Finding Solutions for Future Generations

Program & Abstracts

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48TH NORTH AMERICAN MOOSE CONFERENCE AND WORKSHOP

April 28–May 1, 2014
Girdwood, Alaska

Greetings,

Moose are an icon of life in the circumboreal north. They are an important source of food and a target for trophy hunters. Others enjoy seeing and watching them. As a result they are a focal species of management.

The landscape for moose management in the circumboreal north is always changing. Changes in technology, climate, habitat, disease and parasites, and human use patterns make this observation especially relevant today. In many ways, these challenges in contemporary moose management represent moving and elusive targets for management agencies. Factors that impact moose are often viewed as independent topics but they often interact in complex and unexpected ways.

This forum – The North American Moose Conference and Workshop – has a 47 year history of fostering the innovation of pragmatic management solutions as well as developing the depth of knowledge required to develop more lasting frameworks for understanding and managing moose populations. The Alaska Department of Fish and Game and the Outdoor Heritage Foundation of Alaska are extremely pleased to continue this tradition by again hosting this event in Alaska. Our conference theme "Finding Solutions for Future Generations" seeks only to continue that tradition.

Moose research and management biologists are spread far and wide across the north. Our organizations and our generous sponsors recognize that hosting these events across the range of *Alces* is important for the science, the species, and especially the diverse and manifold people that rely on moose for essential and nutritious wild food, relish them as fundamental parts of their life in the north, or simply appreciate this earthly treasure.

If spoken from all of the languages across the range of *Alces*, we would hear dozens of ways to say thank you for attending this event and for all your efforts on behalf of the people that value this iconic species.

Thank you and welcome!

Doug Vincent-Lang, Acting Director
Division of Wildlife Conservation
Alaska Department of Fish and Game

Eddie Grasser, President
Outdoor Heritage Foundation of Alaska

48th North American Moose Conference and Workshop

April 28–May 1, 2014
Girdwood, Alaska

Finding Solutions for Future Generations

The landscapes of the circumboreal north are changing. Anthropomorphic factors directly and indirectly impact moose populations, making conservation and management of moose challenging. Direct impacts include manipulation of populations and habitats, the expansion of human development, and pollution. Indirect impacts include climate change effects on moose, habitats, species interactions, disease and parasites. In many ways, challenges associated with contemporary moose conservation represent a moving target for management agencies. Factors that impact moose are often viewed as independent topics but they often interact in complex ways. By promoting a holistic perspective, it may be possible to develop a more lasting framework for understanding and managing moose populations.

CONFERENCE COMMITTEE MEMBERS

Conference Chair: Bruce W. Dale (ADF&G)

Program:
Scott M. Brainerd (ADF&G)
Jessica A. Coltrane (ADF&G)
Kalin A. K. Seaton (ADF&G)
Kevin S. White (ADF&G)

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Banquet:
Gino Del Frate (ADF&G)
Lincoln S. Parrett (ADF&G)
Tim C. Peltier (ADF&G)

Conference Booklet:
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Website/Registration:
Dan P. Thompson (ADF&G)
Liz Solomon (ADF&G)

Field Trips:
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Jessica A. Coltrane (ADF&G)
Sierra R. Doherty (ADF&G)
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Hospitality:
Chris D. Anderson (ADF&G)
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48TH NORTH AMERICAN MOOSE CONFERENCE AND WORKSHOP

OVERVIEW

Monday – April 28, 2014

7:00 AM–5:00 PM	Early Check-in and Conference Registration
8:00 AM–12:00 PM	Workshop
12:00 PM–2:00 PM	Lunch
2:00 PM–2:10 PM	Conference Welcome
2:10 PM–5:00 PM	Special Session
6:00 PM–9:00 PM	Reception and Student-Professional Mixer

Tuesday – April 29, 2014

7:00 AM–10:30 AM	Conference Registration
8:00 AM–10:00 AM	Session 1: Spatial Ecology
10:00 AM–10:20 AM	Break
10:20 AM–12:00 PM	Session 2: Physiology and Nutrition
12:00 PM–1:00 PM	Lunch
1:00 PM–2:40 PM	Session 3: Habitat Ecology and Management
2:40 PM–3:10 PM	Break
3:10 PM–4:10 PM	Session 4: Genetics and Morphology
4:10 PM–6:30 PM	Poster Session
6:30 PM–9:00 PM	Banquet

Wednesday – April 30, 2014

8:00 AM–5:00 PM	Field Trips

Thursday – May 1, 2014

7:00 AM–10:30 AM	Conference Registration
8:00 AM–9:40 AM	Session 5: Population Ecology and Management - General
9:40 AM–10:00 AM	Break
10:00 AM–11:40 AM	Session 6: Disease and Parasites
11:40 AM–1:20 PM	*Alces* Business Meeting (lunch)
1:20 PM–3:00 PM	Session 7: Population Ecology and Management - Alaska
3:00 PM–3:30 PM	Break
3:30 PM–4:50 PM	Session 8: Foraging Ecology
4:50 PM–5:00 PM	Closing Remarks

FIELD TRIPS

(Wednesday, April 30)

Alaska Wildlife Conservation Center: A Moose Celebration with Youth

The conference committee presents an educational event to broaden the audience of moose enthusiasts! Alaska Department of Fish and Game will lead a Moose Celebration to introduce local youth to wildlife careers and moose-themed activities. The event will be held at Alaska Wildlife Conservation Center (AWCC), a nonprofit organization dedicated to preserving Alaska's wildlife through conservation, public education, and quality animal care. AWCC takes in injured and orphaned animals year-round and provides spacious enclosures and quality animal care. If you enjoy engaging children in science activities and observing Alaskan wildlife, come be a part of this exciting program.

Hike in the Chugach Mountains

Hike in the beautiful Chugach Mountains led by Anchorage Area Wildlife Biologist Jessy Coltrane. Exact destination will be determined based on trail conditions the week of the conference, but will take place on one of the many scenic trails in the Anchorage/Girdwood area.

University of Alaska Matanuska Research Center, Captive Animal Facility

The Matanuska Research Center Captive Animal Facility houses moose and caribou used in research projects. Some of the moose are fistulated, providing an ideal location for nutrition experiments. ADF&G Wildlife Physiologist Dr. William (Bill) Collins will discuss the overall purpose of the facility and some of the things they have accomplished there, including tannin/digestibility experiments, etc. ADF&G Wildlife Biologist Tony Carnahan will talk about the technique he developed using plant cuticular wax from forage and fecal samples extracted by accelerated solvent extraction to calculate moose diets.

Day Trip to Seward

Visit beautiful Seward, a small city situated at the head of Resurrection Bay on the Kenai Peninsula, about 125 highway miles from Anchorage. Seward is one of Alaska's oldest and most scenic communities. The day trip to Seward will begin with a behind the scenes tour of the Alaska SeaLife Center, leaving the afternoon free for other activities such as going on a gray whale watching tour or exploring the harbor front of Seward.

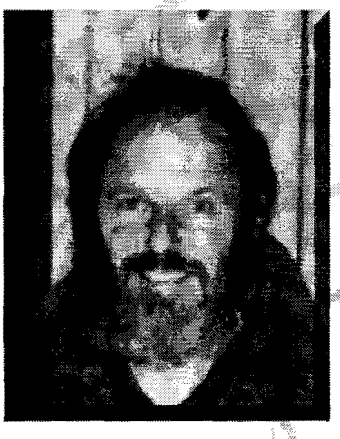
KEYNOTE SPEAKER

DR. F. STUART (TERRY) CHAPIN, III
Professor Emeritus of Ecology
University of Alaska Fairbanks

Climate change impacts on Alaskan ecosystems, wildlife, and communities: Preparing for expected changes and surprises

Climate change is impacting wildlife populations across the globe, especially at extreme latitudes. Terry will discuss impacts of climate change to ecosystems in Alaska, with an emphasis on frequency, moose range, and discuss implications for society.

