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April 27-30, 2009

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Red Lion Inn at the Park, Spokane, Washington
April 27-30, 2009

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NEW CHALLENGES AND OPPORTUNITIES FOR BLACK-TAILED DEER HABITAT IN ALASKA

Thomas A. Hanley, Chief Wildlife Biologist and Team Leader, U.S. Forest Service, Pacific Northwest Research Station, 2770 Sherwood Lane 2-A, Juneau, AK 99801

Abstract: Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) are endemic to the coastal region of southeast Alaska, throughout the Alexander Archipelago, and have been introduced to islands of Prince William Sound and Kodiak Island in south central Alaska. They are closely tied to Sitka spruce-western hemlock (*Picea sitchensis-Tsuga heterophylla*) forests, especially old-growth forests that provide diverse and productive understory vegetation combined with substantial snowfall interception by the forest canopy. Herb-layer evergreen forbs are especially important in the winter energy budget of deer, and although they are abundant in old-growth forests, they are scarce in even-aged, young-growth forests. Forest management issues regarding black-tailed deer habitat in Alaska have changed greatly during the past 50 years. Prior to the construction of pulp mills in the region in the 1950s, deer habitat concerns centered primarily on winter severity (snow) and winter mortality. With extensive clear-cutting throughout the second half or the 20th Century, however, habitat concerns shifted strongly on the importance of old-growth forest for winter range and the inadequacy of even-aged, young-growth forest (depauperate understories). But then, in the 1990s, both pulp mills closed, and the timber industry declined rapidly to only a few, barely surviving local sawmills today. Concerns about old-growth forest winter range for deer remain, but greater attention is now focusing on the >250,000 ha of even-aged, young-growth forest resulting from past clear-cutting. "Restoration" of young-growth forests for deer habitat is greatly needed, especially in areas of high "subsistence" need by rural residents. Silviculture of young-growth forests has thus become both the greatest challenge and greatest opportunity for deer habitat management in Alaska today, yet very little is known about effective silviculture for understory vegetation in the region. In an effort to learn from management and develop effective silviculture prescriptions, the Tongass National Forest has embarked on a true Adaptive Management program of young-growth silviculture, which they call Tongass-Wide Young Growth Studies (TWYGS). Understory response is evaluated with a new food-based system for evaluating habitat for deer, called the Forage Resource Evaluation System for Habitat – Deer (FRESH-Deer: http://cervid.uaa.alaska.edu/deer/). FRESH-Deer is a nutritionally driven system for quantifying the value of food resources (deer days per hectare) relative to species-specific forage biomass, nutritional quality

(digestible energy and digestible protein), and user-specified nutritional constraints. The FRESH-Deer system can be applied to deer range anywhere in the world; its application to the TWYGS data provides an illustration. The first series of 5-year results from TWYGS are now becoming available and offering guidance for new habitat management prescriptions in southeast Alaska.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:7-8.

SEPARATING COMPONENTS OF VARIATION IN SURVIVAL OF MULE DEER IN COLORADO

Paul M. Lukacs, Colorado Division of Wildlife, 317 W. Prospect Road, Fort Collins, CO 80526
Gary C. White, Dept. of Fish, Wildlife, & Conservation Biology, CO State Univ., Fort Collins, CO 80523
Bruce E. Watkins, Colorado Division of Wildlife, 2300 S. Townsend Avenue, Montrose, CO 81401
Richard H. Kahn, Colorado Division of Wildlife, 317 W. Prospect Road, Fort Collins, CO 80526
Bradley A. Banulis, Colorado Division of Wildlife, 2300 S. Townsend Avenue, Montrose, CO 81401
Darby J. Finley, Colorado Division of Wildlife, P.O. Box 1181, Meeker, CO 81641
A. Andrew Holland, Colorado Division of Wildlife, 151 East 16th Street, Durango, CO 81301
Justin Martens, Colorado Division of Wildlife, 346 Grand County Rd 362, Hot Sulphur Spgs, CO 80451
Jack Vayhinger, Colorado Division of Wildlife, 7405 Highway 50, Salida, CO 81201

Abstract: Survival is an important parameter for understanding population dynamics of mule deer (*Odocoileus hemionus*) and other large herbivores. To understand long-term dynamics it is important to separate sampling and biological process variation in survival. Moreover, correlations in survival across space and between young and adults can provide more informed predictions of survival in unsampled areas. We estimated survival of fawn, yearling and adult mule deer from 4 spatially separated regions of Colorado from 1997-2008. We also estimated process variance in survival across time for each age and site using Markov chain Monte Carlo (MCMC) methods. Finally, we estimated correlations in survival between sites and ages with MCMC methods. Average winter fawn survival was 0.721 (SD = 0.024) for the 4 regions. Average winter adult female survival was 0.935 (SD = 0.007). Annual adult female survival ranged from 0.803 (SD = 0.017) to 0.900 (SD = 0.028) for the 4 regions. The correlation between fawn and adult female survival was relatively high, 0.563 (SD = 0.253). Correlations in winter fawn survival were higher between populations at the same latitude than they were for populations to the north and south. We used the survival estimates from our analysis to inform prior distributions for a Bayesian population dynamics model from one population in Colorado and compared that model to one with non-informative prior distributions. Population models including informative prior distributions based on our results performed better than those non-informative prior distributions on survival, providing more biologically defensible results when data were sparse.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:9.

CONSTRUCTION AND VALIDATION OF ELK HABITAT MODELS: NEW LANDSCAPE APPROACHES WITH MULTIPLE DATA SOURCES

Michael Wisdom[1], John Cook[2], Priscilla Coe[3], Mary Rowland[1], Ray Davis[1], David Vales[4], Bruce Johnson[3], Ryan Nielson[5], Rachel Cook[2], Greg Davidson[3], John Lehmkuhl[1], Martin Vavra[1], Peter Singleton[1], Bill Gaines[1], Scott McCorquodale[6], and Andrea Lyons[1]

[1]USDA Forest Service, Pacific Northwest Research Station or Pacific Northwest Region
[2]National Council for Air and Stream Improvement
[3]Oregon Department of Fish and Wildlife
[4]Muckleshoot Indian Tribe
[5]WEST, Inc.
[6]Washington Department of Fish and Wildlife

Landscape models to evaluate wildlife habitat have a long history of development and application, but formal assessments of model performance have been uncommon. Such is the case for elk habitat models in the Pacific Northwest. Habitat models were developed and applied in the 1980s in Oregon and Washington with the use of existing empirical data, but formal validation either has not occurred or been limited to assessment of individual covariates. Moreover, data on additional covariates of interest, such as elk nutritional resources, have not been available until recently. In our presentation, we describe work to construct and validate elk habitat models across multiple study areas, using associated telemetry data, as part of a multi-partner effort to improve elk habitat evaluation methods and applications in Oregon and Washington. Data are now available to evaluate nutritional conditions for elk at landscape spatial extents, and to estimate the probability that elk will use these nutritional resources, given different combinations of covariates that influence or account for landscape choices made by the species. A series of competing models will be evaluated with telemetry data for each study area, using resource selection analysis and measures of model parsimony. Results will be analyzed to identify which models, if any, have high parsimony across study areas. Findings will ultimately be used to identify geographic areas where model applications and inferences are most appropriate. Use of multiple data sources from different study areas represents a compelling but challenging opportunity to improve the scientific basis for landscape modeling across large geographic areas, particularly for widely-distributed species like elk that occur in diverse environments and land ownerships.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:10.

THRESHOLDS IN LANDSCAPE CONNECTIVITY AND MORTALITY RISKS FOR ELK IN RESPONSE TO GROWING ROAD NETWORKS

Jacqueline L. Frair[1], **Evelyn H. Merrill[1]**, Hawthorne L. Beyer[1], and Juan Manual Morales[2]

[1] Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada T6G 2E9; and [2] Ecology and Evolutionary Biology, University of Connecticut, 75 North Eagleville Road Storrs, CT 06269 USA

Abstract: The ecological footprint of roads may extend for several kilometers with overlapping effects from neighboring roads causing a nonlinear accumulation of road effects in the landscape. Availability of preferred habitat, spatial dependencies between roads and habitat types, and fidelity to traditionally used areas further confound our ability to predict population-level responses of animals to growing road networks. To isolate these effects, we developed an individually based movement model using elk *Cervus elaphus* L. as a model system. Empirically derived movement rules redistributed elk under different amounts of preferred habitat (clearcuts), road densities, and road development schemes. We tracked potential mortality risk (given time spent near roads) and emigration rates (given declining accessibility of foraging habitat). Design of the road network accounted for up to 30–55% difference in mortality risk and emigration rates, with the largest differences occurring at intermediate road densities (1–1·5 km km2) when road effects began to saturate the landscape. Maintaining roads in association with clearcuts caused a decline in habitat accessibility equivalent to replacing 50–75% of these foraging patches with conifer forest. A nine-fold difference in potential emigration was observed after varying elk tolerance for declining habitat accessibility despite holding local movement biases constant. Elk responses to growing road networks were non-linear, exposing thresholds for road density that were reflected in the home range occupancy patterns of a large sample of elk in the region. Our approach provides a means of scaling-up complex movement decisions to population-level redistribution, separating the confounding effects of landscape context from road effects, and exposing thresholds in connectivity and mortality risks for wildlife caused by infrastructure growth. We discuss management implications of our simulation studies.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:11.

