52ND NORTH AMERICAN MOOSE CONFERENCE

2018

SPOKANE, WASHINGTON

MAY 14 - 18, 2018

Hosted by Washington Department of Fish and Wildlife

WELCOME MESSAGE

Thank you for joining us at the 52nd Annual North American Moose Conference and Symposium. We hope you will enjoy your time in northeast Washington, take advantage of some of what Spokane has to offer, and engage with colleagues and moose enthusiasts to learn more about these incredible animals and the environments that support them.

On behalf of the Washington Department of Fish and Wildlife, we are thrilled to serve as your host. Feel free to catch any of us with questions during your time here.

Rich Harris, 2018 NAMC Chair

PLANNING COMMITTEE

Michael Atamian
Melia DeVivo
Sarah Kindschuh
James Goerz
Carrie Lowe
Jared Oyster
Annemarie Prince
Kevin Robinette
Chris Loggers
Carmen Perez-Frayne

SCHEDULE AT A GLANCE

MONDAY

3 PM - 7 PM	Registration (Grand Ballroom Foyer)
7 PM - 9 PM	Welcome Reception

TUESDAY

7 AM	Registration (Grand Ballroom Foyer)
8 - 8:20 AM	Opening Remarks
8:20 - 10 AM	Technical Session I
10 - 10:20 AM	Break
10:20 - 12	Technical Session II
12 - 1:00 PM	Lunch (provided)
1 - 2:40 PM	Workshop I
2:40 - 3:00 PM	Break
3 - 5:20 PM	Workshop II

WEDNESDAY

8 - 8:20 AM	Announcements
8:20 - 10 AM	Technical Session III
10 - 10:20 AM	Break
10:20 - 12	Technical Session IV
12 - 1:30 PM	Lunch (provided)
1:30 - 2:45 PM	Technical Session V
2:45 - 3:00 PM	Break
3 - 4:15 PM	Technical Session VI
4:15 - 5 PM	Poster Session
7:30 - 8:30 PM	Presentation

THURSDAY

7 AM - 5 PM	Field Trips
6 PM	Banquet, Awards & Auction (Salon I-III)

FRIDAY

8 - 9:10 AM	Technical Session VII
9:10 - 10 AM	Panel Discussion
10 - 10: 30 AM	Closing Remarks/Announcements

DOUBLETREE MAP

2018 NAMC CONFERENCE

322 North Spokane Falls Court, Spokane, WA

All events will be in Salon V unless otherwise noted

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CONFERENCE SCHEDULE

All events located in Salon V unless otherwise noted

MONDAY, MAY 14, 2018

3:00 – 7:00 PM **REGISTRATION OPEN** *Grand Ballroom Foyer*

7:00 – 9:00 PM **WELCOME RECEPTION WITH NO-HOST BAR** *Salon V*
Come enjoy light hors d'oeuvres and meet participants

TUESDAY, MAY 15, 2018

Breakfast on your own

7:00 – 10:00 AM **REGISTRATION OPEN** *Grand Ballroom Foyer*

8:00 – 8:20 AM **OPENING REMARKS, INTRODUCTION** *Salon V*
Rich Harris, WDFW, 2018 Conference Chair

8:20 – 10:20 AM **TECHNICAL SESSION I: POPULATION DYNAMICS**
Session Chair: Jared Oyster

8:20 – 8:45 AM Determining factors affecting moose population change in British Columbia: a 5-year summary
Heidi Schindler, Gerald Kuzyk, Shelley Marshall, Chris Procter, Becky Cadsand, Helen Schwantje, and Michael Gillingham

8:45 – 9:10 AM Survival rates of 7-month old moose calves in light of continued population declines in central B.C – preliminary results
Shelley Marshall, Chris Procter, and Gerald Kuzyk

9:10 – 9:35 AM Moose population dynamics in Montana
Nicholas J. DeCesare and Jesse R. Newby

9:35 – 10:00 AM Vital rates of moose in two adjacent Washington study areas
James Goerz, Jared Oyster, and Rich Harris

10:00 – 10:20 AM **BREAK**

10:20 – 12:00 PM **TECHNICAL SESSION II: POPULATION ASSESSMENT**

Session Chair: Michael Atamian

10:20 -10:45 AM Estimating winter moose population parameters using spatially explicit capture-recapture modeling of fecal DNA genotypes: a case study from Yellowstone National Park
Ky B. Koitzsch, Jared L. Strasburg, Lisa O. Koitzsch, Colby B. Anton, Tessa L.Tjepkes, and Abby C. Shuman

10:45 – 11:10 AM A model-based optimal sampling approach to survey moose using expert opinion and landscape characteristics
Sophie M. Czetwertynski, Subhash Lele, Peter Solymos, and Mark O'Donoghue

11:10 AM – 12:00 PM Overview of population survey and allowable harvest strategies in the West
Washington, Idaho, Montana, British Columbia, Utah, Colorado, North Dakota, Wyoming

12:00 – 1:00 PM **LUNCH (provided)**

1:00 -2:40 PM **WORKSHOP I: INTEGRATED MODELS TO BETTER UNDERSTAND MOOSE POPULATIONS I**
Brock Hoenes, Washington Department of Fish and Wildlife
Josh Nowak, University of Montana
Michael Clawson, University of Washington-Montana and University of Missouri

2:40 – 3:00 PM **BREAK**

3:00 – 5:20 PM **WORKSHOP II: INTEGRATED MODELS TO BETTER UNDERSTAND MOOSE POPULATIONS II**

Dinner on your own

WEDNESDAY, MAY 16, 2018

Breakfast on your own

8:00 – 8:20 AM **ANNOUNCEMENTS, HOUSEKEEPING** *Salon V*
Rich Harris, WDFW, 2018 Conference Chair

8:20 – 10:00 AM **TECHNICAL SESSION III: DISEASE AND PARASITES**
Session Chair: Melia DeVivo

8:20 – 8:45 AM Calf moose - winter tick relationships in northern New Hampshire: a 5-year summary
Daniel D. Ellingwood, Peter J. Pekins, Henry Jones, and Brent I. Powers

8:45 – 9:10 AM Surviving winter tick infestations in a bioenergetic model or "Sucks to be a moose calf"
Peter J. Pekins

9:10 – 9:35 AM The impacts of winter ticks on Utah moose
Sam D. Robertson, Kent R. Hersey, and Dan R. MacNulty

9:35 – 10:00 AM An update on *Elaeophora schneideri* in western North American Moose
Jared H. Oyster, Nicholas J. DeCesare, Karen A. Fox, Richard B. Harris, Kent R. Hersey, Patrick E. Matthews, Hollie M. Miyasaki, Margo J. Pybus, Helen M. Schwantje, Jason R. Smith, and Timothy P. Thomas

10:00 – 10:20 AM **BREAK**

10:20 – 12:00 PM **TECHNICAL SESSION IV: INTEGRATING BEHAVIOR, PHYSIOLOGY, AND POPULATION**
Session Chair: Carrie Lowe