BIOGRAPHY



Dr. F. Stuart (Terry) Chapin, III is an ecosystem ecologist whose research addresses the sustainability of ecosystems and human communities on our rapidly changing planet. His work emphasizes the impacts of climate change on Alaskan ecology, subsistence resources, and indigenous communities, as a basis for developing climate-change adaptation plans. Terry is an Emeritus Professor of Ecology at the Institute of Arctic Biology and the Department of Biology and Wildlife at the University of Alaska Fairbanks. He is one of the nation's leading ecologists and is the only Alaskan to hold an appointment to the National Academy of Sciences. His background is in plant physiological ecology and ecosystem ecology, with current interests in the resilience of social-ecological systems. The central focus of his research is the study of the resilience of regional systems in the face of directional changes in climate, economics, and culture. Throughout his career he has served in leadership roles on numerous international, national, regional and University panels, committees, editorial boards and working groups, thereby influencing the course of policy in conservation, wildlife, resource and ecosystem management to effect wise stewardship of our natural environment.

INVITED SPEAKERS

DR. DAVID R. KLEIN, *Professor Emeritus of Wildlife Ecology, University of Alaska Fairbanks*

Perspectives from a Lifetime Involved in Management and Investigations of Alaska's Wildlife

Dave gives us his perspectives on the evolution and development of wildlife management and research during the course of his long career as an ungulate biologist in Alaska.

THOMAS F. PARAGI, *Wildlife Biologist, Alaska Department of Fish and Game, Fairbanks*

Increased Logging for Wood Energy in Boreal Forests of Alaska: Implications for Moose and Reforestation

As fuel costs rise, the demand for timber harvest for biofuel is rising in Alaska. Tom discusses the potential biological impact of large-scale timber harvest for chipped or pelleted fuel and considerations for moose habitat and population management.

BRUCE W. DALE, *Deputy Director, Alaska Department of Fish and Game, Division of Wildlife Conservation*

Alaska's Intensive Management Programs

Moose are a vital food resource for Alaskans. The state legislature has mandated specific objectives for moose population abundance and harvest, resulting in several active management programs to achieve elevated harvest. Bruce will discuss various types of active management and provide perspective on the execution, success and future of these programs.

DR. TODD J. BRINKMAN, *Associate Professor, Human Dimensions of Wildlife Management, Department of Biology and Wildlife, University of Alaska Fairbanks*

A Few Ways that the Human Dimensions of Wildlife can Assist Big-Game Management

Quantification of the human dimension provides managers with a way to integrate social considerations with biological information. Todd discusses the importance of this relatively new concept and how it can inform decision-making in wildlife management and improve public relations.

PRESENTATION SCHEDULE

(* = presenter, + = student)

MONDAY – APRIL 28, 2014

7:00 AM–5:00 PM **EARLY CHECK-IN AND CONFERENCE REGISTRATION**

8:00 AM–12:00 PM **WORKSHOP:**

INTEGRATING SOCIAL AND ECOLOGICAL DATA: APPROACHES FOR INFORMING MOOSE MANAGEMENT

Chairs:

DR. TODD J. BRINKMAN, *Associate Professor, Human Dimensions of Wildlife Management, Department of Biology and Wildlife, University of Alaska Fairbanks*
KALIN A. K. SEATON, *Wildlife Biologist, Alaska Department of Fish and Game, Fairbanks*

Overview: The workshop will begin with a brief introduction on the Human Dimensions of Wildlife, broadly defined as human-wildlife interactions and the thoughts and actions of people relating to wildlife. Background information will include an overview of current theory and methods, along with future ideas. Using an extensive dataset on moose in Interior Alaska, the instructors will then provide a spatially- and temporally-explicit framework for integrating social and ecological data that may inform moose management and provide a more holistic view of moose harvest opportunity. Following this data-driven example, the hands-on portion of the workshop will ask participants to apply the framework to the region they research or manage moose. Lastly, instructors will facilitate a group discussion on the pitfalls and potential for expanded integration of the human dimensions into moose management.

12:00 PM–2:00 PM **LUNCH, REGISTRATION OPEN**

2:00 PM–2:10 PM **CONFERENCE WELCOME**

BRUCE W. DALE, *Deputy Director, Alaska Department of Fish and Game*

SPECIAL SESSION:

ALASKAN PERSPECTIVES ON MOOSE MANAGEMENT

Chair: TODD A. RINALDI, *Area Biologist, Alaska Department of Fish and Game, Palmer*

Overview: Challenges to managing moose are as diverse as the habitat and countries they inhabit. In this session, we highlight facets of moose management in Alaska through invited speakers with a range of expertise. Our speakers will then participate in a panel discussion with the audience to discuss and learn from similarities and differences in the management of moose elsewhere in the continent and beyond.

2:10 PM–2:40 PM **(1) CLIMATE-CHANGE IMPACTS ON ALASKAN ECOSYSTEMS, WILDLIFE, AND COMMUNITIES: PREPARING FOR EXPECTED CHANGES AND SURPRISES**

KEYNOTE SPEAKER: DR. F. STUART (TERRY) CHAPIN, III

2:40 PM–3:00 PM **(2) PERSPECTIVES FROM A LIFETIME INVOLVED IN MANAGMEMENT AND INVESTIGATIONS OF ALASKA'S WILDLIFE**

INVITED SPEAKER: DR. DAVID R. KLEIN

3:00 PM–3:20 PM	**BREAK**
3:20 PM–3:40 PM	**(3) INCREASED LOGGING FOR WOOD ENERGY IN BOREAL FORESTS OF ALASKA: IMPLICATIONS FOR MOOSE AND REFORESTATION** INVITED SPEAKER: THOMAS F. PARAGI
3:40 PM–4:00 PM	**(4) ALASKA'S INTENSIVE MOOSE MANAGEMENT PROGRAMS** INVITED SPEAKER: BRUCE W. DALE
4:00 PM–4:20 PM	**(5) A FEW WAYS THAT THE HUMAN DIMENSIONS OF WILDLIFE CAN ASSIST BIG-GAME MANAGEMENT** INVITED SPEAKER: DR. TODD J. BRINKMAN
4:20 PM–5:00 PM	**PANEL DISCUSSION**
6:00 PM–9:00 PM	**RECEPTION & STUDENT-PROFESSIONAL MIXER**

TUESDAY – APRIL 29, 2014

7:00 AM–10:30 AM	**CONFERENCE REGISTRATION**

SESSION 1 – SPATIAL ECOLOGY
(sponsored by ConocoPhillips Alaska, Inc.)
Chair: SCOTT M. BRAINERD, *Research Coordinator, Alaska Department of Fish and Game, Fairbanks*

8:00 AM–8:20 AM	**(6) LINKING HABITAT AND NUTRITION WITH POPULATION PERFORMANCE IN MOOSE** BRETT JESMER+, JACOB GOHEEN, KEVIN MONTEITH, AND MATTHEW KAUFFMAN
8:20 AM–8:40 AM	**(7) MOOSE VISITATION RATES AND SPACE USE OF FORAGING HABITATS IN NORTHERN MINNESOTA** AMANDA MCGRAW+ AND RON MOEN
8:40 AM–9:00 AM	**(8) LINKING RESOURCE SELECTION TO OVERWINTER BODY CONDITION IN A COASTAL ALASKA MOOSE POPULATION** KEVIN WHITE*, DAVE GREGOVICH, AND JOHN CROUSE
9:00 AM–9:20 AM	**(9) COMPARATIVE MOVEMENT PATTERNS OF MOOSE (*ALCES ALCES*) AND GRAY WOLVES (*CANIS LUPUS*) IN VOYAGEURS NATIONAL PARK: A PREDATION RISK ASSESSMENT** BRIAN KOT*, STEVE WINDELS, RON MOEN, AND BRYCE OLSON
9:20 AM–9:40 AM	**(10) AUTOMATED DETECTION OF MOOSE (*ALCES ALCES*) AND DEER (*ODOCOILEUS VIRGINIANUS*) IN AIMS-THERMAL DATA** THOMAS MILLETTE
9:40 AM–10:00 AM	**(11) WHEN REFUGE BECOMES RISK: THE BEHAVIORAL RESPONSE OF MOOSE TO HUNTING IN GROS MORNE NATIONAL PARK, NEWFOUNDLAND** TOM PERRY+ AND PHIL MCLOUGHLIN

10:00 AM–10:20 AM **BREAK** *(sponsored by Vectronic Aerospace)*

SESSION 2 – PHYSIOLOGY AND NUTRITION
Chair: DAN P. THOMPSON, *Wildlife Biologist, Alaska Department of Fish and Game, Soldotna*