CHANGES IN ELK RESOURCE SELECTION ASSOCIATED WITH A LATE-SEASON ELK HUNTING PERIOD

Kelly M. Proffitt[1], Robert A. Garrott[1], Jamin L. Grigg[1,2], Kenneth L. Hamlin[3], Justin A. Gude[4], Julie Cunningham[3], and Craig Jourdonnais[4]

[1] Fish & Wildlife Management Program, Dept. of Ecology, Montana State Univ., 310 Lewis Hall, Bozeman, MT 59717
[2] Current address: Colorado Division of Wildlife, 1715 North Yampa, Craig, CO 81625
[3] Montana Department of Fish, Wildlife, and Parks, 1400 South 19th Avenue, Bozeman, MT 59718
[4] Montana Department of Fish, Wildlife, and Parks, 1420 East 6th Avenue, Helena, MT 59620

Abstract: Changes in resource selection associated with hunting seasons may alter elk distributions and availability for harvest. Using Global Positioning System (GPS) data collected from telemetry-collared cow elk (*Cervus elaphus*), we evaluated effects of refuges (areas where hunting was prohibited), spatial variation in hunting risk, and landscape attributes on resource selection within an established Greater Yellowstone Area winter range. We also evaluated elk distributions during and outside of a late-season hunting period. Refuge areas and landscape attributes such as habitat type and snow water equivalents (SWE) affected resource selection. Elk selection for flat grasslands increased as SWE increased, likely because these areas were windswept, leaving grasses exposed for foraging. Elk distributions differed during hunting and no-hunting periods. During the hunting period, elk increased selection for refuge areas and the estimated odds of elk occupying a refuge area more than doubled. Risk-driven changes in resource selection resulted in reduced availability of elk for harvest. Elk selection for refuges presents a challenge for resource managers that use hunting as a tool for managing populations. Quantifying selection for refuge areas may allow wildlife managers to develop hunting regulations aimed at reducing selection for refuges and quantify the effectiveness of implemented regulations.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:12.

Session 2 April 28, 2009
Moderator: Woody Myers, Washington Department of Fish and Wildlife.

ESTIMATING HABITAT SELECTION WHEN GPS FIX SUCCESS IS LESS THAN 100%

Ryan M. Nielson, Bryan F. J. Manly, Lyman L. McDonald, Hall Sawyer, and Trent L. McDonald
Western EcoSystems Technology, Inc., 2003 Central Ave, Cheyenne, WY, 82001

Abstract: Inferences about habitat selection by animals derived from sequences of relocations obtained with global positioning system (GPS) collars can be influenced by GPS fix success. Environmental factors such as dense canopy cover or rugged terrain can reduce GPS fix success, making subsequent modeling problematic if fix success depends on the selected habitat. Ignoring failed fix attempts may affect estimates of model coefficients and lead to incorrect conclusions about habitat selection. We present a modified discrete choice (MDC) habitat selection model that accounts for missing locations due to habitat-induced data losses. The MDC formulation is similar to adjusting estimates of probability of occupancy when detection is less than 100% in patch occupancy sampling. We apply the MDC to GPS data collected from an adult female mule deer and discuss how to analyze data from multiple animals. Our results suggest that application of the MDC model can produce unbiased estimates of habitat selection for GPS data sets missing up to 50% of the locations.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:13.

ADDRESSING GPS FIX SUCCESS IN RESOURCE SELECTION ANALYSIS FOR THE YAKIMA ELK HERD, WASHINGTON

Peter H. Singleton[1], Scott M. McCorquodale[2], Ryan M. Nielson[3], Andrea L. Lyons[4], William L. Gaines[4], John F. Lehmkuhl[1].

[1]U.S. Forest Service Pacific Northwest Research Station, 1133 N. Western Ave., Wenatchee WA 98801 psingleton@fs.fed.us
[2]Washington Department of Fish and Wildlife, Yakima WA
[3]Western EcoSystems Technology, Inc., Cheyenne WY
[4]U.S. Forest Service Okanogan-Wenatchee National Forest, Wenatchee WA

Abstract: Global positioning system (GPS) fix success can introduce error into resource selection analysis for wildlife radiotelemetry studies that employ GPS collars. We conducted a GPS radiotelemetry study of elk movements for the Yakima herd in the eastern Cascade Mountains of Central Washington. We collected GPS telemetry movement data on 37 elk from 2004 to 2006. Summer (June 15 to August 31) fix success rate ranged from 43% to 91% (average 73%, standard deviation 14%). We used modified discrete choice (MDC) analysis for preliminary modeling to address GPS fix success associated with the habitat characteristics in our resource selection analysis. Our preliminary analysis indicated that the proportion of the sampling units with overstory canopy closure >70% was an important predictor of detection probability, and resource selection was associated with overstory-corrected normalized difference vegetation index, slope, topographic position, and distance to roads. The MDC analysis provided different resource selection function (RSF) coefficient estimates than a standard discrete choice model that did not incorporate probability of detection.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:14.

ESTIMATING POPULATION SIZE AND MOVEMENT PATTERNS OF BLACK-TAILED DEER ON BLAKELY ISLAND, WA

Eric Long, Katie Taylor, Luke Davies, and Stephanie Irvin
Department of Biology, Seattle Pacific University

Abstract: Beginning in 2007, we studied population size, home range characteristics, and movement patterns of black-tailed deer on Blakely Island in the San Juan Archipelago of Washington State. Compared to mainland and other large islands, Blakely Island has a small land area (17.8 km^2), no natural predators, and limited hunting. In summer 2007 and 2008, using Clover traps and dart guns, 15 deer (10 male, 5 female) were captured and equipped with uniquely numbered ear-tags and radio-transmitters, including 9 VHF collars and 6 global positioning system (GPS) collars. Additionally, 19 deer were only equipped with ear-tags. Density estimates of this closed population were estimated using line transect distance sampling and mark-resight estimators (i.e., Bowden's Estimator) via automatic camera traps. Empirical estimators suggest very high population densities (~39/km^2). Average home range size of females (μ_F=0.22 km^2 ± 0.05 SE) was smaller than that of males (μ_M=0.58 km^2 ± 0.17 SE; t = 2.26, p = 0.03). For males captured as subadults and tracked for 2 summers, paired tests indicated no difference between home range size in sub-adult vs. adult year (paired t = 2.78, p = 0.49). Male and female home range sizes on Blakely Island were small and represented only 7 – 62% of reported gender-specific home ranges on larger islands in the Pacific Northwest. Inter-island movements were rare, but one adult, GPS-collared male did make two roundtrip excursions to a neighboring island, approximately 1.0 km away. Our results suggest that distance sampling, and to a lesser extent camera surveys, provide reasonable, efficient estimates for high-density, closed populations of deer. Also, we found that black-tailed deer in high density, predator-free habitats establish home ranges smaller than those typically demonstrated by mainland or large-island populations, and although inter-island movements are rare, channels between islands do not provide complete barriers to movements.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:15.

A DOUBLE-OBSERVER METHOD FOR REDUCING BIAS IN FECAL PELLET SURVEYS OF FOREST UNGULATES

Kurt J. Jenkins[1], Bryan F.J. Manly[2], and Patricia J. Happe[3]

[1]USGS Forest & Rangeland Ecosystem Science Center, Olympic Field Station, 600 E. Park Avenue, Port Angeles, WA 98362
[2]Western EcoSystems Technology, Inc., 2003 Central Avenue, Cheyenne, WY 82001
[3]Olympic National Park, 600 E. Park Avenue, Port Angeles, WA 98362

Abstract: Direct estimation of deer and elk abundance has proven impractical in many dense forest environments of the north Pacific coast, so indices of abundance derived from fecal pellet surveys are receiving renewed attention. Fecal pellet surveys pose significant estimation problems, notably due to high variation in visibility biases and pellet decay rates. We developed maximum likelihood methods using double observer counts to estimate visibility biases associated with Roosevelt elk (*Cervus elaphus roosevelti*) and Columbian black-tailed deer (*Odocoileus hemionus columbianus*) fecal pellet surveys in coniferous forests of Olympic National Park, Washington. Further, we used log-linear modeling to determine the effect of clearing fecal pellets present on transects at the beginning of winter on the pellet group counts obtained the following spring. The relationship between paired cleared and uncleared transect segments is used to adjust data from uncleared transects to more accurately reflect a standard deposition interval. Detection probabilities of pellet groups were related to observer, search time, whether pellets were from deer or elk, number of fecal pellets present in a group, vegetation cover, distance of the pellet-group center from the transect line, and distance x group size interaction. Clearing transects at the beginning of winter reduced spring pellet group counts by 34-53% depending upon landform, and elk pellet group numbers 0-46%. We demonstrate these methods by comparing relative densities of deer and elk pellet groups between species and among geographic regions of the park, and in combination with aerial survey methods to estimate population abundance of elk.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:16.

USING HARVEST AND AERIAL SURVEY DATA TO ESTIMATE ELK POPULATIONS IN NEW MEXICO

Stewart Liley, Darrel L. Weybright
New Mexico Department of Game and Fish, 01 Wildlife Way, Santa Fe, NM 87507

Abstract: Population reconstruction methods as described by Bender and Spencer (1999) were used to estimate elk (*Cervus elaphus*) populations by New Mexico Department of Game and Fish (NMDGF) starting in 2006. Harvest data, from hunter killed animals and ratio data gathered from surveys, are used to reconstruct population sizes. NMDGF switched from sight-biased models to reconstruction models in hopes of 1) improving the precision of generated estimates, 2) reducing the costs associated with flying surveys, and 3) increasing the number of elk populations surveyed in a given year. The switch also occurred as hunter harvest data collection mandatory, rather than voluntary. We present a summary of the parameter requirements and methods for data collection. We also discuss potential biases and their effects on estimated population size. An advantage of reconstruction over using sight-biased models was more precise estimates with less survey effort. Since switching to reconstruction methods precision of estimates (as measured by the half width of the confidence interval divided by the generated population estimate) have remained similar. Reconstruction methods using fall survey data yielded a mean precision estimate of 0.29 (min=0.086, max=1.25) SE=0.03, N=59 whereas sight bias yielded a mean precision estimate of 0.27 (min=0.067, max=0.67) SE=0.02, N=71. However, the proportion of the estimated population surveyed to achieve similar precision was much greater for sight-bias models versus population reconstruction models (population reconstruction $\bar{x}$=0.15; SE=0.017; min=0.006; max=0.62 and sight-bias $\bar{x}$=0.54; SE=0.03; min=0.1; max=0.92). Because survey effort using population reconstruction models is reduced more populations can be flown in a given year than previously accomplished using sight-biased models.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:17.

Session 3, April 28, 2009
Moderator: Eric Bergman, Colorado Division of Wildlife.