10:20 – 10:45 AM Timing of moose conceptions and adult sex ratio
T. Nygrén

10:45 – 11:10 AM Temporal conflict between moose hunters: Differences between hunting regions and hunter type
T.R. Hasbrouck, and T.J. Brinkman

11:10 – 11:35 AM The behavior of wolves hunting ungulate neonates in Minnesota
Austin T. Homkes, Steve K. Windels, Thomas D. Gable, John G. Bruggink and Joseph Bump

11:35 – 12:00 PM Preliminary genome-wide sequence data to investigate moose sub-species designation
Jason A. Ferrante, Laura Thompson, and Margaret E. Hunter

12:00 – 1:30 PM LUNCH (PROVIDED): ALCES BUSINESS MEETING
All conference attendees are welcome to join this working lunch

1:30 – 2:45 PM TECHNICAL SESSION V: HABITATS
Session Chair: Annemarie Prince

1:30 – 1:55 PM Variation in the nutritional landscape links forest management to population performance of moose
T. V. Schrempp, J. L. Rachlow, T. R. Johnson, L. A. Shipley, R. A. Long, J. L. Aycrigg, and M. A. Hurley

1:55 – 2:20 PM Moose adaptation to local habitat conditions
Ron A. Moen and Steve K. Windels

2:20 – 2:45 PM Estimating carrying capacity for moose in Adirondack Park, New York
Samuel S. Peterson, John Stella, and Jacqueline Frair

2:45 – 3:00 PM BREAK

3:00 – 4:15 PM TECHNICAL SESSION VI: HABITATS
Session Chair: Kevin Robinette

3:00 – 3:25 PM Influence of temperature on habitat selection and movement rates of moose in northwestern North Dakota
James J. Maskey Jr. and Jason R. Smith

3:25 – 3:50 PM Variation in summer habitat selection of moose across an urban-wildland interface in northeast Washington
James W. Goerz, Richard B. Harris, Jared H. Oyster and Michael S. Mitchell

3:50 – 4:15 PM Assessing the utility of a spatio-temporally dynamic wind index in Alaskan moose resource selection under thermal stress
Jyoti S. Jennewein, Peter Mahoney, Arjan J.H. Meddens, Sophie Gilbert, Mark Hebblewhite, Natalie Boelman, Scott Brainerd, Kyle Joly, Kim King Jones, Tom Paragi, Kalin Seaton, Graham Frye, Lee A. Vierling, and Jan U.H. Eitel

4:15 – 5:00 PM **POSTER SESSION**

Poster presenters will be attending their posters to answer your questions. Stop and visit our sponsor booths!

Dinner on your own

7:30 – 8:30 PM **SPONSOR PRESENTATION BY OnXmaps**

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THURSDAY, MAY 17, 2018

Breakfast on your own

7:00 – 5:00 PM **FIELD TRIPS**

6:45 AM meet outside the Double Tree to load vans/buses

Mt. Spokane – Meet at the vans

Little Pend Oreille – Meet at the mini-bus

If unsure which you have registered for, please check the list at the Registration Desk.

6:00 PM **BANQUET, AWARDS AND AUCTION** *Salon I-III*

Guest Speaker: Woody Myers, Retired WDFW Ungulate Research Scientist

FRIDAY, MAY 18, 2018

Breakfast on your own

8:00 – 8:20 AM **ANNOUNCEMENTS, HOUSEKEEPING** *Salon V*

Rich Harris, WDFW, 2018 Conference Chair

8:20 – 9:30 AM **TECHNICAL SESSION VII: MOOSE/HUMAN RELATIONSHIPS**

Session Chair: Rich Harris

8:20 – 8:45 AM Possible implications of climate-influenced range shifts in moose on wildlife rehabilitation in the contiguous United States

Lauren A. Caruso

8:45 – 9:10 AM Dealing with nuisance urban moose near Spokane Washington

JoLynn Beauchene

9:10 – 10:00 AM **PANEL DISCUSSION**

Philosophies and practice in dealing with human/moose interactions

Candace Bennett, Roy Rea, Tim Thomas, JoLynn Beauchene, and others

10:00 – 10:30 AM **CLOSING REMARKS, ANNOUNCEMENTS- PLANS FOR NEXT YEAR**

DETERMINING FACTORS AFFECTING MOOSE POPULATION CHANGE IN BRITISH COLUMBIA: A 5-YEAR SUMMARY

HEIDI SCHINDLER[1], GERALD KUZYK[2], SHELLEY MARSHALL[3], CHRIS PROCTER[4], BECKY CADSAND[5], HELEN SCHWANTJE[6], AND MICHAEL GILLINGHAM[7]

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7 University of Northern British Columbia, 3333 University Way, Prince George, British Columbia V2N 4Z9, Canada

Abstract: In December 2013, the British Columbia Government initiated a 5-year moose research project in response to declining moose numbers in central areas of the province. Because population declines coincided with an extensive mountain pine beetle (MPB) outbreak, we are evaluating a landscape change hypothesis that suggests extensive pine tree mortality and subsequent logging activity (road building and tree removal) has increased the vulnerability of moose to hunters and predators. To test this, we selected five study areas with variable amounts of MPB and instrumented cow moose with GPS radio-collars to determine survival rates, causes of mortality, and factors that contribute to their vulnerability. As of May 1, 2017, of the 388 radio-collars deployed, 216 were active, 101 were censored (i.e., dropped at end of battery life, stopped collecting data or slipped from moose), and 71 were recovered from moose that died. Probable proximate cause of death for the 71 mortalities were predation (35), hunting (12; 1 licensed, 11 unlicensed), health-related (16; 8 apparent starvation, 3 septicemia, 1 peritonitis, 4 unknown health-related), natural accident (3), and unknown (5). The combined annual survival rate of cow moose was 92% (95% CI: 84.6 - 99.4) in 2013-14, 92% (87.4 – 96.6) in 2014-15, 86% (81.7 – 90.3) in 2015-16, and 89% (82.8 – 95.2) in 2016-17. The majority of cow moose were in good body condition at the time of capture; however, some cows captured in 2017 were in very poor or emaciated condition.