10:20 AM–10:40 AM **(12) SPERM MORPHOLOGY IN SCANDINAVIAN MOOSE**

JONAS MALMSTEN+, LENNART SÖDERQUIST, CARL-GUSTAF THULIN, AND ANNE-MARIE DALIN

10:40 AM–11:00 AM **(13) MEASURING HEART RATE AND BODY TEMPERATURE IN THE FIELD: A NEW TELEMETRY SYSTEM OPENS NOVEL PERSPECTIVES IN RUMINANT ECO-PHYSIOLOGY**

CLAUDIO SIGNER*, GERHARD FLUCH, PERICA JURCEVIC, THOMAS RUF, AND WALTER ARNOLD

11:00 AM–11:20 AM **(14) RELATIONSHIPS BETWEEN BODY CONDITION AND PREGNANCY IN MOOSE AT THEIR SOUTHERN RANGE LIMIT**

JOEL RUPRECHT+, DANIEL MACNULTY, AND KENT HERSEY

11:20 AM–11:40 AM **(15) EVALUATING PROTEIN BALANCE IN WINTERING MOOSE**

JOHN A. CROUSE* AND PERRY BARBOZA

11:40 AM–12:00 PM **(16) THE EFFECT OF HELICOPTER CHASE AND CAPTURE ON THE PHYSIOLOGY OF FREE-RANGING MOOSE (*ALCES ALCES*), USING BLOOD GASES, LACTATES AND BODY TEMPERATURE AS VARIABLES**

MARIANNE LIAN*, ALINA L. EVANS, SVEN BJÖRCK, MARTINE ANGEL, FREDRIK STENBACKA, NAVINDER J. SINGH, GÖRAN ERICSSON, AND JON M. ARNEMO

12:00 PM–1:00 PM **LUNCH**

SESSION 3 – HABITAT ECOLOGY AND MANAGEMENT
Chair: KALIN A. K. SEATON, *Wildlife Biologist, Alaska Department of Fish and Game, Fairbanks*

1:00 PM–1:20 PM **(17) HYDRO-AXING EFFECTS ON BROWSE RESOURCES AVAILABLE TO WINTERING MOOSE ON THE COPPER RIVER DELTA, ALASKA**

SHARON SMYTHE+, DANA SANCHEZ, AND RICARDO MATA-GONZALEZ

1:20 PM–1:40 PM **(18) CALCULATING THE CARRYING CAPACITY OF MOOSE HABITAT USING NUTRITIONAL ANALYSES, GROUND SURVEYS, AND REMOTE SENSING**

MARION E. GLASER+, NORMAN HARRIS, DONALD SPALINGER, AND THOMAS HANLEY

1:40 PM–2:00 PM **(19) THE EFFECTS OF WILDFIRE SEVERITY ON MOOSE HABITAT USE AND FORAGE PRODUCTION RATES IN INTERIOR ALASKA**

CASEY BROWN+, KNUT KIELLAND, EUGENIE EUSKIRCHEN, AND KALIN A. KELLIE

2:00 PM–2:20 PM **(20) INTEGRATED MANAGEMENT OF MOOSE AND FOREST**

CHRISTINA SKARPE* AND KAREN MARIE MATHISEN

2:20 PM–2:40 PM **(21) MANAGEMENT STRATEGIES FOR REDUCING BROWSING DAMAGE BY MOOSE**

MÄRTHA WALLGREN*, ROGER BERGSTRÖM, AND GÖRAN BERGQVIST

2:40 PM–3:10 PM **BREAK** *(sponsored by Matson's Lab)*

SESSION 4 – GENETICS AND MORPHOLOGY
(sponsored by Safari Club International)
Chair: JESSICA A. COLTRANE, *Wildlife Biologist, Alaska Department of Fish and Game, Anchorage*

3:10 PM–3:30 PM **(22) POPULATION BOUNDARIES AND THE SUBSPECIFIC DIVIDE IN SOUTHEASTERN ALASKAN MOOSE**

KEVIN COLSON*, KEVIN S. WHITE, AND KRIS HUNDERTMARK

3:30 PM–3:50 PM **(23) NATURAL AND ANTHROPOGENIC EFFECTS ON THE SPATIAL GENETIC STRUCTURE OF MOOSE**

ROBERT WILSON*, SEAN D. FARLEY, THOMAS J. MCDONOUGH, SANDRA TALBOT, AND PERRY BARBOZA

3:50 PM–4:10 PM **(24) ANALYSIS OF PHYSICAL CHARACTERISTICS OF BULL MOOSE HARVESTED IN MAINE, 1980–2009**

HALEY ANDREOZZI+, PETER PEKINS, AND LEE KANTAR

4:10 PM–6:30 PM **POSTER SESSION**

6:30 PM–9:00 PM **BANQUET (Columbia Ballroom)**

- Brief introduction/welcome (BRUCE W. DALE)
- Cupiit Yurartet Native Dancers
- Award presentations

WEDNESDAY – APRIL 30, 2014

8:00 AM–5:00 PM **FIELD TRIPS (ALL DAY)**

THURSDAY – MAY 1, 2014

7:00 AM–10:30 AM **CONFERENCE REGISTRATION**

SESSION 5 – POPULATION ECOLOGY AND MANAGEMENT - GENERAL
Chair: KEVIN S. WHITE, *Wildlife Biologist, Alaska Department of Fish and Game, Douglas*

8:00 AM–8:20 AM **(25) CURRENT STATUS OF MOOSE IN NORTH DAKOTA**

JASON SMITH* AND JIM MASKEY

8:20 AM–8:40 AM **(26) COMPARATIVE DEMOGRAPHY OF TWO MOOSE POPULATIONS WITH CONTRASTING PREDATOR DENSITIES**

BRENDAN OATES+, JACOB R. GOHEEN, MATTHEW J. KAUFFMAN, KEVIN L. MONTEITH, AND GARY L. FRALICK

8:40 AM–9:00 AM **(27) USING A SIMULATION MODEL TO HELP UNDERSTAND CAUSES OF THE MOOSE DECLINE IN MINNESOTA**

RON MOEN

9:00 AM–9:20 AM **(28) DETERMINING CAUSE-SPECIFIC MORTALITY IN MINNESOTA'S DECLINING MOOSE POPULATION**

MICHELLE CARSTENSEN*, ERIK HILDEBRAND, DAVID PAULY, MICHAEL SCHRAGE, AND ARNO WUENCHMANN

9:20 AM–9:40 AM **(29) CAUSE-SPECIFIC MORTALITY OF MOOSE CALVES IN NORTHEASTERN MINNESOTA: RESULTS FROM THE FIRST SUMMER**

WILLIAM SEVERUD+ AND GLENN DELGIUDICE

9:40 AM–10:00 AM **BREAK**

SESSION 6 – DISEASE AND PARASITES
Chair: MARIANNE LIAN, *Post-doctoral Fellow, Alaska Department of Fish and Game, Fairbanks*

10:00 AM–10:20 AM **(30) THE HABITAT OF THE WINTER TICK IN THE MOOSE RANGE OF NORTHEAST MINNESOTA**

JULIANN TERRY+ AND RON MOEN

10:20 AM–10:40 AM **(31) SPATIAL AND TEMPORAL ABUNDANCE OF GASTROPOD INTERMEDIATE HOSTS IN NORTHERN MINNESOTA WITH IMPLICATIONS FOR PARELAPHOSTRONGYLUS TENUIS RISK IN MOOSE**

TIM CYR+ AND RON MOEN

10:40 AM–11:00 AM **(32) PATTERNS IN WHITE-TAILED DEER DENSITY AND PARASITE PREVALENCE IN VOYAGEURS NATIONAL PARK: IMPLICATIONS FOR DISEASE TRANSMISSION TO MOOSE**

KIMBERLY VANDERWAAL*, STEVE WINDELS, BRYCE OLSON, AND RON MOEN

11:00 AM–11:20 AM **(33) COMPARING VECTORS AMONG WYOMING MOOSE POPULATIONS WITH VARYING PREVALENCE OF *ELAEOPHORA SCHNEIDERI***

AMY WILLIAMS+, BRANT SCHUMAKER, JENNIFER MCKENNA, MARCE VASQUEZ, AND MYRNA MILLER

11:20 AM–11:40 AM **(34) MAINE MOOSE GENERAL HEALTH SURVEY 2014**

ANNE LICHTENWALNER*, BRENDA KENNEDY-WADE, ANN BRYANT, AND LEE KANTAR

11:40 AM–1:20 PM ***ALCES* BUSINESS MEETING (LUNCH)**

SESSION 7 – POPULATION ECOLOGY AND MANAGEMENT – ALASKA
(sponsored by Alaska Professional Hunters Association)
Chair: THOMAS F. PARAGI, *Wildlife Biologist, Alaska Department of Fish and Game, Fairbanks*