POPULATION MODELING OF A DESERT MULE DEER HERD IN A PREDATOR PROOF ENCLOSURE IN CENTRAL ARIZONA

Rogelio Carrera, Department of Natural Resources, Texas Tech University, Lubbock, TX 79409
Warren B. Ballard, Department of Natural Resources, Texas Tech University, Lubbock, TX 79409
James deVos Jr., Arizona Game and Fish Department, Phoenix, AZ 85023
Paul R. Krausman, School of Natural Resources, University of Arizona, Tucson, AZ 85721
Mark Wallace, Department of Natural Resources, Texas Tech University, Lubbock, TX 79409
Stan Cunningham, Arizona Game and Fish Department, Phoenix, AZ 85023
Ole J. Alcumbrac, Wildlife Health Services, Lakeside, AZ 85929

Abstract: Desert mule deer (*Odocoileus hemionus eremicus*) in central Arizona declined from 11 deer/km^2 in the early 1960s, to 2 deer/km^2 in 2006. Mule deer research conducted in the Three Bar Wildlife Area (TBWA) in central Arizona included the construction in 1971 of the Walnut Canyon Predator Proof Enclosure (WCPPE), a 259 ha enclosure. Mule deer inside the enclosure reached densities between 11–35 deer/km^2, while mule deer in the TBWA remained between 1–5 deer/km^2. The objective of our study was to develop a population model for deer inside the WCPPE. Using available data from deer drive counts in the WCPPE we estimated rates of increase (r), calculated annual proportions of fawns/female, tested for density dependence in deer recruitment, and developed a population model to predict K-carrying capacity (KCC) and maximum sustained yield (MSY). Mule deer recruitment inside the WCPPE exhibited density dependence. A Gompertz logarithmic model predicted increased fawn mortalities between 8 deer/km^2 and 19 deer/km^2 inside the enclosure. The model predicted that the mule deer herd would stabilize at 57 deer/km^2 inside the enclosure (KCC) and that MSY would be achieved around 19 deer/km^2. The population model for the enclosure indicated population growth was slowed at densities below KCC via increased fawn mortality, likely due to mule deer overcrowding and social interactions among female mule deer. The population model for the enclosure predicted a MSY at 33% of the estimated KCC, as opposed to the predicted 50% by the logistic model and above that for other empirically derived deer population models. Our study suggested that MSY may be achieved at a lower standing crop than previously reported and that mule deer sociobiology may be a factor influencing deer population dynamics in important and unknown manners.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:18.

THE ROLE OF RESOURCES, WEATHER, AND PREDATION IN DESERT MULE POPULATION DYNAMICS IN CENTRAL ARIZONA

Rogelio Carrera, Department of Natural Resources, Texas Tech University, Lubbock, TX 79409
Warren B. Ballard, Department of Natural Resources, Texas Tech University, Lubbock, TX 79409
James deVos Jr., Arizona Game and Fish Department, Phoenix, AZ 85023
Paul R. Krausman, School of Natural Resources, University of Arizona, Tucson, AZ 85721
Mark Wallace, Department of Natural Resources, Texas Tech University, Lubbock, TX 79409
Stan Cunningham, Arizona Game and Fish Department, Phoenix, AZ 85023
Ole J. Alcumbrac, Wildlife Health Services, Lakeside, AZ 85929

Abstract: Desert mule deer (*Odocoileus hemionus eremicus*) in central Arizona declined from 11 deer/km^2 in the early 1960s, to 2 deer/km^2 in 2006. The objective of this study was to evaluate the relative roles of weather, resources, and predation in driving mule deer population dynamics. We studied the relationship between fawn:female ratios and precipitation data with and without predators using a predator proof enclosure, monitored deer performance and diet quality in low and high densities, and compared plant species composition and biomass inside and outside the enclosure. A drought index explained 36% of the variability in fawn:female ratios when predators were present, but the relationship was not significant without predators. There was no difference in body mass, body condition scores, and number of fetuses detected *in utero* between mule deer at 35 deer/km^2 inside the enclosure and at 2 deer/km^2 outside the enclosure, but deer inside the enclosure had greater values of subcutaneous rump fat. There was no difference in percent fecal nitrogen (FN) between deer inside and outside the enclosure, but fecal 2,6-diaminopimelic acid (DAPA) concentrations were higher inside the enclosure. There were no differences in plant species composition and biomass of forbs consumed by deer inside and outside the enclosure. Higher mule deer densities inside the enclosure over 35 years have not resulted in impacts on the plant communities. Our data suggested that predation on fawns was the most important force driving mule deer populations, that fawn mortality rates were greater during drought years, and that current densities are well below what the environment is capable of maintaining. Our study suggested that predator control may enhance mule deer populations in central Arizona.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:19.

CAUSE-SPECIFIC MULE DEER FAWN MORTALITY AND THE USE OF VAGINAL IMPLANT TRANSMITTERS IN CENTRAL ARIZONA

Nicole M. Tatman, Texas Tech Univ., 102 Goddard Building, Lubbock, TX 79409
Warren B. Ballard, Texas Tech Univ., 102 Goddard Building, Lubbock, TX 79409
Mark C. Wallace, Texas Tech Univ., 102 Goddard Building, Lubbock, TX 79409
James deVos Jr., Texas Tech Univ., 102 Goddard Building, Lubbock, TX 79409
Paul R. Krausman, Univ. of Montana, Dept. of Ecosystem & Cons. Sciences, Missoula, MT 59812
Ole J. Alcumbrac, Wildlife Health Services, 1939 White Mountain Road, Lakeside, AZ 85929
Chantel O'Brien, Arizona Game and Fish Dept., 5000 W. Carefree Highway, Phoenix, AZ 85086

Abstract: Determining reasons for low mule deer (*Odocoileus hemionus*) fawn recruitment is essential for effective management. Our study area regularly experiences low fawn: doe ratios on the outside of a predator proof enclosure, whereas on the inside of this enclosure fawn: doe ratios are consistently high. The objective of this study was to obtain data on cause-specific mortality of mule deer fawns in central Arizona. Twenty and twenty four mule deer fawns were captured in 2007 and 2008, respectively. Fawns were followed to determine cause and timing of mortality events. Annual survival for fawns was 0.105 and adult survival was 0.865 in 2007. Fawns born in 2008 are currently being monitored. Female mule deer were captured with a net gun fired from a helicopter. Pregnant deer were equipped with a radio-collar and a Vaginal Implant Transmitter (VIT) to determine time and location of parturition events. VIT success rate in 2007 was low with 69% of the VIT's dropping prior to a birth event. On average, VIT's dropped 59.6 (range: 35-95) days early. Mucous buildup on the VIT was correlated with it being dropped. However, with VIT modifications in 2008, success rate increased to 0.9. Fawns were 0-3 days of age at capture. Neonates were equipped with an expandable radio-collar and were monitored daily for survival. Predation accounted for 0.529 (and possibly up to 0.647) of fawn mortalities in 2007, other causes of mortality included sickness and premature births. Predation may be a limiting factor for mule deer in this area.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:20.

FACTORS AFFECTING THE SURVIVAL OF BLACK-TAILED DEER FAWNS ON THE NORTHWESTERN OLYMPIC PENINSULA, WASHINGTON

Robert McCoy and Shannon Murphie, Makah Forestry, P.O. Box 116, Neah Bay, WA 98357; makahwildlife@centurytel.net

Abstract: Black-tailed deer (*Odocoileus hemionus columbianus*) populations have been suspected to be declining in western Washington. Factors surmised to be involved include nutrition, weather, predation, and hair loss syndrome (HLS). During 2006 and 2007, 100 fawns were captured (50 each year) in the Hoko Game Management and on the adjacent Makah Reservation to determine age specific survival rates, sources of mortality, and assess the influence of HLS. The known fates model in program MARK was used to estimate survival rates and compare explanatory models based on Akaike's Information Criteria. Predation was the leading cause of mortality (80%), followed by natural (non-predation) (13%), human caused (5%), and unknown (2%). Mountain lions (*Puma concolor*) were the prominent predator. The best model indicated that survival differed between years and was age dependent with fawns being vulnerable during the first 4 weeks of life and then again during the winter and associated HLS timeframe. The overall survival rate to 46 weeks was 0.39 (95%CI = 0.26-0.53). The incidence rate of HLS in fawns was 49%. Survival rates were lower for fawns afflicted with HLS (52%) than those not afflicted (73%). While survival rates of fawns with HLS were not statistically different than those not afflicted, HLS may be a biologically important by increasing the susceptibility of fawns afflicted to predation. The data collected to date indicates a stable to slightly declining population. Furthermore, the data collected indicates that SAK (sex-age-kill) modeling in Washington which uses pre-hunting season composition data to estimate recruitment is likely over estimating survival to the yearling age class.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:21.

Session 1, April 29, 2009
Moderator: Scott McCorquodale, Washington Department of Fish and Wildlife.

LANDER FRONT MULE DEER HABITAT IMPROVEMENT PROJECT

Carrie Dobey, Habitat Biologist, Wyoming Game and Fish Department

Abstract: Following the harsh winter of 1992-93, the South Wind River mule deer herd located in central Wyoming crashed to less than half its 13,000 animal population objective and never completely rebounded. The post harvest population in 2008 was estimated to be 11,600 animals. In 2003, the Wyoming Game and Fish Commission (WGFC) designated mule deer management as a priority for the Wyoming Game and Fish Department (WGFD). They selected the South Wind River herd as a model to observe how landscape scale habitat improvements could affect population dynamics of the herd. Regional wildlife biologists believed the primary cause for low mule deer numbers was poor quality winter range. Years of drought, overuse, and lack of fire degraded large portions of winter range. In 2004, a contractor was hired to map vegetation across approximately 170,000 acres of winter range located south and east of Lander, Wyoming. As he mapped habitat types, he also identified over 200 potential habitat improvement projects ranging from sagebrush and juniper thinning to water developments. In 2007, WGFD received $494,000 to implement the first phase of projects. So far, 1,165 acres of juniper have been removed with approximately 400 more to be completed this year. Spike was applied to 2,567 acres of dense sagebrush and 75 acres of sagebrush were mowed. Treatments have resulted in reduced shrub cover and bare ground and increased forb and litter cover. Two wells were converted to solar arrays with excess water being directed to basin areas that previously held water prior to current drought conditions. WGFD is currently planning and obtaining funds for the next phase of projects which include more juniper and sagebrush thinning and Russian olive and saltcedar removal.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:22.