SURVIVAL RATES OF 7-MONTH OLD MOOSE CALVES IN LIGHT OF CONTINUED POPULATION DECLINES IN CENTRAL BC – PRELIMINARY RESULTS

SHELLEY MARSHALL[1], CHRIS PROCTER[2], and GERALD KUZYK[3]

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[2] *Ministry of Forests, Lands and Natural Resource Operations, 1259 Dalhousie Drive, Kamloops, British Columbia V2C 5Z5, Canada*

[3] *Ministry of Forests, Lands and Natural Resource Operations, 205 Industrial Road G, Cranbrook, British Columbia V1C 7G5, Canada*

Abstract: In January 2017, the British Columbia Government began investigating factors influencing the survival of 7-month old moose calves because cow survival rates from 2013-2018 were sufficient to support stable moose populations but moose populations continue to decline in central areas of the province. We fit 7-month old calves with satellite-enabled GPS collars in 2 study areas (Bonaparte and Prince George South). Our objectives were to determine calf survival rates, causes of mortality, factors that contribute to their vulnerability, and true recruitment and its influence on moose population change. We aimed to collar cow/calf pairs, either by collaring calves of existing collared cows or capturing new cow/calf pairs. In winter 2016-17, 20 calf collars were deployed (12F, 8M calves) in Bonaparte, 19 of which were collared cow/calf pairs. In winter 2017-18, 20 calf collars were deployed (5F, 15M calves) in Bonaparte, all of which were collared cow/calf pairs, and 20 calf collars were deployed (11F, 9M calves) in Prince George South, 15 of which were collared cow/calf pairs. Of the 20 calves collared in 2016-17, 11 died prior to one year of age. Proximate causes of mortality were predation (4 wolf, 1 bear), health-related (4 apparent starvation, 1 unknown health-related with health tests pending), and vehicle collision (1). None of the 8 male calves survived past October; 2 male calves died as yearlings during the fall hunting season. Calf survival rate from the date of capture (Jan/Feb 2017) to 1 year of age was 45 ± 22% (±95% CI). Of note, 77% of the mortalities occurred in April.

MOOSE POPULATION DYNAMICS IN MONTANA

NICHOLAS J. DECESARE AND JESSE R. NEWBY

Montana Fish, Wildlife & Parks, 3201 Spurgin Road, Missoula, MT 59804, 406-542-5558, ndecesare@mt.gov

Abstract: Facing indication of moose (*Alces alces*) population declines in Montana and elsewhere in recent decades, Montana Fish, Wildlife & Parks began a 10-year study in 2013. We aimed to estimate population growth rates and vital rates, and to assess the relative influence of a suite of factors potentially limiting moose populations in three study areas. During 2013–18, we have captured and radio-collared 141 adult female moose, and annually monitored vital rates of adult survival, pregnancy, parturition, litter size, and calf survival associated with each collared female. Preliminary results from the first four biological years of monitoring are indicative of 3 different scenarios playing out across the three study areas. In the Cabinet-Fisher area of northwest Montana, relatively high adult female annual survival (0.93, SE = 0.026) coupled with lower rates of fecundity (0.63 calves/female) and calf survival (0.31, SE = 0.065) have yielded a stable to slightly increasing population growth rate estimate of $\lambda = 1.02$. In the upper Big Hole Valley of southwest Montana, somewhat lower adult survival (0.837, SE = 0.036) coupled with higher rates of fecundity (0.71 calves/female) and calf survival (0.437, SE = 0.063) translate to stable to slightly decreasing population growth rate estimate of $\lambda = 0.98$. Lastly, on the Rocky Mountain Front, high rates of all vital rates, including adult female survival (0.927, SE = 0.027), fecundity (0.81 calves/female), and calf survival (0.507, SE = 0.063) indicate an increasing population, with an estimated growth rate of $\lambda = 1.12$. We have not yet completed formal sensitivity analyses of vital rates or limiting factors, but results to date suggest meaningful roles being played by parasites, predators, and nutrition, each to varying degrees depending upon the study area.

VITAL RATES OF MOOSE IN TWO ADJACENT WASHINGTON STUDY AREAS

JAMES GOERZ[1], JARED OYSTER[2], and RICH HARRIS[3]

[1] *University of Montana – Missoula, Montana Cooperative Wildlife Research Unit, Missoula, MT 59812, james.goerz.umontana.edu*
[2] *Washington Department of Fish and Wildlife, Spokane, WA 99216*
[3] *Washington Department of Fish and Wildlife, Olympia, WA 98501*

Abstract: Relative newcomers to the state, moose evidently increased in abundance and distribution throughout the northeastern portion of Washington State from the 1970s through approximately 2013. In that year, the Washington Department of Fish and Wildlife and the University of Montana began a cooperative study of moose demography in 2 adjacent study areas north of Spokane, Washington. Two wolf packs have had territories that included the northern study area during 2013-2018; to date, only occasional lone individual wolves (presumably dispersers) have been documented in the southern study area. Topography and vegetation are similar among the study areas, although industrial timberland and private ownership is more common on the southern study area, whereas US Forest Service ownership predominates in the northern area. We followed the fate of 46 GPS-collared cow moose (and their calves) in the northern area, and 27 in the southern study area captured during Decembers of 2013, 2014, and 2016. Our Kaplan-Meier estimates of mean annual adult female survival from 1 January 2014 through 31 December 2017 were similar in the 2 study areas: 0.80 (95% confidence interval 0.72—0.89) in the northern and 0.81 (95% confidence interval 0.72—0.90) in the southern. Causes of death, however, differed. In the northern area, 10 of 18 mortalities with known causes were health/external parasite related, and an additional 7 were attributed to predation (5 wolf, 2 cougar). In the southern study area, 11 of 14 mortalities were from legal hunter-harvest and none from predation. Because we did not collar calves (depending on repeated observations to quantify survival), our estimates of calf survival were subject to additional uncertainty. Using a protocol that required 2 high quality observations of the cow unaccompanied by a calf to consider a mortality to have occurred, mean annual (1 June—31 May) calf survival was 0.31 (0.18—0.53) in the northern study area, and 0.68 (0.53—0.88) in the southern study area. Using a protocol that required a single high quality observation of the cow unaccompanied by a calf to consider a mortality to have occurred, mean annual (1 June—31 May) calf survival was 0.11 (0.05—0.26) in the northern study area, and 0.48 (0.34—0.68) in the southern study area. We suspect truth lies between these 2 estimates of calf survival, and are currently exploring using a Cormack-Jolly-Seber approach to estimate it. Estimated mean fecundity (calves/females in early summer) was 0.56 in the north and 0.70 in the south. Point estimates of the annual growth rate (λ) were 0.75—0.84 for the northern and 0.94—0.99 for the southern area. We discuss what we know, and what we still hope to understand through further analyses.