1:20 PM–1:40 PM **(35) POPULATION TRENDS OF DENALI NATIONAL PARK AND PRESERVE MOOSE, 1917–2013**

VICTOR VAN BALLENBERGHE

1:40 PM–2:00 PM **(36) A TALE OF TWO POPULATIONS: CHALLENGES OF MOOSE MANAGEMENT ON THE KENAI PENINSULA, ALASKA**

THOMAS J. MCDONOUGH*, JOHN A. CROUSE, AND JEFF S. SELINGER

2:00 PM–2:20 PM **(37) MOOSE COLONIZATION AND POPULATION GROWTH ON THE TOGIAK NATIONAL WILDLIFE REFUGE IN SOUTHWESTERN ALASKA**

ANDY ADERMAN

2:20 PM–2:40 PM **(38) MOOSE IN THE ALASKAN ARCTIC LINKED TO 20TH CENTURY WARMING**

KEN D. TAPE* AND DAVID GUSTINE

2:40 PM–3:00 PM **(39) POPULATION FLUCTUATIONS AND MORTALITY FACTORS FOR THE NORTHERN-MOST MOOSE POPULATION**

GEOFF M. CARROLL*, LINCOLN S. PARRETT, AND TODD M. O'HARA

3:00 PM–3:30 PM **BREAK**

SESSION 8 – FORAGING ECOLOGY
(sponsored by ExxonMobil)

Chair: KIMBERLY KING JONES, *Wildlife Biologist, Alaska Department of Fish and Game, Palmer*

3:30 PM–3:50 PM **(40) TREE SPECIES AND TWIG DIAMETER SELECTION BY INDIVIDUAL MOOSE ALONG DAILY MOVEMENT TRACKS IN NORTHERN SWEDEN**

R. THOMAS PALO* AND GLENN IASON

3:50 PM–4:10 PM **(41) BROWSE REMOVAL AND PLANT ARCHITECTURE AS INDICES TO CHANGES IN MOOSE DENSITY**

THOMAS F. PARAGI*, C. TOM SEATON, KALIN A. KELLIE, RODNEY D. BOERTJE, KNUT KIELLAND, DONALD D. YOUNG JR, MARK A. KEECH, AND STEPHEN D. DUBOIS

4:10 PM–4:30 PM **(42) FACTORS GOVERNING FOOD PREFERENCES OF ALASKAN MOOSE**

LAUREN CARUSO+, DONALD SPALINGER, WILLIAM B. COLLINS, AND DOUGLAS CAUSEY

4:30 PM–4:50 PM **(43) BROWSING PRESSURE IN THE PAST — A STRONG PREDICTOR OF CURRENT BROWSING**

KAREN MARIE MATHISEN*, JOS MILNER, AND CHRISTINA SKARPE

4:50 PM–5:00 PM **CLOSING REMARKS**

POSTERS (* = presenter, + = student)

(44) ESTIMATION OF HORIZONTAL COVER
WILLIAM B. COLLINS* AND EARL F. BECKER

(45) EFFECTS OF CLIMATE AND GROWING CONDITIONS ON BROWSE QUALITY
WILLIAM B. COLLINS* AND DONALD E. SPALINGER

(46) AN EVALUATION OF USING VAGINAL IMPLANT TRANSMITTERS IN MOOSE
JOHN CROUSE, BRUCE DALE, ERIC WALD, AND THOMAS J. MCDONOUGH*

(47) PREVALENCE AND SPECIATION OF LUNGWORMS IN MAINE MOOSE
JORDAN GAGNE+ AND ANNE LICHTENWALNER*

(48) WHAT IS LIMITING MOOSE ABUNDANCE IN CENTRAL BRITISH COLUMBIA?
DOUG HEARD*, JESSICA COURTIER, AND GERALD KUZYK

(49) DEMOGRAPHICS MONITORING OF MOOSE IN GAME MANAGEMENT UNIT 25D, YUKON FLATS NATIONAL WILDLIFE REFUGE, ALASKA
MICHAEL HINKES*, BRYCE LAKE, AND MARK BERTRAM

(50) EVALUATING COMPETITION BETWEEN HUMANS AND WOLVES BY EXAMINING LANDSCAPE USE
IAN JOHNSON+, TODD J. BRINKMAN, KRIS HUNDERTMARK, AND BRYCE LAKE

(51) REPRODUCTIVE FAILURE IN MOOSE (*ALCES ALCES*) DUE TO EMBRYONIC MORTALITY AND UNFERTILIZED OOCYTES
JONAS MALMSTEN+ AND ANNE-MARIE DALIN

(52) THE IMPACT OF SUPPLEMENTARY FEEDING STATIONS FOR MOOSE ON SHOOT SIZE IN SCOTS PINE, NORWAY SPRUCE AND DOWNY BIRCH
KAREN MARIE MATHISEN*, AMANDINE REMY, AND CHRISTINA SKARPE

(53) DECIPHERING GPS COLLAR DATA FROM CAPTIVE MOOSE
DAN P. THOMPSON*, JOHN A. CROUSE, BRENT J. GROBAREK, AND KEVIN S. WHITE

(54) ESTIMATING MOOSE ABUNDANCE IN LINEAR SUBARCTIC HABITATS WITH DISTANCE SAMPLING AND A KERNEL ESTIMATOR
ERIC WALD* AND RYAN NIELSON

(55) MOOSE ON THE MOVE: PARASITE PLAGUED MOOSE MAY BE SEEKING REFUGE IN THE NORTH CASCADES
ELISSA KOBRIN+

(56) MOOSE (*ALCES ALCES*) BROWSE AVAILABILITY AND USE IN RESPONSE TO POST-FIRE SUCCESSION ON KANUTI NATIONAL WILDLIFE REFUGE, ALASKA
ERIN JULIANUS+

(57) BALANCING MOOSE POPULATION HEALTH AND HARVEST OPPORTUNITY: A COMPARISON OF FEMALE HARVEST SCENARIOS
CAMERON J. CARROLL, DONALD D. YOUNG, JR.*, KNUT KIELLAND, AND PAT DOAK

(58) MOOSE WINTER FORAGE PATTERNS AND DAMAGE TO NATIVE TREES AND SHRUBS IN RELATION TO THE RELATIVE ABUNDANCE OF NON-NATIVE CHOKECHERRY TREES IN URBAN FORESTS OF ANCHORAGE, ALASKA
GINO GRAZIONO*

PRESENTING AUTHORS
(Oral 1–43, Poster 44–57)

Aderman, Andy	(37)	Mathisen, Karen Marie	(43) (52)
Andreozzi, Haley	(24)	McDonough, Thomas J.	(36) (46)
Brinkman, Todd J.	(5)	McGraw, Amanda	(7)
Brown, Casey	(19)	Millette, Thomas	(10)
Carroll, Geoff	(39)	Moen, Ron	(27)
Carstensen, Michelle	(28)	Oates, Brendan	(26)
Caruso, Lauren	(42)	Palo, R. Thomas	(40)
Chapin III, F. Stuart	(1)	Paragi, Thomas F.	(3) (41)
Collins, William B.	(44) (45)	Perry, Tom	(11)
Colson, Kevin	(22)	Ruprecht, Joel	(14)
Crouse, John A.	(15)	Severud, William	(29)
Cyr, Tim	(31)	Signer, Claudio	(13)
Dale, Bruce W.	(4)	Skarpe, Christina	(20)
Glaser, Marion E.	(18)	Smith, Jason	(25)
Graziono, Gino	(58)	Smythe, Sharon	(17)
Heard, Doug	(48)	Tape, Ken D.	(38)
Hinkes, Michael	(49)	Terry, Juliann	(30)
Jesmer, Brett	(6)	Thompson, Dan P.	(53)
Johnson, Ian	(50)	Van Ballenberghe, Victor	(35)
Julianus, Erin	(56)	VanderWaal, Kimberly	(32)
Klein, David R.	(2)	Wald, Eric	(54)
Kobrin, Elissa	(55)	Wallgren, Märtha	(21)
Kot, Brian	(9)	White, Kevin S.	(8)
Lian, Marianne	(16)	Williams, Amy	(33)
Lichtenwalner, Anne	(34) (47)	Wilson, Robert	(23)
Malmsten, Jonas	(12) (51)	Young, Jr., Donald D.	(57)