EVALUATION OF WINTER RANGE HABITAT TREATMENTS ON OVER-WINTER SURVIVAL AND BODY CONDITION OF MULE DEER

Eric J. Bergman, Mammals Research, Colorado Division of Wildlife
Chad J. Bishop, Mammals, Research, Colorado Division of Wildlife
David J. Freddy, Mammals Research (retired), Colorado Division of Wildlife
Gary C. White, Department Fish, Wildlife and Cons. Biology (Emeritus) - Colorado State University
Paul Doherty, Department of Fish, Wildlife and Cons. Biology - Colorado State University

Abstract: During the winter of 2004-2005, the Colorado Division of Wildlife initiated a 5-year, life table experiment designed to assess the impacts of landscape level winter range habitat improvement efforts on mule deer population performance. Conducted on the Uncompahgre Plateau and in adjacent valleys in southwestern Colorado, we repeatedly measured over-winter fawn survival and total deer density on 4 study areas as well as on a fifth, variable area, each winter of the study. Additionally, on 2 of the study areas we estimated late-winter body condition of does. Compared to results from other research throughout the west, as well as on the Uncompahgre Plateau, survival estimates for 6-month old mule deer fawns were highly variable between areas, but tended to be above published long term averages. Preliminary evidence suggests that areas that have received habitat treatments have higher fawn survival. Point estimates of deer density on the 5 study areas across winters have varied, but in general, the variance surrounding deer density estimates have followed a consistent trend between all winters of the study with no major annual change observed. Estimates of total body fat for adult female deer showed no apparent distinction between treatment and reference study areas. Preliminary conclusions from this study lend support to habitat management efforts as a means to mitigate mule deer habitat loss or to improve mule deer population performance. Ultimately, study results will be incorporated into a structured decision making framework that will allow managers to optimally allocate limited habitat mitigation funds to areas where the greatest results in mule deer performance may be realized.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:23.

AN EVALUATION OF ELK HABITAT AND SILVICULTURAL TREATMENTS IN NORTHERN IDAHO

Scott Robinson, Certified Wildlife Biologist, Retired, Spokane, WA 99217

Abstract: The Bureau of Land Management removed 5.4 million board feet of timber from 700 acres of BLM public lands in Boundary County, Idaho. Approximately 50% of this volume was small diameter trees and 20% was pulpwood material, which was either too small or too defective to be manufactured into dimensional lumber. This presentation describes the inventory (before) and monitoring (after) of elk habitat as it relates to the NEPA analysis, but is not intended to pass judgment of either the proposed or resultant removal of timber. Forest vegetation data was collected and processed using the Forest Service's Forest Vegetation Simulator, which projects tree growth into future years. Using the "before" data, the foresters proposed cutting prescriptions and I analyzed the effects to elk habitat. Using the "after" data, I compared the resultant cutting against the anticipatory effects. "Before" and "after" values for tree top height, canopy closure, crown profile area, and crown volume match one another during the first 50 years after treatment. "Before" and "after" values for trees per acre, foliage biomass, snags, and dead surface fuels (aka logs) have similar but separate trend lines. The completed project met the snag requirements, but failed to meet the stipulation to retain larger dead surface fuels. "After" values consistently hide less of an elk at 200 feet than the "before" values. Anecdotal observations during 2007 correspond to 78% of an elk that could be visible at 200 feet. Therefore, the resultant cover to forage ratio of 12:88 as predicted in the Environmental Analysis is validated. Based upon my observation and interpretation of these results, the forestry growth model provides a useful tool for assessing and monitoring the impacts to elk habitat from prescribed silvicultural treatments.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:24.

PREDICTING HABITAT CHANGE FOR ELK IN THE CENTRAL EAST SLOPES OF ALBERTA

Webb, S. M. and **R. B. Anderson**
Alberta Conservation Association, Box 336, Rocky Mountain House, AB T4T 1A3

Abstract: In collaboration with the University of Alberta and Alberta Sustainable Resource Development, we developed a habitat-disturbance planning tool that incorporated information from a five-year wolf and elk radio telemetry study in the foothills of Alberta. The goal of this project was to develop a user-friendly GIS planning tool that could be used to evaluate the influence of proposed landscape changes on elk occupancy and survival. The resulting tool allows the user to conduct scenario evaluations by defining the study area extent, then adding new roads, seismic lines, well sites, cutblocks, and/or prescribed burns to the landscape. Map layers are generated for elk habitat states based on predicted elk occurrence, wolf occurrence, and elk survival in summer and winter seasons. These habitat states delineate expected primary and secondary sink and source habitats across the landscape. In this presentation, we describe the development and use of the GIS tool and discuss the predicted habitat value for elk in west-central Alberta.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:25.

Session 2, April 29, 2009
Moderator: Mary Rowland, U.S. Forest Service

ELK USE OF HIGHWAY CROSSING STRUCTURE

Rob Nelson, Research Branch, Arizona Game and Fish Department

Abstract: As traffic volumes and road densities increase throughout Arizona major up-grades are taking place to existing highways and interstates to accommodate Arizona's growing population, these trends magnify the adverse effects on habitat connectivity for elk and other large mammals. One such highway, State Route 260 in central Arizona, provided a great opportunity to promote wildlife connectivity, while minimizing the incidence of wildlife-vehicle collisions along the recently expanded highway. Historically, State Route 260 had a high incidence of wildlife-vehicle collisions, primarily with Rocky Mountain elk (*Cervus elaphus*) in some cases exceeding 6 elk per mile per year. In 2000, Arizona Department of Transportation began reconstruction along a 28 km section of this highway, up-grading it to a four-lane divided highway and implementing 11 sets of wildlife underpasses and six bridges to facilitate wildlife passage across the highway corridor. Elk-proof fencing, along with alternative options to fencing, is being applied along this 28 km section to funnel wildlife to the crossing structures. From 2002-2008, we used data from 110 elk fitted with GPS collars, providing 12 locations per day for two years to determine the effectiveness of the structures by assessing levels of permeability prior to, during, and following reconstruction and completion of wildlife passage structures and associated fencing. Using video camera surveillance systems to evaluate the effectiveness of crossing rate through the structures, we have documented >15,000 animals on film and overall elk passage rates (crossings/approaches) through all crossing structures is 70%. After construction of the underpasses with funnel fencing, elk-vehicle collisions have been reduced by >90% along completed sections of highway. Our findings indicate that wildlife underpasses, in conjunction with funnel fencing, is effective for wildlife connectivity across major roadways. Currently, we are employing GPS technology across many other major highways and interstates in Northern Arizona to recommend where crossing structures should be incorporated into future highway up-grades. Some of these roadways have three times the traffic volumes of State Route 260 which create an increased barrier, minimizing opportunities for wildlife to safely cross roadways. Elk, mule deer (*Odocoileus heminous*), pronghorn antelope (*Antilocapra americana*), and desert bighorn sheep (*Ovis canadensis*) are species being outfitted with GPS collars to assess movement patterns across roadways.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:26.

EFFECT OF ARCHERY HUNTING SEASONS ON ELK PREGNANCY RATES AND CONCEPTION DATES IN THE STARKEY EXPERIMENTAL FOREST AND RANGE, NORTHEASTERN OREGON

Gregory A. Davidson, Bruce K. Johnson, James H. Noyes, Oregon Department of Fish and Wildlife,
La Grande, OR 97850
Brian L. Dick, Michael J. Wisdom, USDA Forest Svc, Pacific NW Research Station, La Grande, OR 97850

Abstract: Calf to adult cow (calf:cow) ratios of elk (*Cervus elaphus*) in northeastern Oregon have been decreasing over the past two decades. Two mechanisms that could contribute to lower calf:cow ratios is reduction in pregnancy rates and delay in conception dates due to human disturbance during the rut. The popularity of archery hunting in Oregon has increased dramatically as rifle hunting opportunities have declined, raising the possibility that the rut may be disrupted due to the coincidence of archery season with the rut. We varied the number of archery hunters in the Starkey Experimental Forest and Range to evaluate effects of archery hunting disturbance on pregnancy rates and conception dates of elk. We estimated and compared pregnancy rates, conception dates, and body condition of adult cow elk bred by bulls ≥3 years of age (bull to cow ratios ≥ 18:100) during years without (n = 6) and with (n = 7) archery seasons concurring with general statewide archery seasons (30-day season, starting the last Saturday in August). Hunter densities were controlled for high densities during 4 years (2.8 tags sold/mi^2) and low densities during 3 years (1.4 tags sold/mi^2). We determined pregnancy status, age, body fat (converted from kidney fat index, [KFI]), lactation status, and the conception dates of fetuses from cow elk killed in December. Using generalized linear models (GLM), we modeled date of conception as the response variable using hunter density, age, lactation status, and body fat as covariates. We tested for differences in pregnancy rates with known fate models in Program MARK using the same covariates. Models containing body fat accounted for 100% of model weights for conception date and pregnancy rate. Models containing hunter density accounted for 88% of the model weights for conception date and 99% of the model weights for pregnancy rate. Models containing the interaction of body fat and hunter density accounted for 57% of the model weights for conception date and 38% of the weights for pregnancy rate. These results indicate strong support for fat and hunter density as explanatory covariates, and moderate support for the interaction of body fat and hunter density. High hunter density combined with low and average fat levels resulted in significantly lower pregnancy rates and later conception dates of lactating cow elk. We did not detect any difference in conception dates among years with low or no archery hunter density. In management units with low calf:cow ratios and high archery hunter densities, managers may want to consider archery hunter density and its potential interaction with nutritional condition as contributing factors.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:27.