ESTIMATING WINTER MOOSE POPULATION PARAMETERS USING SPATIALLY EXPLICIT CAPTURE-RECAPTURE MODELING OF FECAL DNA GENOTYPES: A CASE STUDY FROM YELLOWSTONE NATIONAL PARK

KY B. KOITZSCH[1], JARED L. STRASBURG, LISA O. KOITZSCH, COLBY B. ANTON, TESSA L.TJEPKES, ABBY C. SHUMAN

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*Abstract***:** Estimating population parameters for moose (*Alces alces*) can be difficult due to their preference for densely vegetated habitats, low degree of sociability, and occurrence at low density. Winter aerial surveys, the standard for collecting population data, are subject to sightability bias and can be logistically challenging. Capture for mark-resight studies is invasive and is not permitted in certain study areas. Furthermore, some mark-recapture models do not adequately address heterogeneity in capture probability of individuals, their spatial distribution relative to survey effort, and problems associated with determining effective trapping area. However, accurate demographic data is essential for long-term population monitoring, evaluating management practices, and informing conservation strategies. We present a case study demonstrating a non-invasive survey method using spatially explicit capture-recapture modeling of fecal DNA genotypes to estimate population parameters of moose wintering in northern Yellowstone National Park. Because genotypes derived from fecal DNA can be prone to errors and missing allele data, and because genotyping budgets are often limited, we developed methodology using non-genetic pellet data including location and date of samples, volume, and progestagen concentration to determine potential matching genotypes. We collected fecal pellets over three consecutive winters to identify individuals and their sex. We recorded 586 captures of 142 moose from 722 pellet samples. Density estimates ranged between 6-7/100 km^2, and estimated population size was 159 (95% CI: 146-172) for 2013, 163 (95% CI: 150-174) for 2014, and 172 (95% CI: 158-185) for 2015. Finite rate of population change was 1.04 (95% CI: 0.96-1.12), and sex ratio averaged 81 bulls/100 cows. Our methods were effective for monitoring a low-density moose population in dense conifer forest and mountainous terrain, in a study area where winter aerial surveys were proven ineffective, and where capture and radio-collaring are discouraged.

A MODEL-BASED OPTIMAL SAMPLING APPROACH TO SURVEY MOOSE USING EXPERT OPINION AND LANDSCAPE CHARACTARISTICS

SOPHIE M. CZETWERTYNSKI, SUBHASH LELE, PETER SOLYMOS, AND MARK ODONOGHUE

Yukon Environment, Fish and Wildlife Branch, P.O Box 2703, Whitehorse, YT Y1A 2C6, 867-667-5787, sophie.czetwertynski@gov.yk.ca

Abstract: In Yukon, Stratified Random Block and Geospatial approaches have been used to conduct aerial surveys and estimate moose populations and their composition since the early 1990s. In 2013, we first tested a model-based approach that allows for optimal sampling, integrates local information, and uses relevant landscape characteristics to predict the number of moose in un-surveyed units. The population composition is then estimated using a multinomial analysis to ensure that we account for potential sampling bias in the composition of the population. We have developed an R-based graphical user interface to facilitate analyses and select survey units to sample during the survey. Here we use a 2017 early-winter moose survey conducted in the Mayo area in central Yukon to describe how we use this approach in the field.

CALF MOOSE - WINTER TICK RELATIONSHIPS IN NORTHERN NEW HAMPSHIRE: A 5-YEAR SUMMARY

DANIEL D. ELLINGWOOD, PETER J. PEKINS, HENRY JONES, BRENT I. POWERS

Univ. of New Hampshire, Dept. of Natural Resources and the Environment, 56 College Rd,

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Abstract: In response to a declining population, we monitored 162 radio-marked calf (8-12 month old) moose (*Alces alces*) during 2014-18 to measure survival, and cause of mortality. Measurements taken at capture in January included tick load, blood serum, and body weight (in 2016-18 only) to set a baseline for physical condition. We conducted field necropsies and collected tissue samples for histopathology to determine cause of death in March-April each year. Calf survival from capture in January through April was low in 2014-16, ranging from 21-38%, but increased to 70% in 2017. Survival data for the winter of 2018 is pending. The primary cause of calf mortality in all years was heavy infestation of winter tick (*Dermacentor albipictus*) that resulted in severe weight loss and signs of acute anemia consistent with massive blood loss. Tick load (measured at capture) in January was the primary factor in determining calf fate, however body weight had some counterbalancing effect, with heavy calves (> 174 kg) expressing a somewhat heightened resistance to mortality at low to moderate tick loads. Winter survival of adult cows (93%), and comparison with measurements taken on heavier calves (+18 kg) in northern Maine (2016-17) support these findings, with higher winter calf survival (49-76%) occurring each year despite similar tick loads.

SURVIVING WINTER TICK INFESTATIONS IN A BIOENERGETIC MODEL OR "SUCKS TO BE A MOOSE CALF"

PETER J. PEKINS

Department of Natural Resources and the Environment, University of New Hampshire, Durham, NH, 03824 USA

Blood consumption by winter ticks (*Dermacentor albipictus*) affects protein and energy balance, behavior, and nutritional condition of moose (*Alces alces*), often resulting in marked local and regional die-offs. High calf mortality, and more limited yearling and adult mortality have been documented throughout much of the North American moose range, and are of current concern given climate change predictions. Chronic blood loss and mortality of calves due to protein and energy imbalance occurs in late winter-early spring when digestible protein is limited, the protein requirement associated with blood replacement is high, and endogenous energy and protein eventually deplete. Winter tick epizootics (>50% calf mortality) have been documented in northern New England in 2014-2016 during a continuous study in New Hampshire and Maine. Calf body weights measured at capture in January and at death in March-April in 2016 and 2017 provide a unique opportunity to study energy and protein balance of animals of known fate. I investigated temporal declines in body condition of calves relative to mortality date using bioenergetics models, with emphasis on predicting the acute, temporal impacts of winter ticks.

THE IMPACTS OF WINTER TICKS ON UTAH MOOSE

SAM D. ROBERTSON[1], KENT R. HERSEY[2], DAN R. MACNULTY[1]

[1] *Utah State University, Old Main Hill, Logan, Utah 84332*

[2] *Utah Division of Wildlife Resources, 1594 W. Temple, Box 146310, Salt Lake City, Utah 84114*

Abstract: Although adult moose (*Alces alces*) in Utah face few large predators, they are at risk to a very small predator: winter tick (*Dermacentor albipictus*). Warmer, dryer winters favor ticks, and increased tick abundance may threaten moose because heavy infestations can cause severe anemia, skin irritation, hair loss, reduced foraging time, and ultimately death. We investigated the effects of ticks on moose reproduction. In 2017 and 2018, Utah Division of Wildlife initiated tick counts on captured moose via 10 cm transects across the shoulder and rump. Moose with higher tick loads at the time of capture were less likely to have a calf at heel and were less likely to have a new calf at heel the following summer. Calf recruitment was also lower for moose with higher tick loads; however, this finding was not significant and may be due to a small sample size. Moose that live at higher elevations in the late summer-late fall were more likely to have a calf and fewer ticks than moose that spend their time at lower elevations during the late summer-late fall. Higher elevations could be acting as refugia for moose by allowing them to avoid questing ticks. The reduction in ticks could be due to higher snowpack in the spring, cooler temperatures or different vegetation types at higher elevations, and this ability to move to higher elevations could be critical for Utah moose.