ABSTRACTS

(Oral 1–43, Poster 44–57)

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(1) CLIMATE-CHANGE IMPACTS ON ALASKAN ECOSYSTEMS, WILDLIFE, AND COMMUNITIES: PREPARING FOR EXPECTED CHANGES AND SURPRISES

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Abstract: Alaska is experiencing some of the most rapid climate warming anywhere on the planet, a trend that is expected to continue or intensify. This leads to clear predictions of likely change in wildlife habitat, ecology, and population dynamics and consequences for subsistence-dependent communities. Consistent with patterns seen in recent decades, we expect warmer temperatures, especially in winter, more winter rains, longer growing seasons, more extensive and severe wildfires, and northward movement of many plant and animal species, including moose and various pest species. However, surprises are inevitable because of complex interactions among expected changes (e.g., interaction of changes in habitat and disease) and expected increases in climatic variability. The strong trends and increased likelihood of surprises provides new opportunities and challenges for wildlife managers and the public. It seems wise to prepare to manage in the context of expected changes rather than to expect to wildlife ecology to remain as it was in the past. Management to address surprises and extreme events requires a different approach—capacity to flexibly change regulations in response to surprises and extreme events and well-designed experiments to improve understanding of the impacts of potential surprises and management responses. Finally, the human dimensions of wildlife management may change radically, if declining state revenues lead to less public support for rural communities and therefore their greater dependence on subsistence resources. Subsistence harvest that meets both conservation and livelihood needs may require more liberalized harvest of some species when harvest of other species is constrained by conservation concerns.

(2) PERSPECTIVES FROM A LIFETIME INVOLVED IN MANAGEMENT AND INVESTIGATIONS OF ALASKA'S WILDLIFE

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Abstract: In 1955, having completed a Master of Science degree at the University of Alaska and serving a year in the U.S. Army during the Korean War, I began my full time career as a wildlife biologist in Petersburg, Alaska jointly employed by the Alaska Game Commission and the U.S. Fish and Wildlife Service (USFWS). When Alaska became a state in 1959 and the management of fish and wildlife was transferred to the new state, I resigned from the USFWS, and joined the newly established Alaska Department of Fish and Game (ADF&G). In 1962, having completed the PhD at the University of British Columbia doing dissertation research on deer ecology funded by ADF&G, I moved to Fairbanks with family to become Leader of the Cooperative Wildlife Research Unit and a professor in the Department of Biology and Wildlife. After 35 years and retirement from the Cooperative Fish and Wildlife Research Unit program and as a faculty member in the Department of Biology and Wildlife, I remain active professionally as a professor emeritus at UAF. Over my professional career I have been a participant as well as a committed observer in the evolution and development of wildlife management and associated investigations of wildlife ecology in Alaska and North America. I will elaborate on the development of wildlife management and associated change that have taken place in supportive ecological investigations in Alaska from Territorial times to the present. These include the technological advances in electronics that have enhanced our ability to track wildlife and their populations which provide a sounder basis for proscribing science-based harvest levels. At the same time however, they have often lead to reduced understanding of the ecological variability in wildlife habitats that may often be the dominant driver in changes at the population level. Coincident with these technological changes in management of Alaska's wildlife has been the increased politicization of the management process, often tied to corruption at the administrative and legislative levels of state government. This correlates with the over-commercialization of hunting as a sport and the associated deterioration of the ethics of hunting throughout North America in recent decades.

(3) INCREASED LOGGING FOR WOOD ENERGY IN BOREAL FOREST OF ALASKA: IMPLICATIONS FOR MOOSE AND REFORESTATION

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Abstract: Rising cost of heat and electricity in central Alaska is prompting feasibility projects with wood biomass as a commercial fuel source. Increased wood harvesting, even if only during a transition period until other energy sources are developed, would require new forest roads and produce landscape habitat legacies near communities. Logging is unlikely to approach the scale of wildland fire, but an increase in early seral vegetation can influence moose vital rates, risk of moose collision with trains or vehicles, and hunter access. Food security in our relatively isolated state includes discussion of intensive game management, but public disagreement on moose population and harvest objectives complicates planning, particularly on time scales of forest rotation periods. If moose are maintained at high density where large predators are harvest limited, herbivory on birch, aspen, and poplar can hasten transition of post-disturbance regeneration to canopy dominated by black spruce and white spruce. This effect could be at odds with climatic trends (deciduous trees favored in warmer drier environments), desired production of deciduous woody biomass on shorter rotations, and management of hazardous coniferous fuels near communities. Salvage logging from wildland fires or other natural disturbance events near the road system, if designed to ensure retention of late seral legacies for other ecosystem features and processes, may be a complementary balance to harvesting live trees. Strong public values on forests, moose, and road access will require careful coordination between land and wildlife managers and effective public engagement when seeking to define and achieve multiple desired outcomes.

(4) ALASKA'S INTENSIVE MOOSE MANAGEMENT PROGRAMS

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Abstract: The State of Alaska has a statutory mandate to identify moose, caribou, and deer populations important for high levels of consumptive use and manage them for elevated harvest. This legislation requires that the Alaska Department of Fish and Game implement feasible predator and/or habitat management if needed to achieve population and harvest objectives. ADF&G currently has several active intensive management programs for moose. The department strives for an adaptive approach to learn while implementing these programs in accordance with an intensive management protocol that specifies feasibility assessments, operational plans which include adaptive and explicit decision frameworks, and transparent semi-annual reporting that includes administrative and operational costs. The structure, details, and results of these programs designed to enhance high levels of consumptive use of moose are discussed along with future goals and challenges.

(5) A FEW WAYS THAT THE HUMAN DIMENSIONS OF WILDLIFE CAN ASSIST BIG-GAME MANAGEMENT

TODD J. BRINKMAN

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Abstract: Broadly defined, the human dimensions of wildlife (HDW) is the interactions and relationships between people and wildlife and the thoughts and behaviors of people toward wildlife. This field merges and applies theories of both the natural and social sciences. During early development of HDW, wildlife researchers and managers were hesitant to embrace HDW. The field was criticized for being unsystematic and overly subjective. Today, however, the more structured and rigorous implementation of this research has enhanced its credibility and acceptance. Within a large-game system context, I present several case studies and approaches that highlight the value of HDW science. Some of these benefits include 1) improved understanding of wildlife problems, 2) increased likelihood that research objectives address stakeholder needs, 3) expanded view of hunter opportunities, 3) and potentially an increase in job satisfaction for wildlife managers. Ultimately, I argue that social and ecological data are mutually reinforcing when integrated carefully.

(6) LINKING HABITAT AND NUTRITION WITH POPULATION PERFORMANCE IN MOOSE

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Abstract: A major goal in population ecology is to understand the factors underlying density-dependent shifts in demography, including behavioral and nutritional drivers. Meanwhile, management agencies often try to manage for long-term stability in wildlife populations to serve a variety of public interests. Populations approaching carrying capacity may be characterized by a sequence of events where population growth is accompanied by density-dependent shifts towards lowered nutritional condition and depressed vital rates. Many moose (*Alces alces*) populations are declining in the Intermountain West. Although an increase in apex predators may be contributing to poor population performance and population declines in some regions, many other moose populations continue to exhibit poor population performance in the absence of such apex predators. This pattern suggests that habitat limitation may be playing a key role in the predominately poor population performance observed in moose across the Intermountain West. From 2011 to 2013, we linked data on habitat condition (Keigley live-dead index) and nutritional condition (kidney fat) with 2 metrics of population performance (pregnancy and recruitment) in 6 moose populations in the Intermountain West. Our results indicate that habitat condition is strongly related to nutritional condition and pregnancy rates—but not recruitment rates— in these areas. Our overall goal is to use these results is to develop a system of "early warning" indicators that will 1) allow managers to detect when populations approach carrying capacity, and 2) prevent large fluctuations in moose populations.