SURVIVAL AND MORTALITY OF ELK IN THE WASHINGTON BLUE MOUNTAINS

Scott M. McCorquodale, Paul Wik, and Pat Fowler, Washington Department of Fish and Wildlife

Abstract: We collected data to estimate survival rates and quantify mortality sources among male and female elk ≥ 1 yr-old in the Blue Mountains of Washington during 2003-2006. We instrumented elk with rumen radio-transmitters and traditional radiocollars and monitored their movements and fates via aerial radio-tracking. We estimated survival rates using known fate models in Program MARK, and used model selection criteria to assess the relative evidence for 11 a priori models that embodied simple hypotheses about survival. We did our analyses using 3 alternate versions (Data A, B, C) of our dataset to address censoring issues. We identified a 90% confidence model set that consisted of 6 models for each of the 3 alternate datasets. The top 3 models for Data A and B assumed equal survival for adult (≥4 yr-old) and subadult (2-3 yr-old) bulls; these models differed relative to area and year effects on branch-antlered bull survival. In general, the simplest models (3 and 4-parameter models) were among the best supported; complex models (7 and 8 parameters) had little support. We estimated annual survival rates were 0.38-0.45 for yearling bulls under a spike-only general season structure. Survival of adult and subadult bulls was relatively high (0.79-0.85) during our study when branch-antlered bull permits were very limited. Adult cow survival was approximately 0.75-0.80 among our radiomarked animals. Most of the deaths we recorded were among yearling bulls and were due to nontribal hunting. Tribal hunting and predation were nontrivial sources of mortality and removed relatively equal numbers of elk from among our radiomarked sample. Tribal hunting mostly removed branch-antlered bulls. We documented very few poaching losses, but noted substantial natural mortality among radiomarked adult bulls. Nearly 80% of all deaths occurred during Aug-Dec, strongly peaking during Sept-Nov, when most hunting mortality occurred. We discuss the implications of our findings for management of elk in the Washington Blue Mountains.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:28.

Session 3, April 29, 2009
Moderator: Kevin Robinette, Washington Department of Fish and Wildlife

USE OF HERDING TECHNIQUES TO ENCOURAGE MIGRATION IN SEDENTARY ELK

[1]Holger R. Spaedtke, [1]C. Cassady St. Clair, [2]Mark Hebblewhite
[1]Department of Biological Sciences, University of Alberta, Edmonton, AB
[2]Wildlife Biology Program, College of Forestry and Conservation, University of Montana, Missoula, MT

Abstract: Montane fescue grasslands comprise one of the most threatened ecosystems in Canada. A nationally-important parcel of fescue occurs on the Ya Ha Tinda Ranch just east of Banff National Park, which is also a traditional and important wintering range for elk (*Cervus elaphus*). Over the past two decades, an increasing number of elk have remained on this range during summer, which may eventually threaten the viability of the grassland and, hence, the elk population itself. We assessed use of aversive conditioning on horseback as a means of reducing grazing pressure and restoring migratory behavior in elk. Each spring, from 2005 to 2007, we conditioned elk by herding them daily in the direction of their historic migratory route. We monitored changes in elk distribution by fitting 15 non-migratory elk (determined by earlier studies) with GPS radio collars each year. After three years of aversive conditioning treatments, summer elk presence on the targeted grassland had declined by 30%. Over the same period, elk use had shifted to areas west of the areas targeted, but we did not detect any longer-distance migration in targeted elk. Our research suggests that aversive conditioning in the form of herding on horseback can temporarily reduce grazing pressure on threatened grasslands, but is unlikely to change migratory behavior in a short time period.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:29.

A COOPERATIVE APPROACH TO ELK MANAGEMENT IN THE WILDLAND/URBAN INTERFACE OF MISSOULA, MONTANA – A DYNAMIC STRATEGY FOR A GROWING PROBLEM

Victoria L. Edwards, Montana Fish, Wildlife and Parks, Missoula, Montana 59804
Shawn M. Cleveland, Wildlife Biology Program, University of Montana, Missoula, Montana 59812
Bert Lindler, North Hills Resident, Missoula, Montana 59808

Abstract: The Missoula Valley in western Montana is home to nearly 800 wintering elk, of which 300 are from the North Hills elk herd. From 1980 to 2007, this herd grew from 17 to 290, with a 48% growth rate occurring between 2000 and 2007. Without an effective harvest, this population is projected to double every five years. With increased residential development in elk winter range, a diverse public's opinion on the management objectives of the herd, and the herd's juxtaposition to the City of Missoula and the Rattlesnake Wilderness and National Recreation Area, wildlife biologists have needed to become more creative with their management strategies. To more effectively manage the herd at a sustainable level and to keep it wild, wildlife biologists from Montana Fish, Wildlife and Parks have coordinated and collaborated with numerous landowners and staff at the University of Montana and the USDA Forest Service. This presentation is an integration of the social and biological sciences, with discussions on the successes and failures of tested strategies to manage elk in the wildland/urban interface. The discussion will include the perspective and conservation efforts of a North Hills homeowner, as well as data from a Master student's thesis project on daily/seasonal movements and elk redistribution related to hunting pressure as collected with 10 GPS and 11 VHF collars. The discussion will conclude with a description of the adaptive management approaches utilized by Montana Fish, Wildlife and Parks' wildlife biologists, and the efficacy of those strategies.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:30.

ANTIPREDATOR BEHAVIOR OF ELK IN THE WILDLAND-URBAN INTERFACE: CAN HUMAN HUNTING BE RESTRUCTURED TO REDUCE HABITUATION?

Shawn Cleveland[1], Mark Hebblewhite[1], Mike Thompson[2], Vicky Edwards[2], Bob Henderson[2]
[1] Wildlife Biology Program, University of Montana, Missoula, MT
[2] Montana Department of Fish, Wildlife and Parks, Missoula, MT

Abstract: Many elk populations throughout the western United States are at unprecedentedly high levels. At the same time, urban sprawl into elk winter ranges is occurring throughout the western states. Urban sprawl into elk winter range increases human/elk interaction which leads to habituation. These urban areas represent a significant challenge to wildlife managers given the complex nature of ownerships and beliefs of landowners. Elk hunting, if allowed at all, must be intensively managed to reduce public relations problems. In Missoula, MT, the North Hills elk herd has been growing approximately 11% annually since 1980, with the population currently around 300 animals. Hunting opportunity ranges from complete exclusion to intensively managed special permit hunts. Montana Department of Fish, Wildlife & Parks has focused three hunts on this herd to reduce the population growth rate, reduce crop depredation on local ranches, and maintain a non-habituated elk herd. We used these special hunting seasons to test the efficacy of human hunting for reducing habituation beginning in fall of 2009. Antipredator response data was also collected in four areas across a predation risk gradient; Mammoth, WY, Missoula, MT, Dome Mountain area, MT, and the Lamar Valley, WY. These areas represent low, moderate, and high human predation risk, and wolf only predation risk respectively. We found a significant reduction in antipredator responses at low predation risk compared to all others. Wolves elicited slightly reduced antipredator behaviors than highly and moderately hunted areas which had the highest proportion of antipredator behaviors. Our data also indicate that the proportion of time elk exhibit antipredator behaviors diminishes after the end of active hunting. We used these responses to prescribe an adaptive hunting season framework for the WUI to reduce habituation of elk and human-wildlife conflict within the WUI.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:31.

AN APPROACH TO BALANCING ELK OBJECTIVES AND COUGAR PREDATION

David J. Vales, Muckleshoot Indian Tribe, 39015 172nd Ave. SE, Auburn, WA 98092

Abstract: Wildlife population objectives for predator and prey are often developed independent of each other and without rigorous population analyses. I present a model and management approach developed by the Muckleshoot Wildlife Program to balance cougar (*Puma concolor*) and their principal prey, elk (*Cervus elaphus*) objectives. Our modeling approach will help managers set population objectives and conduct predator management actions necessary to reach those objectives. The model is based upon empirical data collected on radio-marked calves and cow elk over 10 years in the Green and White River drainages of Western Washington. Elk herds had suffered serious declines resulting in unacceptable reduction in harvest opportunity. The study time period spans high cougar numbers before Tribal intervention to reduce cougars as well as post-reduction. I present a fundamental functional relationship of spring calf ratio to calf mortality rate due to cougar that drives model predictions. The effects of other mortality factors on calf and cow mortality, and potential compensatory mortality are also explored. The model predicts "tolerable" numbers of cougars but this requires intensive monitoring of cougars within management areas. The Tribe's micromanagement approach is to radio-mark and monitor the predicted core cougar population compatible with prey population objectives. Several options to consider once elk numbers are at objective are discussed.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:32.

MANAGING IDAHO DEER AND ELK POPULATIONS IN THE WAKE OF WOLF RECOVERY

Pete Zager, Idaho Department of Fish and Game, 3316 16th Street, Lewiston, ID 83501
George Pauley, Idaho Department of Fish and Game, Route 2, Box 192, Kamiah, ID 83536
Craig White, Idaho Department of Fish and Game, 3101 South Powerline Road, Nampa, ID 83686
Mark Hurley, Idaho Department of Fish and Game, P.O. Box 1336, Salmon, ID 83467

Abstract: To establish a demographic benchmark, we captured, evaluated, radio-collared, and monitored 30 adult female mule deer and elk in 12 study areas across Idaho during 2005-08. The study areas represented a broad range of ecological conditions, including wolf densities. Annual survival for elk ranged from 75% in the Lolo Zone to 89% in the Tex Creek and Wieser zones. Hunter harvest and predation were the primary proximate causes of mortality. The proportional role of each varied with Elk Zone. Predation effects varied spatially, probably influenced by factors such as habitat productivity, landscape features, and prey populations. Predation effects also varied temporally as an expanding wolf population seeks a dynamic equilibrium with the prey base. Re-establishment of wolves in Idaho complicates elk management because the effect of predation on ungulate populations is difficult to measure and may be additive, compensatory, or some combination. Nevertheless, predation must be considered within the context of other mortality factors when setting elk harvest goals. Elk population dynamics become an "ecological black box" so the populations are best managed adaptively. To do so requires an effective elk monitoring program that generates accurate and precise population estimates. Hunting opportunity has been reduced substantially to counter declining elk populations in portions of Idaho, even though the relative importance of the factors ultimately responsible for declines is not clear. There is a clear need for a collaborative, large-scale research effort to investigate the mechanisms that drive elk population dynamics in the Northern Rocky Mountains.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:33.