AN UPDATE ON *ELAEOPHORA SCHNEIDERI* IN WESTERN NORTH AMERICAN MOOSE

JARED H. OYSTER[1], NICHOLAS J. DECESARE[2], KAREN A. FOX[3], RICHARD B. HARRIS[4], KENT R. HERSEY[5], PATRICK E. MATTHEWS[6], HOLLIE M. MIYASAKI[7], MARGO J. PYBUS[8], HELEN M. SCHWANTJE[9], JASON R. SMITH[10], AND TIMOTHY P. THOMAS[11]

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Abstract: Wildlife Managers began to notice and investigate arterial worms (*Elaeophora schneideri)* in moose in the early 1970s. In 1971, David Worley reported the first case of arterial worms in moose in southcentral Montana. Mule deer are the normal definitive host for the arterial worm, although moose and other ungulates can become aberrant hosts, with horse flies serving as the vector. Symptoms can include ear cropping, ataxia, lethargy, lack of fear, walking in circles, blindness, and death. We compiled available data on arterial worm surveillance across 8 western US states, as well as British Columbia and Alberta. Most surveillance efforts included gross examination of carotid arteries of hunter-harvested moose. Prevalence rates (% of moose infected with worms) were high in Utah (64%), Wyoming (49%), and southwest Montana (40%). We found lower prevalence rates in Colorado (13%), northwest Montana (5%), and Washington (4%). To date, no worms have been found in moose in British Columbia, Alberta, or North Dakota. Arterial worms are hypothesized to be a limiting factor in areas of high prevalence; however, more study is needed to understand the physiological effects (e.g. body condition, pregnancy rates, survival) of arterial worms on moose. We discuss potential actions for future management and research.

TIMING OF MOOSE CONCEPTIONS AND ADULT SEX RATIO

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Abstract: Up to 1993, moose hunting season in Finland began around October15. From 1994 through 2017, the season has started on the last Saturday of September. I hypothesized that the earlier hunting season and changes in adult sex ratios were possible reasons for the decrease of calf carcass weights observed since 1994. I tested this hypothesis using information about moose population structure, and a sample of 793 female moose collected in 1985 from South Finland. In order to estimate the timing of fertilizations, a scale was developed for documenting the growth of embryos and foeti during the first 87 days of gestation. I found evidence that the timing of conception was delayed with decreasing proportion of bulls in the adult population. The effect was weakest in the middle-aged females and strongest in the old females. When the number of cows per bull increased from ≤ 1.3 to ≥ 2.5 conception was delayed by 9 days on average. Data on timing of conceptions during 1993–2017, when the hunting season started earlier, were not available but timing data of rutting behavior in 1985 and 2017 supports my conclusion that decreasing proportion and age of bulls, the change to the hunting season occuring during the most intensive rutting period, and an increase in hunting with dogs are some of the reasons behind the decrease of calf weights.

TEMPORAL CONFLICT BETWEEN MOOSE HUNTERS: DIFFERENCES BETWEEN HUNTING REGIONS AND HUNTER TYPE

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Abstract: Hunting is an important activity for individuals, families, and state economies. Motivations for hunting are diverse, including those linked with subsistence or a trophy opportunity. Conflict can arise when hunter crowding and competition is perceived as high, or when hunters do not share the same values. Competition between hunting groups may reduce hunt satisfaction, success, or trust of management agencies. We aim to use moose harvest data beginning in 2000 to compare hunting patterns and temporal overlap between local, non-local, and non-resident hunters in a rural environment. This will allow us to assess where conflict may arise, and to explore patterns between rural and urban regions.

THE BEHAVIOR OF WOLVES HUNTING UNGULATE NEONATES IN MINNESOTA

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Abstract: White-tailed deer (*Odocoileus virginianus*) fawns and moose calves are important summer prey for wolves (*Canis lupus*) in southern boreal ecosystems. Parturition of both ungulate species are synchronized (~late May-early June for deer fawns and early-late May for moose calves) and wolves must adapt their foraging strategies rapidly to use the abundant new prey source. Although wolves rely heavily on ungulate neonates during summer, how wolves hunt both species regionally is mostly unknown because of the difficulty of observing predation events or finding evidence of wolf-killed fawns/calves in forested systems. We fit wolves with GPS collars (20 minutes/location) during spring 2016 and 2017 in the Greater Voyageurs National Park Ecosystem, Minnesota. By visiting clusters of GPS locations to identify kill sites, we located 56 fawn kill sites during May-June of 2016 and 2017. No moose calf predation events were detected but this was likely a function of low moose density (<0.10 moose/km^2) in the study area. We determined the vegetative cover type and distance to important landscape features (e.g., roads/trails, clearcuts, wetland edge) at all kill sites and at 56 random locations during summers of 2016 and 2017. Preliminary analyses suggest that the probability of wolf kills increased with proximity to roads/trails, water bodies, and clearcut forest patches. At a finer spatial scale, visual obstruction, measured with cover boards, was significantly greater at kill sites than at random locations. Broadly, these preliminary findings provide valuable insight into 1) habitat use by white-tailed deer fawns, and 2) summer hunting behavior of wolves on fawns in a southern boreal ecosystem, highlighting the use of linear features by wolves to facilitate hunting. We will discuss how wolf predation patterns on deer fawns may differ from those on moose calves based on life history strategies of deer and moose.

PRELIMINARY GENOME-WIDE SEQUENCE DATA TO INVESTIGATE MOOSE SUB-SPECIES DESIGNATION

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Abstract: Genetic surveys of moose have been used to investigate local population structures, moose evolution, and bottleneck events. To date, however, there have been no published studies using genome-wide analyses to compare sub-species within the United States. In our study, we are conducting a genome-wide scan through genotyping by sequencing (GBS). This type of sequencing identifies single nucleotide polymorphisms (SNPs) among all the moose surveyed, and can be used to compare the genomes between individuals, sub-populations, and sub-species of moose. To date, we have isolated DNA from 166 individual moose collected from populations across five states (New Hampshire, Minnesota, Montana, Idaho, and Wyoming), which include all three moose sub-species found in the contiguous U.S. All samples were sent for sequencing and the first 93 samples have been completed (n = 4 for ID, n = 31 for MN, n = 24 for MT, and n = 34 for NH). The genotyping effort resulted in the identification of 5,297 loci where SNPs are present. Our initial analysis involved using a software program (STRUCTURE) designed to use multi-locus genotype data to investigate geographic population structure. Intriguingly, preliminary STRUCTURE analysis of these data suggests one to two distinct genetic clusters may exist. However, we recognize greater power for this investigation will arise when the remaining data for the other 72 moose are added, which include more samples from each of the four states and adds samples from Wyoming (n = 28).