(STUDENT)

(7) MOOSE VISITATION RATES AND SPACE USE OF FORAGING HABITATS IN NORTHERN MINNESOTA

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Abstract: Home range estimates have been used to evaluate habitat use by animals since before radiotelemetry was developed in the 1960s. Kernel methods improve the analysis of space use, but alternative approaches should be explored given the scale at which locations can be collected. GPS radio collars were deployed on 64 moose across northern Minnesota. Locations were recorded every 20 minutes and activity was recorded at 5 minute intervals. Traditional methods to define space use, such as creation of minimum convex polygons or kernel density estimators can be used. New methods, such as visual assignment of core areas based on clustering of locations as well as movement patterns associated with life history events can also be used. Fine scale space use and activity data can be modeled simultaneously with time to determine visitation rates and use of key habitats such as foraging habitats and birth sites. We determined use of early successional forest stands created by logging events. Stands harvested since 1991 were digitized from aerial photographs. Harvested stands available to moose in northeast Minnesota are about 45 acres (min = 1 acre, max = 2,400 acres). Moose typically used larger stands that were available (173 acres, SD = 160). Based on GPS locations moose visited 18 different harvested areas (SD = 8) over the course of a year. Moose used each harvested area about 19 days each year. Initial conclusions from this data are that in the absence of natural disturbance in Minnesota moose make extensive use of harvested areas.

(STUDENT)

(8) LINKING RESOURCE SELECTION TO OVERWINTER BODY CONDITION IN A COASTAL ALASKA MOOSE POPULATION

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Abstract: Understanding the relationship between habitat selection and animal performance is of fundamental importance to wildlife ecology. Unfortunately, resource selection patterns are not necessarily linked to measures of individual or population performance and further understanding of such relationships are needed. In this study, we examined the linkage between resource selection and nutritional condition in adult, female moose during winter in Gustavus, Alaska. Specifically, we examined how individual variation in resource selection is correlated with loss of overwinter reserves of body fat. Initially, we developed a forage-based resource selection function (RSF) model (i.e., a model that yields values proportional to the probability of use of a given resource unit) using GPS-radiotelemetry data ($n = 25$) and remote sensing data to describe resource selection patterns at the population-level. We then examined how individual variation in resource selection, relative to the population, influenced individual overwinter change in body fat (a correlate of reproductive success). Overall, RSF modeling results indicated that moose selected for areas with low snow depth and high forage biomass of willow (*Salix* spp.) and horsetail (*Equisetum variegatum*), critical winter forages. Further, we determined that loss of overwinter fat reserves tended to be lower for individual moose that exhibited stronger selection for areas with high forage biomass and low snow depth. These findings provide an empirical basis for understanding the nutritional implications of moose resource selection patterns in coastal Alaska.

(9) COMPARATIVE MOVEMENT PATTERNS OF MOOSE (*ALCES ALCES*) AND GRAY WOLVES (*CANIS LUPUS*) IN VOYAGEURS NATIONAL PARK: A PREDATION RISK ASSESSMENT

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Abstract: Voyageurs National Park (VNP) is a lake-dominated ecosystem in northern Minnesota that contains important habitat for moose (*Alces alces*) and their main predator, gray wolves (*Canis lupus*). Other prey for wolves in the park include white-tailed deer (*Odocoileus virginianus*) and beaver (*Castor canadensis*). In the past 25 years the VNP moose population has been stable in contrast to declining populations in other areas of northern Minnesota. To better understand the risk of predation by wolves on moose we analyzed data from GPS collars on wolves ($n = 4$) and moose ($n = 8$) that may have overlapped in space from October 2012 to February 2013. Collars on wolves collected GPS locations every 3–6 hours whereas collars on moose collected locations every 2 hours. These data allowed us to calculate home ranges, movement patterns, wolf territory sizes, and habitat overlap of moose and wolves. Ground-based investigations allowed us to characterize some wolf kill site habitats, and determine species, sex and age class of prey. Wolf distribution in the park remains consistent in recent years, with 2–4 packs occupying the Kabetogama Peninsula and 2–5 packs in the southeast region. Movement data demonstrated that moose and wolf habitats overlap within core moose range in VNP. Collared wolves moved through their individual home ranges with statistically significant differences ($P < 0.05$) in mean daily velocity but not mean travel direction. Moose throughout VNP are exposed to predation by wolves but how predation risk is influenced by spatial and temporal patterns in prey abundance will be a continued focus throughout this 3-year investigation.

(10) AUTOMATED DETECTION OF MOOSE (*ALCES ALCES*) AND DEER (*ODOCOILEUS VIRGINIANUS*) IN AIMS-THERMAL DATA

THOMAS MILLETTE

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Abstract: A new generation of uncooled microbolometer based radiometric thermal imaging cameras have led to renewed interest in aerial thermography for moose (*Alces alces*) census (Millette et al. 2011) and landscape utilization analysis (Millette et al. 2014). Despite the advances in thermal camera technology for these applications, successful data analysis still requires human interpreters with deep skills in aerial thermography. Although this technique can be highly successful, it is generally time consuming and therefore expensive. The process of moose target identification in radiometric thermal imagery using digital image processing techniques holds promise despite the numerous complicating factors. The factors include atmospheric attenuation, ambient surface temperature flux, general environmental variability, vegetation, and an almost unlimited collection of metallic objects heating in direct illumination and generating false-positive heat signatures that can confound automated detection. This paper reports the preliminary results of a pilot study to test some basic image processing techniques to screen individual images for potential moose targets. Thermal imagery was acquired with the AIMS-Thermal instrument under almost ideal conditions (100% snow cover, 100% cloud cover, ambient temperature below 0°C) between 24 December 2013 and 14 January 2014 for Wildlife Management Unit D2 in northeastern Vermont. A variety of image processing techniques were tested to screen more than 103,000 thermal images including clustering, supervised classification, image segmentation, thresholding, convolution, and image algebra. Initial results indicate that virtually all techniques worked with reasonable success within a single image. However, when any individual technique was applied to a large collection of images such as a series of adjacent flight lines, the accuracy of the detection dropped precipitously. It is thought that most of the standard image processing techniques tested to date are insensitive to the complex environmental variability of landscape temperature as recorded from an airborne sensor. As a result, temperature characteristics from one image to the next appear completely different and confound the particular algorithm in use. The researcher is presently developing new techniques that measure and model individual scene variability together with collective flight line variability and using a hybrid decision rule to screen for moose targets. Initial tests have been promising, but not yet conclusive.

(11) WHEN REFUGE BECOMES RISK: THE BEHAVIORAL RESPONSE OF MOOSE TO HUNTING IN GROS MORNE NATIONAL PARK, NEWFOUNDLAND

TOM PERRY+ AND PHIL MCLOUGHLIN

University of Saskatchewan, Canada

Abstract: An unconventional invasive species in Canadian Boreal forests, moose (*Alces alces*) have grown to reach hyperabundant population numbers in Gros Morne National Park (GMNP), Newfoundland. Intense browsing of understory plants and regenerating trees in sites of natural disturbance has suppressed the succession of mature forest stands. In order to preserve the ecological integrity of GMNP forests, park managers initiated a controlled hunt in October 2011. So far, Gros Morne hunters have harvested approximately 700 of the estimated 5,000 moose living within the park; moreover, hunters may have also produced unexpected changes in moose behavior. During the hunting season, hunters have been recorded to concentrate in certain areas of GMNP (i.e., near roads, snowmobile trails and communities) which has resulted in a landscape consisting of varying degrees of human predation risk for moose. Our research intends to quantify a metric for hunter predation risk across GMNP, and then test how this "hunter risk factor" influences moose habitat selection, movement patterns and diurnal activity prior to, and following 3 years of hunting in GMNP. The moose management problem in GMNP offers a serendipitous opportunity to test the popular landscape of fear paradigm on a previously hunter-naïve moose population. More importantly, information of moose behavioral responses to human hunting patterns may have useful management application. Integrating knowledge of animal behavior into management decisions may be particularly valuable for wildlife managers who are searching for novel solutions for dealing with overabundant ungulate populations.

