512 USA

Abstract: Collaboration among multiple stakeholders is often necessary for the successful completion of wildlife management and research projects. Unfortunately, those relationships can deteriorate or the project may be abandoned due to a variety of reasons. In 2011, an energy proponent funded the capture and radiocollaring of mule deer (*Odocoileus hemionus*; n = 10) and elk (*Cervus elaphus*; n =5) in the Wilson Creek Range of Lincoln County, Nevada to determine the potential effects of a proposed 1250 ha wind farm on deer and elk habitat and to develop appropriate mitigation strategies. The proposed development was canceled soon after project initiation and the dataset was transferred to the Nevada Department of Wildlife. We used these data to develop a resource selection probability function to determine preferences of deer and elk for areas that would have been developed. We then used the results of our analysis to infer how the hypothetical loss of those developed areas to wind turbines and infrastructure may affect the deer and elk herds in the Wilson Creek Range. Our analysis helps to clarify the relationship between wild ungulates and wind development, which is a topic underrepresented in the current body of literature. Our example also illustrates how agencies can utilize data from incomplete projects to make informed decisions about wildlife management in their state or region.

Presenter and email: Cody McKee; cmckee@ndow.org

IS COUGAR FORAGING ECOLOGY SHAPED BY THE URBAN-TO-WILDLAND GRADIENT OF WESTERN WASHINGTON

CLINT ROBINS, University of Washington, School of Environmental and Forest Sciences, Box 352100, Seattle, WA 98195-2100 USA

DR. BRIAN KERTSON, Washington Department of Fish and Wildlife, 16018 Mill Creek Boulevard, Mill Creek, WA 98012 USA.

DR. AARON WIRSING, School of Environmental and Forest Sciences University of Washington Box 352100. Seattle, WA 98195 USA

Abstract: Humans have dramatically altered ecosystem structure through landscape manipulation. Large carnivores are especially vulnerable to such habitat alterations because they tend to have low population densities, high prey requirements, and roam widely in search of prey. Cougars (*Puma concolor*) have proven resilient to urbanization, however, with individuals demonstrating a tolerance for fragmented and managed landscapes. Yet, the influence of urbanization on cougar foraging behavior remains unclear. Thus, our goal is to better understand whether and how cougar foraging is shaped by habitat variation along the transition from wildland to urban environments. We will study the foraging behavior of cougars in an area encompassing Snoqualmie and Marckworth Forests and adjacent areas by visiting 500 kill sites and 2,000 random sites (non-confirmed kill sites) to determine 1) if cougar hunting is based on local cover characteristics ("selective ambusher" hypothesis), and 2) whether the importance of understory cover at kill sites differs along the transition from wildland to urban environments. Preliminary results will be presented following the winter 2015 field season.

Presenter and email: Clint Robins; clint.robins4@gmail.com

ANTLER AND BODY SIZE IN BLACK-TAILED DEER: RETROSPECTIVE ANALYSIS OF COHORT EFFECTS

JOHANNA C. THALMANN, Department of Biological Sciences, Idaho State University, Pocatello, ID 83209 USA

R. TERRY BOWYER, Department of Biological Sciences, Idaho State University, Pocatello, ID 83209 USA

KEN AHO, Department of Biological Sciences, Idaho State University, Pocatello, ID 83209 USA

FLOYD W. WECKERLY, Department of Biology, Texas State University, San Marcos, TX 78666 USA

DALE R. MCCULLOUGH, Department of Environmental Science, Policy & Management, UC Berkeley, Berkeley, CA 94720 USA

Abstract: For large mammalian herbivores, extreme climatic events and high population densities decrease forage availability and create cohort-wide declines in fitness. We examined harvest data from a previous study to determine cohort effects on body and antler size of black-tailed deer (*Odocoileus hemionus columbianus*) (n = 450) in central California, USA. Two models were created, each with numerous extrinsic variables to predict a single intrinsic variable (body or antler size). Extrinsic factors such as weather, specifically annual precipitation, during parturition and the first year of growth are often cohort specific, and have lasting effects on antler and body size in males. Female population density can greatly affect forage availability during critical stages of growth and development of offspring, and thereby also influence size of males later in life. In our study, female population density during the first year of growth had a more dominant effect than precipitation. Harvest of female deer resulted in increases in the overall size of males, even during years of drought. Extrinsic factors during gestation were important in determining antler size of male deer, but not body size. Temperature during the year prior to harvest influenced both body and antler size of male deer. The insights that our study offers about the interactions between density-dependent and independent factors will enhance our understanding of the variable growth of cervids between cohorts.

Presenter and email: Johanna Thalmann; thaljoha@isu.edu