VARIATION IN THE NUTRITIONAL LANDSCAPE LINKS FOREST MANAGEMENT TO POPULATION PERFORMANCE OF MOOSE

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Forested lands in the western USA have undergone changes in management and condition that are resulting in a shift towards climax vegetation. These changes can influence the quality and quantity of forage for herbivores that rely on early-seral plants. To evaluate how management of forested landscapes might affect nutrition for Shiras moose (*Alces alces shirasi*) at large spatial scales, we evaluated the effect of summer diet composition, forage availability and selection, and forage quality on population dynamics for moose across 21 population management units in northern Idaho, USA. We identified 20 forage shrubs in the diets of moose, 11 of which comprised the bulk of the diets and were mostly consumed in proportion to their availability. Forage species varied markedly in both energy and protein. By adapting established field sampling methods and integrating them with recent advances in remote sensing analyses in a modeling framework, we predicted current and past (i.e., 1984) quantity of forage shrubs across northern Idaho. We also created indices of population trend and productivity for moose across population management units. Predicted quantities of forage shrubs varied markedly across the study area with generally higher values in the north than the south. The quantity of forage shrubs was estimated to have declined over the past 30 years in about half the population management units, with the greatest declines predicted for high-energy forage species. Population trends were most strongly associated with the percent change in availability of moderate-energy forage, and population productivity was positively correlated with both the current quantity and the percent change in high-energy and high-protein forage shrubs. Our results demonstrated that spatiotemporal variability in forage quantity and quality existed, and was correlated with indices of moose population performance, supporting our hypothesis that forage is likely affecting population dynamics for moose in northern Idaho.

MOOSE ADAPATION TO LOCAL HABITAT CONDITIONS

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Abstract: In wildlife management, we think of habitat as something that can be manipulated to benefit a species. Moose, for example, need early successional stages for foraging habitat. Moose also need thermal cover, especially at the southern edges of their range. At the same time, across the North American continent, moose encounter different habitat types. Changes in habitat types are also consistent at a smaller scale. For example, habitat composition of areas with GPS-collared moose in Minnesota has large ranges in different cover types. Deciduous forest ranges from 10% to 25% of area, conifer forest from < 5% to 25%, mixed conifer-deciduous forest from 5% to 30%, and woody wetlands from 10% to over 60% of the area. There were seasonal trends in cover type use, and there were temperature-driven changes in cover-type use based on over 1,000,000 locations from over 80 moose. However, changes were not absolute, and individual moose varied in their response, in large part driven by cover types that were available at the home range scale. The most consistent pattern that emerged across all individuals was that at the home range scale, comparing used locations to random locations, a simple linear regression explained 60% to over 80% of the variation in cover type use for all cover types. One interpretation of this result is that moose are responding to local conditions and using habitats almost in proportion to availability at the annual and seasonal scales. Another consequence is that cover type selection in relatively rare extreme weather conditions is swamped by cover type selection in more typical weather conditions throughout the year.

ESTIMATING CARRYING CAPACITY FOR MOOSE IN ADIRONDACK PARK, NEW YORK

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Abstract: Despite 6.2 million acres of forest habitat under protection in northern New York State, USA, moose have languished at low population densities since recolonizing the area in the 1980s. We addressed the degree to which moose may be food-limited within the Adirondack Park that has experienced only limited timber harvest and natural disturbance. Twenty-six female moose were fitted with GPS collars transmitting locations every 2 hours in January of 2015, 2016 and 2017. We identified principle browse species for collared moose by visiting browsing locations and documenting the species and browse intensity on individual plants. We predicted browse biomass of these species across the Park using allometric equations relating plant size to available biomass to estimate individual plant level biomass and Monte Carlo simulations to incorporate various sources of error while scaling up to a landscape level estimate of biomass. Based on these data, we compared the relative number of animal use days, constrained by digestible protein (DP) and digestible energy (DE) requirements of moose, of eighteen 3000 ha blocks with varying levels of timber harvesting. Red maple (*Acer rubrum*) dominated summer and winter moose diets, but was of intermediate DP (0.19-2.2 g/100 g of browse) and DE (2.01-2.36 kcal/gram) compared to other browse species used by moose (0.01-6.19 g/100g browse and 1.66-2.85 kcal/gram). Most species were used in proportion to their occurrence; an exception was quaking aspen (*Populus tremuloides*) in the winter season, which exhibited the highest DP (3.78 g/100g), second highest DE (2.63 kcal/gram) and was used at a higher proportion than expected given its availability. American beech (*Fagus grandifolia*) was avoided in both seasons despite high availability across the landscape (DE 1.66-1.77 kcal/g, DP 2.30-3.0 g/100g). Observed nutritional values were similar to other estimates in the region, however the sparse understory of the Adirondack Park limits the density of available energy and protein across the landscape. Nutrient availability in the summer appears to be the most limiting nutritional factor for moose, and areas with high levels of timber harvest show relatively higher estimates of total animal use days than areas without timber harvest during that season. Our study indicates that moose likely are near carrying capacity in the Adirondack Park, and that carrying capacity could increase through broad-scale disturbance that sets back forest succession.

INFLUENCE OF TEMPERATURE ON HABITAT SELECTION AND MOVEMENT RATES OF MOOSE IN NORTHWESTERN NORTH DAKOTA

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Abstract: We examined temperature conditions found in different habitat types, and evaluated the impact of temperature on habitat selection and movement rates for moose in northwestern North Dakota. We deployed black globe thermometers to determine whether effective environmental temperatures differed among woodland, shrub, and open habitats. We paired locations for 20 GPS-collared moose with a corresponding temperature value from the nearest weather station and then calculated habitat selection indices for temperature quartiles for winter, summer, and fall. We compared seasonal habitat selection among quartiles using repeated-measures ANOVAs. Additionally, we estimated the straight-line distance (step length) between GPS locations for each moose and constructed multiple regression models for individual moose for each season to determine if step length was influenced by temperature, time of day, and/or the temperature X time-of-day interaction. Woodland and shrub habitats were cooler than open habitats, although during summer, mean daily maximum temperatures for all habitats exceeded values associated with heat stress in moose. In winter, moose increased selection of thermal cover at the coolest and warmest ambient temperatures, but in summer, habitat selection was unaffected by temperature. In fall, selection of thermal cover declined as temperature increased. Temperature had a weak positive effect on movement rate in winter, but movement rate was not influenced by temperature in summer or fall. However, for all seasons, moose exhibited more pronounced daily movement cycles at the coolest and warmest temperatures. Moose in northwestern North Dakota likely face temperatures capable of causing heat stress, but these conditions appear to have a subtle impact on moose behavior. Given the high rates of survival and reproduction we observed, it does not appear that warm temperatures are currently having a negative impact on the fitness of moose in our study area.

VARIATION IN SUMMER HABITAT SELECTION OF MOOSE ACROSS AN URBAN-WILDLAND INTERFACE IN NORTHEAST WASHINGTON

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Abstract: Human-caused environmental changes often outpace the ability of species to evolve adaptive morphological or physiological characteristics. Despite this evolutionary constraint, regional persistence of species, such as moose (*Alces alces*), may be aided by behavioral strategies employed by individual animals that mitigate the challenges of rapid environmental change. To evaluate this possibility, we captured and fitted with GPS radio-collars 67 adult female moose from 2013 to 2016 to estimate the influences of thermal exposure, predators, and forage on summer habitat selection patterns as well as resulting fitness consequences (survival and reproduction). We studied moose in a northern (n = 41) and a southern (n = 26) study area that spanned an urban-wildland interface north of Spokane Washington. The two study areas also differed in their abundance of predators (wolves [*Canis lupus]*, black bears [*Ursus americanus*], and cougars [*Puma concolor*]). We found significant variation between individual moose in their selection for open versus closed canopy forest types; selection was correlated with both local relative predator density and time of day. Reproduction and calf survival also varied greatly between individual radio-collared females. Variation in habitat selection between moose may explain variation in fitness and provide clarity on the environmental stressors which moose can effectively mitigate through behavior and those they cannot. Associations between fitness and the habitat selection strategies predicted to influence it will be discussed. Additionally, implications for forest management which facilitate adaptive habitat selection strategies of moose will also be covered.