(STUDENT)

(12) SPERM MORPHOLOGY IN SCANDINAVIAN MOOSE

JONAS MALMSTEN+, LENNART SÖDERQUIST, CARL-GUSTAF THULIN, AND ANNE-MARIE DALIN

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Abstract: Knowledge of reproductive biology of game species is vital for a sustainable management. In moose (*Alces alces*) research in reproductive characteristics has had a female biased focus, whereas reports in male moose are few. The aim of the present study was to investigate sperm morphology and its relationship with testicular and epididymal features. In total, 143 male moose aged 1.5–11.5 years were sampled from 2008 to 2011. The proportion of normal spermatozoa (PNS) ranged from 1.5 to 82.0%, with a mean of 51%. PNS decreased temporally, and was positively associated with carcass and testes weight. Body weight and testes weight had positive effect on PNS regardless of age. The testis/body weight ratio of moose (0.033%) is among the lowest reported among mammals, indicating a less polygynous mating system than in roe deer and red deer. For reproduction success in moose, a high body weight in males is favorable, as is a balanced sex ratio. Thus, males should not be harvested prior to the time when the majority of females have passed their first oestrus of the season.

(STUDENT)

(13) MEASURING HEART RATE AND BODY TEMPERATURE IN THE FIELD: A NEW TELEMETRY SYSTEM OPENS NOVEL PERSPECTIVES IN RUMINANT ECO-PHYSIOLOGY

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Abstract: Measuring physiological parameters in free-ranging animals is of general biological concern, but difficult to perform. We have developed a minimally-invasive telemetry system for ruminants that is capable of measuring heart rate (HR) and body temperature (Tb). A ruminal unit is per os placed into the reticulum and therefore located in close proximity to the heart. With the use of an integrated acceleration sensor, the ruminal unit reliably detects HR of animals at rest and also measures Tb. HR and Tb signals are transmitted via short-distance UHF link to a repeater system located in a collar unit. The collar unit may be equipped with further telemetry options, such as activity sensors, VHF beacon, or GPS module. The telemetry system has so far successfully been applied to free-ranging Alpine ibex (*Capra ibex*), Alpine chamois (*Rupicapra rupicapra*), and red deer (*Cervus elaphus*). Data from Alpine ibex indicate a substantial down-regulation of endogenous heat production and metabolic rate during winter. These mechanisms, in combination with basking as a partially heterothermic strategy, enable the animals to minimize their energy expenditure in order to survive harsh winter conditions. By detecting physiological parameters in animals living under truly natural conditions, our telemetry system reveals novel research perspectives in eco-physiology. The telemetry system is now available at VECTRONIC Aerospace GmbH, Germany.

(14) RELATIONSHIPS BETWEEN BODY CONDITION AND PREGNANCY IN MOOSE AT THEIR SOUTHERN RANGE LIMIT

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Abstract: A leading paradigm in the ecology of species range limits is that various components of fitness decline from the center of a species' range toward the edges along a gradient of increasing environmental stress. Although evidence is scarce, a number of studies have shown that decreased body condition occurs in edge populations relative to central populations. However, empirical evidence of low reproductive output in peripheral populations is lacking. We report findings on the relationships between pregnancy and body condition in Utah moose — the southernmost naturally-occurring moose population in North America. Although our data only represent one year of sampling, rump fat depths in our study may be the lowest ever recorded for adult female moose. However, despite low body condition, we found little evidence of decreased fertility in this edge population, as pregnancy rates in our study were roughly comparable to the rangewide average after controlling for age. Our results show a nonlinear relationship between depth of winter rump fat and the probability of pregnancy from the previous fall. Although our results display a similar pattern as other studies, we show that southern moose require less body fat to achieve pregnancy than central populations, which is likely an expression of phenotypic plasticity of moose at low latitudes. Whether low body fat in our study results from marginal environmental conditions owing to the population's location at its southern range limit, or is a novel thermoregulatory adaptation to cope with the area's high ambient temperatures, is uncertain.

(STUDENT)

(15) EVALUATING PROTEIN BALANCE IN WINTERING MOOSE

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Abstract: Moose contend with declining supplies of energy and protein as the concentrations of plant toxins and fiber increase in browse. Body stores are used to meet demands for energy and protein when dietary supplies are insufficient for normal activities and reproduction. Measures of rump fat thickness are used to assess seasonal dynamics in body energy reserves but a similar indicator of body protein use has not been demonstrated. We used the stable isotope of nitrogen (∂15N) to distinguish between protein in the diet and the body of female moose (n = 6) over 3 winters. Body mass and rump fat thickness declined following rut in October through parturition in late May. Serum concentrations of urea were low in winter but increased in spring when green leaves emerged, which indicated that N oxidation was minimized when dietary protein was low. Body protein was used through winter when 76 ± 5 % of N in urea was derived from body protein whereas only 8 ± 12 % of urea-N was derived from the body in spring. Plant toxins may exacerbate N losses in moose during winter because more urinary N was lost as ammonia than as urea, especially as the concentration of phenols increased in urine. Moose recycled body proteins during winter because ∂15N values of serum proteins were 1.14 ± 0.62 ppt greater than those of red blood cells. Metabolites of N in urine and blood can be combined with rump fat thickness and calf mass to evaluate the effect of habitat on production of moose.

(16) THE EFFECT OF HELICOPTER CHASE AND CAPTURE ON THE PHYSIOLOGY OF FREE-RANGING MOOSE (*ALCES ALCES*), USING BLOOD GASES, LACTATES AND BODY TEMPERATURE AS VARIABLES

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Abstract: Previous studies indicate that free-ranging moose darted with etorphine-acepromazine-xylazine from helicopter are mildly to severely hypoxemic, acidemic and hyperlactemic. We evaluated how helicopter chase and capture event affect moose by comparing arterial blood gas and lactate measurements from unstressed captive moose with values collected from free-ranging moose. Twelve adult moose bulls from captive facilities were ground darted for antler removal in Östersund, Sweden, September 2012 and 2013. They were immobilized with the same combination previously used on free-ranging moose, but with lower dosages. We collected arterial blood gases and lactate, and compared the results with previously collected data from helicopter darted free-ranging moose. Immobilized captive moose had significantly ($P < 0.012$) lower arterial oxygenation, than free-ranging moose. They also had significantly lower lactate values ($P < 0.001$) and pH values ($P < 0.001$), suggesting a normal muscle metabolism. Body temperature sensors were placed in the rumen of 19 moose in Northern Sweden, winters 2012 and 2013. Rumen temperature showed a significant seasonal variation with a maximum of 38.7°C in July and a minimum of 37.7°C in April. Sensors recorded body temperature in the rumen every 5 minutes post capture, allowing for detailed descriptions of the recovery period. It took 36 ± 8 hours on an average for body temperature to normalize to 37.8°C, following the capture. Rumen temperature of immobilized moose was compared to reference values, as well as to assess how long it takes for the rumen temperature to normalize post capture in free-ranging moose.

(17) HYDRO-AXING EFFECTS ON BROWSE RESOURCES AVAILABLE TO WINTERING MOOSE ON THE COPPER RIVER DELTA, ALASKA

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Abstract: Moose (*Alces alces gigas*) were introduced to the Copper River Delta (CRD) of Southeast Alaska from 1949 to 1958. Stakeholder pressure is mounting to increase the current population of approximately 600 moose. However, in 1964 an earthquake raised the delta by 1.8–3.4 m and accelerated the successional shift from more palatable browse species like sweetgale and willow (*Myrica gale, Salix* spp.) to less palatable alder and spruce (*Alnus viridis sinuata, Picea sitchensis*). Managers implemented experimental hydro-axing in multiple stand types in 1990, 2008, and 2010 in order to counter the successional trend. We investigated responses in diversity, biomass, nutritional values, and utilization of browse species between treated and untreated stands. We found strong stand type differences in response to hydro-axing. For example, treated (1990) sweetgale-dominated stands displayed little change in species diversity but produced 46.7% greater available biomass of willows and sweetgale than untreated controls. Utilization of 3 core browse species, Barclay's willow (*Salix barclayi*), Hooker's willow (*S. hookeriana*), and Sitka willow (*S. sitchensis*), increased to 3 times the level observed in untreated stands, implying benefits to productivity, quality, or both. Other stand types, such as (2008) spruce-cottonwood-dominated, (2010) alder-dominated, (2010) sweetgale-dominated stands, displayed an initial decrease in diversity of less-preferred species. These analyses, combined with estimates of NCC under a range of winter scenarios, will assist managers in deciding whether the significant costs and difficulties associated with hydro-axing are practical to increase or sustain the moose herd in this area.