Session 4, April 29, 2009
Moderator: Jerry Nelson, Washington Department of Fish and Wildlife

SURVIVAL AND CAUSES OF MORTALITY OF CALF ELK IN SLED SPRINGS AND WENAHA WILDLIFE MANAGEMENT UNITS, NORTHEASTERN OREGON

Bruce K. Johnson, Priscilla K. Coe, Scott L. Findholt, James H. Noyes Oregon Dept. of Fish & Wildlife, La Grande, OR 97850
John G. Cook, Rachel C. Cook, National Council for Air and Stream Improvement, La Grande, OR 97850
Robert Anthony and Spencer Rearden, Oregon State University, Corvallis, OR 97331

Abstract: Recruitment of elk (*Cervus elaphus*) calves in some management units in northeastern Oregon has declined over the last 30 years raising management, economic, and social concerns. From 2002- 2008 in Wenaha and Sled Springs Wildlife Management Units in NE Oregon, we examined how cow elk nutritional condition and predation affected calf elk survival. Each spring, we estimated body fat, age, and pregnancy status of 40 to 55 cow elk, placed vaginal implant transmitters (VITs) in 35 to 40 pregnant cows, and determined birth date, birth weight, sex, and survival of their calves (n = 101). Additional calves were caught to increase sample size for a total of 460, of which 89 were censored. Each fall, we measured body fat, pregnancy status, and lactation status of cow elk we captured or that were killed by hunters in late fall hunts. Pregnancy rates for all cows 3 to 14 years old were 0.87 $\pm$ 0.05 (95% CI, n = 157) in Wenaha and 0.90 $\pm$ 0.04 (n = 290) in Sled Springs for all years. Pregnancy rates for lactating cows were 0.73 $\pm$ 0.17 (n = 26) in Wenaha and 0.89 $\pm$ 0.05 (n = 170) in Sled Springs for all years. We estimated cougar (*Puma concolor*) densities at the start of elk parturition each year using population reconstruction from ages of 58 cougars we captured and radiocollared and 21 unmarked cougars killed by hunters in our study areas. Densities of subadult females and adults ranged from 1.7 to 4.1 cougars per 100 km^2. We documented 232 calf mortalities. Causes of calf elk mortality included predation [cougar, n = 169; bear, n = 33; unknown, n = 9; coyote (*Canis latrans*), n = 2; and bobcat (*Felix rufus*), n = 1)], unknown (n = 8), human caused (hunting, vehicle, fence n = 6), and disease and abandonment (n = 4). We used known-fate models in Program MARK to estimate survival of VIT calves and all calves from birth through August 31 on a weekly time step, and from birth through 1 year on a monthly time step. We analyzed sets of competing models that included sex, study area, year, birth mass, birth date, and time step along with covariates for time trend, cow mass, age, and body fat in spring and cougar densities. The top-performing models of calf survival were best represented by linear time (T), exponential time (T + TT), or curvilinear time (ln T), with survival lowest for the early time intervals. Birth date entered all top models, with earlier-born calves having higher survival rates than later-born calves; however, birth mass was not in any top models ($\geq$2 ΔAICc). For covariates describing cow elk, cow age entered into some of the top models, with survival higher for calves born to younger cows. Spring fat of cows entered into some models, but its coefficient was negative and overlapped zero, indicating low or no significance. Cougar

density entered into top models with a negative coefficient; as cougar density increased, calf survival decreased. Our data indicated that predation by cougars limited recruitment of elk calves in our 2 study areas; we predict that calf recruitment will increase if cougar populations are reduced. The high predation rates we observed may mask nutritional limitations that would otherwise result in predation leading to at least partially compensatory mortality. We caution managers to carefully consider relationships among pregnancy rates, timing of predation, and nutritional characteristics of elk populations before extrapolating our results to other areas.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:34-35.

WOLF-UNGULATE INTERACTIONS AND POPULATION TRENDS WITHIN THE GREATER YELLOWSTONE AREA, SOUTHWESTERN MONTANA, AND MONTANA STATEWIDE

Kenneth L. Hamlin and **Julie A. Cunningham,** Montana Fish, Wildlife and Parks, 1400 S. 19th Ave, Bozeman, Montana 59718

Abstract: We present results from extensive and intensive monitoring of wolves, elk, and deer across Montana and the Greater Yellowstone Area (GYA). This cooperative effort includes work from Montana Fish, Wildlife and Parks, Montana State University, the National Park Service, and the U.S. Fish and Wildlife Service. Our objectives were to determine what effects wolves may and may not have on elk and deer across Montana. Wolf populations in the northern Rocky Mountains met biological recovery goals in 2002. In Montana, populations continue to rapidly increase (10 to 34% annually). In southwestern Montana and the GYA, wolves primarily prey on elk, generally selecting for calves, against adult females, and variably for or against bulls. Wolf kill rates on elk vary by pack and location, from 7 to 23 elk per wolf per November-April period. Wolves kill fewer elk in summer. In areas with high predator (grizzly bear and wolf) to prey ratios, elk numbers have declined substantially since wolf reintroduction (i.e., the Madison-Firehole, Gallatin, and Northern Yellowstone elk herds). However, areas with lower predator-prey ratios generally show stable to increasing elk numbers (i.e., the west side Paradise Valley, the Madison Valley, and the Gravelly mountain range). We found that elk pregnancy rates were generally unaffected by wolf presence, but declines in calf:cow ratios occurred in areas with high predator densities. Adult female elk survival rates have remained high even during wolf population increase. Additionally, wolves may have small-scale effects on elk spatial distribution and movement rates. In northwestern Montana white-tailed deer are the primary prey of wolves. White-tailed deer numbers are rebounding from a low following the severe winter of 1996-97, and numbers have increased steadily (indexed by buck harvest) through 2006. Recent white-tailed deer highs were below previous highs, but occurred during wolf population increase. White-tailed deer recruitment is key to population growth or decline, and in northwest Montana, recruitment may be affected by harsh winters compounded by predation. Given these influences on recruitment, liberal hunting regulations and antlerless harvest may substantially impact white-tailed deer population dynamics. We conclude that predation can affect ungulate population dynamics, but the nature of these effects, and the effect sizes, may differ from area to area based on the different ecological factors at play in differing landscapes.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:36.

CAUSE-SPECIFIC MORTALITY AND THE ROLE OF PREDATORS AND CLIMATE IN NEONATAL ELK SURVIVAL ACROSS FIVE WESTERN STATES

K. Griffin, M. Hebblewhite, P. Zager, S. Barber-Meyer, S. Creel, N. Harris, M. Hurley, D. Jackson , B. Johnson, W. Myers, J. Raithel, M. Schlegel, B. Smith, C. White, and P. White, University of Montana, Missoula, Montana, 59812.

Abstract: Knowledge of elk (*Cervus elaphus*) calf survival and cause-specific mortality is essential to our understanding of elk population dynamics. Past local studies of elk have demonstrated that survial and cause-specific mortality rates may fluctuate regionally with environmental conditions, habitat quality, the assemblage of predators present, as well as characteristics particular to individuals such as sex, age, birth weight and date, and condition of the mother. A regional meta-analysis of elk calf survival allows researchers to answer questions about the large-scale role of climate, predation, and habitat quality on elk calf recruitment that can not be answered within any one specific study area. Our overall goal is to estimate mean neonatal elk survival rates and variation across broad spatial and temporal scales which include different habitats, predator assemblages, and climatic conditions. For this meta-analysis, we used data from 12 different studies in Oregon, Washington, Idaho, Montana, and Wyoming ranging from 1973-2006. Most mortality of calves occurs within the first summer, thus our analysis was focused on neonatal elk (May – September). We used telemetry data on over 2,000 marked calves to model survival as a function of a number of regional and independent covariates in a Cox proportional hazards framework. We characterize cause-specific mortality and quantify spatial and temporal patterns of elk calf survival across the 5 states. Ultimately, we will provide wildlife managers with a regional perspective of trends in neonate elk survival and its drivers towards a goal of better elk management.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:37.

ELK CALF SURVIVAL IN NORTHCENTRAL IDAHO: INFLUENCE OF PREDATOR HARVEST, BIOLOGICAL FACTORS, AND LANDSCAPE

Craig G. White, Idaho Department of Fish and Game, 3101 S. Powerline Road, Nampa, ID 83686
Peter Zager, Idaho Department of Fish and Game, 3316 16th Street, Lewiston, ID 83501
Michael W. Gratson, Idaho Department of Fish and Game, 3316 16th Street, Lewiston, ID 83501

Abstract: We evaluated survival of elk (*Cervus elaphus*) calves on 2 contrasting study areas in northcentral Idaho from 1997 to 2004. Recruitment was modest (>30 calves:100 cows) and stable on the South Fork study area, and low (<20 calves:100 cows) and declining on the Lochsa study area. The primary proximate cause of calf mortality on both study areas was by black bears (*Ursus americanus*) and mountain lions (*Puma concolor*). We experimentally manipulated populations of black bears and mountain lions on a portion of each study area. Black bear harvest (harvest density/ 600km^2) initially doubled on the Lochsa treatment after manipulating season bag limits. Mountain lion harvest also increased by 60%, but varied widely during the manipulation period. Harvest seasons were closed for black bears and mountain lions on the treatment portion of the South Fork study area. Using Cox proportional hazards model we examined the effects of landscape structure, predator harvest levels, and biological factors on summer calf survival. We used Akaike's Information Criteria (AIC_c) and multi-model inference to assess a number of potentially useful predictive factors relative to calf survival. Our models predicted that calf survival was influenced by biological factors, the landscape surrounding calf locations, and predator harvest levels. The model that best explained mortality risk to calves on the Lochsa included black bear harvest (harvest density/600 km^2), estimated birth mass of calves, and percentage of shrub cover surrounding calf locations. Model averaging indicated that estimated birth mass of calves and black bear harvest were twice as important as the next variables, but the age of calves at capture was also influential in calf survival. The model that best explained mortality risk to calves on the South Fork included black bear harvest, age of calves at capture, and gender of calves. These results suggested that levels of predator harvest, and presumably predator density, resource limitations expressed through calf birth mass, and habitat structure had a substantial effect on calf survival.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:38.