ASSESSING THE UTILITY OF A SPATIO-TEMPORALLY DYNAMIC WIND INDEX IN ALASKAN MOOSE RESOURCE SELECTION UNDER THERMAL STRESS

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Abstract: Accelerated warming in Arctic-Boreal regions has led to warmer, wetter, and more variable environments. Wildlife living in these systems must adapt to these changes. For instance, moose (*Alces alces*) are cold-adapted ungulates who can experience heat stress year-round. To combat heat stress, moose adopt thermoregulatory behaviors that include selection of taller and denser forest canopies and convective/evaporative cooling from exposure to wind. Despite its role in thermoregulation, wind parameters are rarely included in resource-selection studies. One approach to estimate the effect of wind in resource-selection modeling is the use of dynamic terrain attributes, such as a wind shelter index, which model long-term, highly-dynamic meteorological data across a digital elevation model. To investigate the utility of dynamic terrain attributes, we modelled a wind shelter index as a thermoregulation mechanism in four game management units in Alaska. Next, we compared a null winter model that included habitat features related to thermoregulation (i.e., elevation, solar radiation, distance to closed canopy) to a wind model that added the wind shelter index to the null model. Four moose datasets (n = 177 total), were analyzed independently to assess location-specific resource selection; we also split datasets into female and male groups prior to analysis. A resource-selection function in a used-available sampling design estimated the proportional probability of resource use, and a step-selection function generated ten available points per used location. We used matched case-control logistic regression to contrast the used and available points. This analysis suggested that the dynamic wind shelter index is a statistically significant predictor ($P < 0.001$) of winter resource selection in Alaskan moose, with selection for or against wind sheltered areas varying by region. Additionally, incorporating wind shelter also improved model fit in 5 of 7 models examined (Δ BIC from -3 to -195). Finally, results from cross validation demonstrate an increase in predictive power in all wind models compared to null models (Δ ρ +3-10%). These results suggest that the wind shelter index provides insight into winter moose resource selection, as well as to thermoregulation by moose that could not be gained using only static landscape characteristics. Future applications of such dynamic terrain indices that incorporate time-varying meteorological data may be increasingly important in modelling habitat selection under continued climate change scenarios.

POSSIBLE IMPLICATIONS OF CLIMATE-INFLUENCED RANGE SHIFTS IN MOOSE ON WILDLIFE REHABILITATION IN THE CONTIGUOUS UNITED STATES

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Abstract: Understanding the foraging behavior of herbivores is a critical step in conserving both the wildlife populations themselves and the natural habitats in which they live. It has been hypothesized that food selection by moose and other herbivores is the result of complex spatial and temporal interactions between the animal and its environment, and that because animals that explore their environment in search of profitable foods are favored by natural selection, they are considered better prepared to cope with unexpected changes in the environment. Over the last two decades, research has indicated that moose are adapted to habitats that have undergone large range shifts associated with climate change, but few quantitative studies exist on the rate of occurrence and consequences of moose moving into more urban landscapes. Closer proximity to humans means a greater likelihood for negative human-wildlife interactions, but few wildlife rehabilitation centers are equipped to accommodate moose. Furthermore, the vast majority of wildlife rehabilitators' professional experience with ungulates in the contiguous U.S. is limited to smaller deer species, leaving either immediate transfer or euthanasia as the most responsible and humane options for injured or orphaned moose. A growing knowledge of how climate change impacts habitat use of herbivores while foraging is crucial to the perpetuation of their populations; hence, continuing education and training on how to handle less common large herbivores, like moose and elk, in the field of wildlife rehabilitation should be a priority as these changes occur.

DEALING WITH NUISANCE URBAN MOOSE NEAR SPOKANE WASHINGTON

JOLYNN BEAUCHENE

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Abstract: Urban expansion continues to encroach into wildlife habitat, often causing increased human-wildlife interactions. Over the last several decades, both the moose population and human populations have increased in the area around Spokane, Washington, USA. Consequently, the number of moose-human interactions has increased over that time. When these close encounters occur in and around urban areas, the primary concern for the Washington Department of Fish and Wildlife (WDFW) is public safety. WDFW receives hundreds of phone calls and emails every year from the public regarding moose interactions. Reports received by the Department have ranged from a simple "sighting", to pets being trampled and injured or killed, to people being charged and getting injured. Enforcement officers and other WDFW staff spend a considerable amount of time raising awareness about urban moose and educating the public about safe practices when dealing with moose. Additionally, human-moose interactions have received considerable media interest, especially when moose need to be relocated out of urban areas. We discuss best practices when hazing moose from nuisance situations. Additionally, we discuss the risks, challenges, and resources needed when relocating moose out of urban areas.

Note: The author was unable to attend.

GEOPHAGIA OF MOOSE IN THE CENTRAL YAKUTIA, RUSSIA

VALENTINA V. STEPANOVA, ALEXANDR V. ARGUNOV. RUSLAN A. KIRILLIN AND INNOKENTIY M. OKHLOPKOV

Abstract: We documented geophagia of wild ungulates using camera-traps at five mineral licks in central Yakutia (Russia). Data consisted of a total of total of 235 trail-camera days (June: 34, July: 60, August: 65, September: 60, October:16). During this period, we documented 122 visits of moose to mineral licks, representing an estimated 215 individual (including 24 visits of females with calves). The average time moose spent at licks was 8.7 (standard deviation = 7.8 min, range1—40 minutes; *n* = 125). The average number of visits per day was 3.1 (range 1-8 visits; *n* = 54). We recorded as many as 4 individual moose present at mineral lick simultaneously. The largest number of unique moose seen at lick in a single day was 6. Proportional use of licks by month was June: 43.3%, July: 49.2%, August: 5.8%, September: 1.7%, and none in October. Among individuals using mineral licks, we observed 10 bulls and 11 cows.

Poster Session

Poster presentation

QUANTIFYING LEAF DROP CHANGE USING GOOGLE EARTH ENGINE: IMPLICATIONS FOR MOOSE HUNTING

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ABSTRACT: Warming temperatures are causing extended growing seasons in Alaska. Although changes in spring phenology (e.g., leaf out) have been well studied, fall phenology (e.g., leaf drop) is less understood. Fall phenology should be assessed to understand implications during fall moose (*Alces alces*) hunting season (September). Previous research has concluded that hunting success is more closely linked to accessibility than wildlife distribution or abundance, and sightability may be considered an important factor to accessibility. We used Google Earth Engine, a powerful spatial analysis platform, to assess the change in leaf drop date from 2000-2017 in Interior Alaska. Preliminary results show a significant increase in NDVI across the study period indicating a shift towards later dates in leaf drop. This shift has been noted by communities in Interior Alaska, and there are concerns about the impacts of fewer days during hunting season with adequate visibility. Considering the importance of moose meat for different user groups in Alaska, environmental factors that induce additive challenges should be assessed to maintain the well-being of hunters.