DISCRETE OR CONTINUOUS? COMPARING DIFFERENT PARADIGMS OF SURVIVAL ANALYSIS IN WILDLIFE ECOLOGY

Mark Hebblewhite,[1], M. Hurley[2], A. Mynsberg[1], J. Tucker[1]
[1] Wildlife Biology Program, University of Montana, Missoula, MT, 59812
[2] Idaho Department of Fish and Game, P.O. Box 1336, 99 Highway 93 N, Salmon, ID 83467

Abstract: Wildlife management often depends on knowledge of survival rates to design effective management strategies. Analysis of survival in wildlife studies developed over the last 50-years from simple Mayfield nest survival approaches to sophisticated analyses exemplified by analysis of marked animals using program MARK. In general, the wildlife literature has developed analysis techniques within the discrete-time paradigm of survival analyses, where survival is estimated within discrete intervals. For known-fate data types, with radiocollared animals, however, survival can also be estimated under a continuous time paradigm. The growing popularity of approaches like Cox-proportional hazards regression raises the question about the relative strengths and weaknesses of the two approaches for survival analyses. We review the different assumptions and limitations/advantages of the two paradigms. Then, to evaluate these two paradigms of wildlife we analyzed three datasets typical of common applications in known-fate wildlife studies; over 600 mule deer fawns in 6 game units in Idaho over a 6-year period; 35 black bears in Banff National Park, and n=160 adult female elk in Banff National Park. We analyzed these 3 sample datasets using program MARK and Cox proportional hazards regression with the goals of comparing results (model selection, survival estimates, and covariate effects). Surprisingly, we found differences in all three datasets between the two paradigms in either model selection, covariate effects, and – most troubling of all – survival estimates. Although not conclusive, we feel that reasons for the differences arose from violation of assumptions of the two approaches including the assumption of constant survival within discrete intervals and the assumption of proportional hazards with continuous time approaches. Despite these preliminary results, future work is needed using simulations to determine which approach is valid under what conditions, but we encourage wildlife biologists to carefully consider assumptions made under each paradigm.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:39.

Session 1, April 30, 2009
Moderator: Kevin Robinette, Washington Department of Fish and Wildlife

FECAL INDICES IN MULE DEER WINTERING IN CLOSE PROXIMITY TO ELK

M. Paul Atwood[1], Pete Zager[2], Joshua J. Millspaugh[3], Marjorie D. Matocq[4], R. Terry Bowyer[1], and John G. Kie[1]
[1]Department of Biological Sciences, Idaho State University, Pocatello, ID 83209
[2]Idaho Department of Fish and Game, Lewiston, ID 83501
[3]Department of Fisheries and Wildlife Science, University of Missouri, Columbia, MO 65211
[4]Department of Natural Res. and Environmental Science, University of Nevada Reno, Reno, NV 89512

Abstract: We measured nitrogen, neutral detergent fiber, and glucocorticoid metabolites in mule deer (*Odocoileus hemionus*) feces at Tex Creek Wildlife Management Area near Idaho Falls, Idaho, USA, during Jan-Mar 2007 and Jan-Apr 2008. We also used DNA techniques to determine sex of the individual depositing each fecal group. Finally, we used location data derived from GPS collars placed on elk (*Cervus elaphus*) and kernel techniques to build maps of elk population density for each month for both winters. We then analyzed each fecal index as a function of year, month, sex, elk population density, and interactions among those variables. In 2007, there was a significant positive relationship between elk population density and glucocorticoid metabolites found in deer feces, indicating increased stress among mule deer wintering near large numbers of elk. Conversely, deer fecal nitrogen was inversely related to elk density, possibly because of reduced protein intake when competing closely with elk. Neutral detergent fiber in deer feces, a function of dietary digestibility, did not vary as a function of elk density. No differences between sexes in any of the fecal indices among deer were observed. The first year of this study (2007) was a mild winter, and elk started to leave the winter range in late February. Consequently, glucocorticoid metabolites in deer feces decreased and fecal nitrogen in deer feces increased as elk began to migrate. The increase in deer fecal nitrogen was likely also a result of early green-up of vegetation. The second winter (2008), by contrast, was more severe with deeper snow persisting for most of winter, and both mule deer and elk stayed on the winter range for longer than in 2007. The 2008 data was not all available at this time this abstract was written, but will be presented and discussed at the meeting.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:40.

WASHINGTON HUNTER PUBLIC OPINIONS: USING RESIDENT HUNTER PREFERENCE TO MEET DEER AND ELK POPULATION OBJECTIVES

Dave Ware, Washington Department of Fish and Wildlife

Abstract: Fish and Wildlife Agencies are tasked with managing sustainable deer and elk populations as well as providing hunting recreation. It is obvious to most in the wildlife management profession that this involves consideration of biological factors as well as social factors including hunter preferences. Of the western states, Washington is probably most similar to Oregon and California in terms of reliance on resident hunters for the majority of its license sales and funding. Therefore we spend considerable time and energy in developing hunting opportunities consistent with resident license buyer preferences. This discussion will focus on a couple of recent case studies used to develop agency hunting season regulations. All of the hunting season options we considered were designed to achieve deer or elk population objectives. Those options with the greatest overall support and resulting in the least hunter displacement were generally recommended.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:41.

VIABILITY OF RESIDENT DEER AND ELK HUNTER PARTICIPATION IN MONTANA

Julie A. Cunningham, Montana Fish, Wildlife, and Parks, 1400 S. 19th Avenue, Bozeman, MT, 59718
Justin A. Gude, Montana Fish, Wildlife, and Parks, 1420 East 6th Avenue, Helena, MT, 59620,
Thomas R. Baumeister, Montana Fish, Wildlife, and Parks, 1420 East 6th Avenue, Helena, MT, 59620
Jeffrey T. Herbert, Montana Fish, Wildlife, and Parks, 1420 East 6th Avenue, Helena, MT, 59620

Abstract: The majority of funding for Montana FWP programs is generated or tied to sales of deer and elk hunting licenses. Future declines in deer or elk hunter participation could therefore have negative consequences for wildlife management and conservation programs. To investigate deer and elk hunter participation rates in Montana, we made use of the FWP Automated Licensing System (ALS) database. Since 2002, the number of individuals buying deer and elk licenses has been roughly stable. We converted the data in ALS to a 6 (years) by 255,851 (unique individuals) matrix of resident hunter encounter histories for the period 2002-2007. Using a multi-state mark recapture model, we estimated hunter retention rates, hunter license buying probabilities, and transition probabilities between major age classes, considering hunter sex and region of residence as group covariates. We then used FWP hunter education databases to estimate hunter recruitment rates. Using these estimated rates, we parameterized and analyzed a stage-based population projection matrix. Estimated recruitment rates for teenagers following hunter education courses were sufficient to stabilize the trend in deer and elk hunter participation, given our estimates of retention and license buying rates, in agreement with the overall trend in license sales for 2002-2007. Based on sensitivity and elasticity analyses of the projection matrix, future hunter participation rates and license sales would be most influenced by increases in recruitment rates and license buying probabilities for middle-aged adult and teenage males. We discuss the implications of these results for FWP hunter recruitment and retention efforts and social trends.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:42.

2006 IDAHO MULE DEER HUNTER OPINIONS AND ATTITUDE SURVEY

Boudreau, Toby A., B.B. Compton, R.B. Smith, J.S.Rachael, B. Ackerman, N. Sanyal, E. Krumpe, D. Coombs

Abstract: A statewide random survey of Idaho's mule deer hunters was conducted in 2007. Objectives of the survey were to measure current hunter demographics and hunter attitudes about mule deer populations, managing for quality versus opportunity, elk versus deer management, antlerless harvest, and off road vehicles. Included in the survey were a series of questions about motivations of hunters that were asked in similar surveys conducted in 1971 and 1989, to identify and compare changes in hunter motivations. Results indicate that attitudes about mule deer and motivations of hunters have changed during the past 35 years. During the 1970s, meat was an important motivation for hunting deer. In the 1980s, nature-related variables were most important. In the most recent survey, participating in a recreational activity with friends and family was a primary motivation for mule deer hunting. When faced with forced-choice options, most hunters chose opportunity to hunt more frequently rather than the opportunity to hunt for large antlered deer less frequently. Additionally, hunters did not favor deer management at the cost of elk populations, favored more restrictions on Off Road Vehicle use, and found antlerless harvest acceptable under certain conditions. Overall mule deer hunter satisfaction was higher than expected based on general public meeting input.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:43.

MONTANA'S HARVEST SURVEY PROGRAM

Robin Russell, Biometrician, Justin Gude, Keri Wash
Montana Fish, Wildlife, and Parks

Abstract: Montana Fish, Wildlife, and Park's Harvest survey program uses stratified random sampling to survey 80,000 households a year and gain valuable feedback on hunter harvest rates, hunter success, and time spent by hunters in different hunting districts across Montana. By randomly selecting hunters, Fish, Wildlife, and Parks is able to make inferences regarding the unsampled population. We present an overview of Montana's Harvest Survey Program, results from recent surveys, and discuss potential areas of improvement including measuring bias in non-responder hunting behavior and improving hunter response rates.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:44.