Poster Presentation

SEASONAL MOVEMENTS AND HOME RANGE SIZE OF MIGRATORY AND NON-MIGRATORY MOOSE (*ALCES ALCES*) IN NORTH-CENTRAL, BRITISH COLUMBIA

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Understanding animal movements and home range use is essential for good management practices. Moose have been shown to exhibit a range of spatial use patterns including residency, migratory, and nomadic life-histories. For this study, 45 moose (*Alces alces*) were GPS-collared in the John Prince Research Forest, near Fort St. James in north-central British Columbia, Canada. Moose wore collars for 1 to 4 years during the 4-year study period (2014-2017), during which we received a total of 27,722 moose locations. We classified moose as resident if their summer and winter home ranges overlapped, and as migratory if they did not. The overall mean annual home range for migratory individuals was 336 km^2, which was significantly larger than 66 km^2 ranges of residents. Migratory moose stayed at significantly higher mean elevations than residents during April–November, but not from December–March when snow depth was greatest. Migratory individuals tended to leave their winter ranges in early to mid-April in a synchronous fashion. Their return from mid-December to early February was less synchronous among individuals. We suggest that the migratory behaviours that we observed could have implications for winter Stratified Random Block (SRB) surveys of moose due to a mismatch between survey time and the return of migratory moose to their winter ranges.

Poster Presentation

PHYSICAL, EMOTIONAL, AND HEALTHCARE RESOURCE IMPACTS OF MOOSE AND DEER VEHICLE COLLISIONS IN NORTHERN BRITISH COLUMBIA

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Northern British Columbia is home to two species of deer and three subspecies of moose. In northern B.C. between 2006 and 2010, at least 8,900 deer and 3,100 moose vehicle collisions were reported to the Insurance Corporation of British Columbia. Wildlife vehicle collisions result in injury/death to people and wildlife, the need for emergency services, healthcare system costs, vehicle damages, and repair costs. We aimed to compare and contrast the physical and emotional impacts resulting from moose- and deer-vehicle collisions. Additionally, we assessed the requirement of emergency services directly following the collision, and the use of a variety of healthcare providers and services. We used a survey composed of open- and closed-ended questions delivered to drivers who had hit a deer (n = 47) or moose (n = 52) in northern British Columbia. Survey responses were collected online and in person. Our findings suggest that moose-vehicle collisions resulted in more injuries and a higher usage of healthcare resources and providers than do deer-vehicle collisions. A two proportions z test suggested that victims of moose-vehicle collisions required emergency services significantly more frequently compared to deer-vehicle collisions ($\hat{p}$ =0.53, z = -5.5, $P \leq 0..001$). However, the emotional impacts to victims of moose- and deer-vehicle collisions were not significantly different than one another with about half of both groups reporting feeling anxious when reminded of the collision. Our findings increase our understanding of the physical and emotional impacts of moose- and deer collisions and elucidate the range of emergency and healthcare services/providers accessed by those involved.

Poster presentation

ESTIMATING MOOSE ABUNDANCE USING REMOTE CAMERA TRAPS

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Abstract: Precise estimates of animal abundance are key for effective management of large mammals, yet they are difficult, dangerous, and costly to obtain via aerial surveys. Alternative methods to estimate abundance are needed for species that occur at low density or are visually concealed by habitat. Throughout Idaho, the distribution and density of moose (*Alces alces*) exemplify such characteristics of cryptic species, and are important yet difficult to monitor. Spatially balanced arrays of remote camera traps offer a relatively safe and cost-effective means to monitor moose in Idaho; however, the analytical assumptions of independent detections and movement rates are difficult to meet with unmarked individuals. Two promising methods address these challenges for unmarked ungulates using a survival-modeling framework (space-to-event and time-to-event models) and the trapping rate of cameras. We are currently using and expanding these methods to estimate moose abundance during winter in southeastern Idaho. To maximize detection capability of cameras at the population level, we used Random Forest modeling to predict winter range habitat at the landscape scale (2nd order home range; 30 m resolution), then stratified a sampling grid (1.5 km resolution) to the 75th quantile of the raster surface. To account for movement rates of individuals, we captured and fit eight adult moose with GPS-collars, recording locations at 30-minute intervals. Although still in the developmental phase, we are encouraged by the potential to estimate moose abundance using remote camera traps with the new analytical techniques of continuous time- and space-to-event modeling as a safer, more cost-effective alternative to aerial surveys.

Sponsored presentation

NEW TECH FOR THE WILDLIFE RESEARCH TOOLKIT

ALEX BAER, AND MARK HELVESTON

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Geographic Information System (GIS) technology and its potential for application within wildlife science is advancing at a rapid pace. Most mapping products are designed for use in the office, however, data collection in remote off-grid settings often relies on the ability to render and summarize spatial information as well. In this presentation, we will demonstrate a new consumer mapping product which provides these capabilities to wildlife researchers.

The study of wildlife often requires research personnel to cover vast expanses of land in order to capture, mark and follow uniquely marked animals. Global Positioning System (GPS) radio-collars provide significant information on the animal's location. However, many research questions require re-location of animals to obtain supplementary information (parturition, calf survival, body condition, etc.). In many areas occupied by moose, land access represents a significant obstacle to obtaining these "follow-up" data. For the researcher in the field, knowing whether a marked animal is on public or private land is extremely important. Both public trust and the efficiency of field-work are affected by reliable access to current information on land ownership in the field. If marked animals move onto private lands during monitoring, researchers can make contact with the appropriate landowner to obtain public observation information or request permission to enter the property and continue monitoring. Time and money is wasted if field researchers do not have the necessary information to make contact with private landowners or are unaware of their own location due to low-resolution maps or loss of cellular reception.

Like almost every technology we currently use in wildlife research, the advancements begin in the private sector – and GIS is no exception. Many of the issues we face as researchers in the field can be overcome by embracing new technologies when they become efficient, reliable and economically viable. The mapping product presented here is precisely that tool.

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KEYNOTE SPEAKER

Woodrow L. Myers

Woody retired from the Washington Department of Fish and Wildlife in 2016 after over 40 years as a wildlife biologist, mostly as a researcher studying mule deer, elk, white-tailed deer and moose. He introduced aerial net-gunning to the agency as a capture technique to equip ungulates with telemetry and GPS tracking collars, logging over 3500 hours in small aircraft and capturing over 1600 animals. From the first moose he darted with immobilization drugs in Spokane for relocation in 1990, to the 50-some he radio-collared for study, Woody has handled about 200 moose.

NOTES

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