Session 2, April 30, 2009
Moderator: Dave Ware, Washington Department of Fish and Wildlife

HAIR-LOSS SYNDROME IN DEER IN SOUTH CENTRAL WASHINGTON

Jeffrey A. Bernatowicz, Washington Dept. of Fish & Wildlife, 1701 South 24th Ave, Yakima, WA 98902
Kristin Mansfield, Washington Dept. of Fish & Wildlife, 2315 N. Discovery Place, Spokane, WA 99216
James W. Mertins, National Veterinary Services Laboratories, Ames, Iowa
William Moore, Washington Dept. of Fish and Wildlife, 1701 South 24th Ave, Yakima, WA 98902

Abstract: We sampled 15 deer during winter or early spring 2005, 2006 and 2008. Eight deer had signs of hair-loss syndrome (HLS); 7 did not. Lice were found on all deer with HLS and 6 of 7 with no clinical HLS signs. All lice were identified as *Bovicola tibialis,* a parthenogenic chewing louse native to Eurasian fallow deer (*Dama dama*). This is the first documentation of *B. tibialis* in Washington and HLS from *B. tibialis*. Thirty-nine hunter harvested deer were sampled in fall 2005. No lice were found, and no deer exhibited any sign of HLS during fall. Aerial deer population surveys have been flown over portions of the winter range since 2003. The population surveys indicated a decline of 30-50% since deer with signs of HLS first appeared. The pattern of deer population decline does not match any weather pattern, and HLS is believed to be a contributing factor. Buck harvest across the area has declined 79% since the early 1990's, although a regulation change to three-point minimum is partially responsible. HLS is impacting both black-tailed deer (*Odocoileus hemionus columbianus*) and mule deer (*Odocoileus hemionus hemionus*). *B. tibialis* appears to be very similar to *Damalinia (Cervicola) spp.* which causes HLS in Columbian black-tailed deer (*Odocoileus hemionus columbianus*) in western Washington (Bildfell et al. 2004). *B. tibialis* but does not appear to reach the densities or be spread as rapidly as *Damalinia (Cervicola) spp*. The lack of *Damalinia (Cervicola) spp.* in southcentral Washington and *B. tibialis* in western Washington suggests lice are spreading in either late fall or winter.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:45.

DISEASE IN THE NEW WEST: BRUCELLOSIS IN FREE-RANGING ELK OF THE GREATER YELLOWSTONE ECOSYSTEM

P.C. Cross[1], E.K. Cole[2]*, A.P. Dobson[3], W. H. Edwards[4], K.L. Hamlin[5], G. Luikart[6], A.D. Middleton[7], B.M. Scurlock[8], P.J. White[9]
[1] U.S. Geological Survey, Northern Rocky Mtn. Science Ctr., 229 AJM Johnson Hall, Bozeman MT 59717 pcross@usgs.gov
[2] U.S. Fish and Wildlife Service, National Elk Refuge, PO Box 510, Jackson WY 83001
[3] Princeton University, 224 Guyot Hall, Princeton, New Jersey 08544
[4] Wyoming Game and Fish Department, PO Box 3312, Laramie, Wyoming 82071
[5]Montana Fish, Wildlife, and Parks, 1400 S. 19th Ave., Bozeman, MT 59718
[6] Centro de Investigacao em Biodiversidade e Recursos Geneticos, University of Portugal, Vairão, Portugal; and Division of Biological Sciences, Health Sciences Building, Rm. 105, University of Montana, Missoula, MT
[7]Cooperative Fish and Wildlife Research Unit and Program in Ecology, 1000 E. University Ave. University of Wyoming, Laramie, WY 82071
[8] Wyoming Game and Fish Department, PO Box 850, Pinedale, Wyoming 82941
[9] National Park Service, PO Box 168, Yellowstone National Park, WY 82190

Abstract: While many wildlife species are threatened, some populations have recovered from previous overexploitation. We show that free-ranging elk (*Cervus elaphus*) are now a maintenance host for *Brucella abortus* in new areas of the Greater Yellowstone Ecosystem (GYE). Brucellosis seroprevalence in free-ranging elk increased from 0-7% in 1991-1992 to 8-20% in 2006-2007 in 4 of 6 herd units around the GYE, which was comparable to some herd units where elk are artificially aggregated on supplemental feedgrounds. There are several possible mechanisms for this increase that we evaluated using statistical and population models. Simulations of an age-structured population model suggested that high levels of seroprevalence are unlikely to be sustained by dispersal from areas with supplemental feedgrounds or a changing age structure. Increases in brucellosis seroprevalence and the total elk population size in areas with feedgrounds have not been statistically detectable. Meanwhile, the rate of seroprevalence increase was related to the population size and density of each herd unit. Therefore, data suggest that enhanced elk-to-elk transmission in free-ranging populations may be occurring due to larger winter aggregations. Elk populations inside and outside of the GYE that traditionally did not maintain brucellosis may now be at risk due to recent population increases. In particular, some neighboring populations of Montana elk were five to nine times larger in 2007 than in the 1970's with some aggregations that were comparable to the Wyoming feedground populations. Addressing the unintended consequences these increasing populations present is complicated by limited hunter access to private lands, which puts many ungulate populations out of administrative control. Agency-landowner hunting access

partnerships and the protection of large predators are 2 management strategies that may be used to target high ungulate densities in private refuges and reduce the current and future burden of disease. In our ongoing research, we are using hierarchical Bayesian models to assess the spatial structure of brucellosis seroprevalence.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:46-47.

BRUCELLOSIS IN MONTANA ELK POPULATIONS: SURVEILLANCE STRATEGIES AND SEROPREVALENCE OF BRUCELLOSIS IN ELK POPULATIONS OF MONTANA

Neil Anderson and Jennifer Ramsey, Montana Dept. of Fish, Wildlife and Parks, 1400 South 19th Ave., Bozeman, MT 59718

Abstract: Montana Fish, Wildlife and Parks (MFWP) has been conducting surveillance for brucellosis in wild elk populations since the early 1980's. To date, brucellosis has only been detected in elk populations in the area surrounding Yellowstone National Park. The recent loss of Montana's brucellosis free status has resulted in increased concern over the disease in elk. As a result MFWP initiated a large-scale surveillance program aimed at determining the geographic distribution and seroprevalence of brucellosis in elk populations. A brief history of surveillance efforts, the most recent surveillance efforts and the potential influence of changing elk distribution parameters on brucellosis seroprevalence are discussed.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:48.

GREATER YELLOWSTONE AREA ELK MOVEMENTS: BRUCELLOSIS RISK AND HUNTER ACCESS

Kenneth L. Hamlin and Julie A. Cunningham, Montana Fish, Wildlife and Parks, 1400 S. 19th Ave, Bozeman, Montana 59718
Thomas O. Lemke. Montana Fish, Wildlife & Parks. 406 Chestnut Lane N., Livingston, Montana 59047
Justin A. Gude, Montana Dept. of Fish, Wildlife, and Parks, 1420 East 6th Avenue, Helena, MT 59620

Abstract: We examined elk (*Cervus elaphus*) movement data from across the Greater Yellowstone Area (GYA; Montana, Idaho and Wyoming) 1976-2006, comparing and contrasting movement patterns within and between elk herd units. Our objectives were to understand how public hunter access related to elk movement and brucellosis risk. Focus areas included the Madison, Gallatin and east side Paradise Valley (the Northern Yellowstone herd). In the Madison Valley, we compared movement dynamics of 27 cow elk monitored 1976-1986 (VHF collars) and 43 cow elk monitored 2005-2006 (GPS collars). During 2005-2006, we also monitored a wolf pack with GPS and VHF collars, and examined wolf movements relative to the elk herd. Between 1976-1986 and 2005-2006, land ownership changes occurred that reduced or eliminated hunter access to large tracts of private land. We found that, compared with 1976-1986, elk monitored in 2005-2006 migrated earlier to wintering ranges, left later to summer ranges, and used private land areas more extensively. During the rifle season, cow elk monitored 2005-2006 were less available to hunters due to increased use of private land (41.7% of locations) than elk monitored 1976-1986 (3.3% of locations). Wolves did not appear to influence large-scale elk movements, with highly overlapping kernel density estimators. In the Northern Yellowstone (NY), we compared elk movements from 1984-1987 (VHF collars) with preliminary data from 2007-2008 (GPS collars). NY elk migrated to and from winter range generally in accordance with weather conditions, and overlapped with cattle ranches less than Madison elk. Some cows were more available to public hunters than others (range = 0% to 100%) based on behavioral and movement patterns. Data from 2007-2008 indicate Northern Yellowstone elk spend summertime further south and west in Yellowstone National Park than had previously been thought, and that Northern Yellowstone elk may be coming into contact with Jackson Hole, WY elk on these ranges. We conclude that elk may become concentrated on private lands where public hunting is prohibited, potentially resulting in large-scale changes in elk migratory and distributional behavior. Further, elk migration and distribution affect brucellosis risk differently in different areas.

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:49.

COMPREHENSIVE RANGE WIDE PHYLOGEOGRAPHY OF MULE DEER (*ODOCOILEUS HEMIONUS*)

Emily K. Latch[1], **James R. Heffelfinger[2]**, and Olin E. Rhodes[3]

[1] Department of Biological Sciences, University of Wisconsin – Milwaukee, 3209 N. Maryland Ave., Milwaukee, WI 53211
[2] Arizona Game and Fish Department, 555 N. Greasewood Road, Tucson, Arizona 85745, jheffelfinger@azgfd.gov
[3] Purdue University, Department of Forestry and Natural Resources, West Lafayette, IN 47907

Abstract: Repeated glaciation of western North America during the Pleistocene profoundly impacted biota in the North Temperate Zone, and has been recognized as a dominant force in shaping the evolutionary trajectory of many species. During the last 18,000 years, beginning with the retreat of the ice sheets, many organisms expanded their ranges into recently de-glaciated areas as suitable habitat became available. Signatures of glacial expansion and contraction cycles remain in many species, and the genetic legacy of refugial isolation often is reflected in the subspecific taxonomic classifications that currently are recognized. Although large, vagile herbivores would have been significantly impacted by the climatological conditions associated with glaciation events, such species should have been able to recolonize newly available habitats quickly. However, for species such as *Odocoileus hemionus* (black-tailed and mule deer), whose modern range includes both coastal and southern ice-free regions and areas once covered by the Pleistocene ice sheets, it is difficult to predict where refugia might have existed and what role more stable, southernmost populations of this species may have played in shaping the phylogenetic patterns currently supported. Eleven subspecies of mule deer have been recognized across this species' range in North America and, although several studies have revealed portions of the underlying genetic basis for phenotypic variation in this species, no comprehensive, range wide analysis of genetic diversity in this species has been conducted to help clarify the taxonomic and management conundrum that this species poses. In this study we utilize mitochondrial sequence data from more than 1,700 black-tailed and mule deer, representing 70 sampling locations distributed across their range, to achieve 2 goals: 1) to characterize the range wide phylogeographic patterns within *O. hemionus*; and 2) to identify potential Pleistocene refugia associated with postglacial recolonization of *O. hemionus.*

WESTERN STATES AND PROVINCES DEER AND ELK WORKSHOP PROCEEDINGS 8:50.