(STUDENT)

(18) CALCULATING THE CARRYING CAPACITY OF MOOSE HABITAT USING NUTRITIONAL ANALYSES, GROUND SURVEYS, AND REMOTE SENSING

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Abstract: Wildlife managers often need to assess habitat with regards to its benefit to ungulates. However, the assessment is often qualitative due to habitat complexity and limited resources. We used the forage evaluation model, FRESH-Moose, to estimate moose habitat carrying capacity based on browse quality and quantity. The FRESH-Moose model required biomass estimates and nutritional analyses of all browse species to calculate the number of moose-days per hectare. One moose-day is equal to the amount of food required to satisfy 1 adult female moose for 1 day. Our study sites consisted of 5 transects which traversed both mature and treated forest habitat in the Chugach National Forest, Alaska. Carrying capacity estimates for young and mature forest were compared, as were estimates based on ground surveys and remotely sensed data. Remotely sensed data consisted of vegetation maps created from overlapping, orthorectified, classified aerial photographs that ranged from 70% to 90% accurate. Moose Days per hectare calculated from ground surveys for treated sites were 97, 40, 3, 35, and 102; for untreated sites, they were 1, 2, 2, 8, and 48. Moose Days per hectare calculated from the vegetation maps for the same treated areas were 7, 21, 11, 16, and 71; and for untreated sites were 5, 4, 1, 7, and 59, respectively. Excluding the first stand, the relation between ground surveys and mapping accounted for 85% of the variation. This method provided a metric for evaluating habitat quality which can be useful for land managers interested in evaluating forage resources.

(STUDENT)

(19) THE EFFECTS OF WILDFIRE SEVERITY ON MOOSE HABITAT USE AND FORAGE PRODUCTION RATES IN INTERIOR ALASKA

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Abstract: Wildfire is the most common ecological disturbance in the boreal forest and recent studies have documented an increase in the frequency, extent and severity of wildfires in Interior Alaska under a changing climate. Fire severity, in particular, can influence the seeding of favorable browse species affecting forage production for moose. More recent findings have also found that increasing severity of boreal fires may contribute to a shift towards a deciduous dominated forest system. Such a shift could influence a broad suite of ecosystem processes including wildlife habitat use. Although it is generally accepted that burns can sustain or increase moose populations through regeneration of habitat, the extent of forage production and habitat use following burns is unknown. We quantified forage production and offtake across a fire severity gradient in a 20-year-old burn in Interior Alaska. We used global positioning system (GPS) locations collected from a sample of adult male moose to model relative frequency or probability of use as a function of habitat variables including fire severity. Forage production and removal estimates were highly variable depending on the fire severity at each site. On average high-severity sites produced more forage biomass than medium of low- severity sites. However, forage offtake was greatest in medium-severity sites. The results from this project will provide an opportunity for researchers to incorporate information into future management strategies that maximize the positive effect of natural wildfire for both moose nutrition and harvest.

(STUDENT)

(20) INTEGRATED MANAGEMENT OF MOOSE AND FOREST

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Abstract: In Scandinavia almost all young pines, *Pinus sylvestris*, are browsed by moose, *Alces alces*. The trees compensate, but substantial browsing reduces total production. In addition moose bark stripping, top shoot browsing and top breaking reduces timber quality. As pine is the most valuable timber tree, the result is that foresters and forest companies want to reduce moose populations. There is little thought of integrating the management of forest and moose, and that the moose might have a cost. There is routinely quantification of the damage by moose, but not of the only factor important for foresters: the density of undamaged trees. In a large scale experiment including treated areas and controls we record moose density, forage production, availability and consumption. As previous browsing is a strong predictor of future browsing we leave damaged trees in the treated areas. In addition, clearing of trees is done by top-cutting above the lowest productive branches. These will then continue producing forage until they are browsed or shaded out. We establish very dense pine regenerations, where moose select which trees to browse and which to leave alone. We log and thin pine during winter, making logging residues available. Also this forage from old trees is said to be preferred to that from young trees. With these efforts we hope to redirect the browsing pressure to the browsed and top-cut trees, to browsed trees in dense regeneration, and to logging residues increasing density of undamaged pine.

(21) MANAGEMENT STRATEGIES FOR REDUCING BROWSING DAMAGE BY MOOSE

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Abstract: Forestry is a main land use in Sweden and contributes significantly to the country's economy. The Swedish moose (*Alces alces*) population is among the densest in the world and moose hunting is culturally, socially and economically valued. One of the most important tree species for Swedish forestry is Scots pine (*Pinus sylvestris*), which also constitutes the most important winter forage for moose. Moose browsing on young Scots pine may affect the trees in terms of retarded growth, increased risk of mortality and reduced stem quality. This may be costly for forest owners, both at present time by, e.g., replanting and in the future by lower value of the trees when harvested. A current challenge for forestry researchers is to find means for reducing browsing damage in young pine stands by various forest management actions. We studied spatial distribution of browsing and damage by moose in young pine stands in central Sweden and possibilities of using selective thinning of damaged stands as a tool for reducing the economic losses for forestry. Our results revealed complex relationships between damage levels and explanatory variables depending on spatial scale. In conclusion, pre-commercial and commercial thinning can be used to reduce damage levels in pine stands, but the actions should be evaluated in relation to additional factors, such as stem density and tree species mixture, on relevant spatial scales. Our findings are discussed in the light of other studies of forest management practices for reducing browsing damages and related economic costs within the Nordic countries.

(22) POPULATION BOUNDARIES AND THE SUBSPECIFIC DIVIDE IN SOUTHEASTERN ALASKAN MOOSE

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Abstract: Moose (*Alces alces*) are a recent arrival to southeastern Alaska, having only colonized this topographically complex region in the last 100 years. While previous studies in Alaska have found little to no population genetic structure across the northern regions of the state, the southeastern region of Alaska has not previously been examined using intensive sampling and nuclear DNA markers. Here, we sample moose from Alaska and British Columbia to examine regionwide population structure, examine what factors may lead to its formation, and attempt to identify any subspecific divides in the area. We find that the area has extensive genetic structuring, with all of our sampled locations being differentiated from each other. Analyses reveal few effective migrants between population pairs, and an assignment test only found 2 potential migrants among the identified populations. We also find large or serial founder effects may account for creating initial genetic differentiation between populations, where after very low levels of dispersal prevent homogenization. Finally, we identify moose in the northernmost part of southeastern Alaska as belonging to *A. a. andersoni*, and not *A. a. gigas* as previously indicated, suggesting the subspecific boundary is further north than previously thought.

(23) NATURAL AND ANTHROPOGENIC EFFECTS ON THE SPATIAL GENETIC STRUCTURE OF MOOSE

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Abstract: Dispersal of individuals can influence population dynamics and the spatial and temporal distribution of a species' genetic variation. Natural landscape features (mountains) as well as anthropogenic barriers (roads) can influence movements at multiple scales from dispersal events to seasonal migration to daily foraging. We evaluated the genetic diversity and connectivity between 2 populations (Anchorage and Kenai Peninsula) within Southcentral Alaska and assessed the fine-scale genetic structure within Anchorage to explore the potential effects the Glenn Highway has on a resident moose population. At the regional scale, moose populations on the Kenai Peninsula were significantly differentiated from the Anchorage population and had significantly lower genetic diversity. In addition, there was little evidence of contemporary gene flow suggesting that these 2 areas may represent demographically independent units. At the local scale, urban Anchorage moose were weakly structured as 2 subpopulations within this apparently contiguous population. The area of contact between the 2 Anchorage subpopulations appears to coincide with a major highway. While the road is not an impenetrable barrier, it has likely reduced dispersal between areas fairly recently. Conversely within the Kenai, high levels of gene flow were detected between its 2 management units and no genetic subdivisions were observed, suggesting Kenai moose are of a panmictic population. Understanding the distribution of genetic diversity and how moose populations are structured can provide valuable information for mitigation strategies on the local scale as well as conservation plans to manage isolated populations at range margins.

(24) ANALYSIS OF PHYSICAL CHARACTERISTICS OF BULL MOOSE HARVESTED IN MAINE, 1980–2009

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Abstract: Biological data collected in 1980–2009 from harvested bull moose (*Alces alces*) in Maine were analyzed to assess whether temporal change has occurred in their physical characteristics. Measurements included age, field-dressed body weight, and antler spread; measurements and proportions of trophy bulls (spread ≥137 cm) in the harvest were also analyzed. There was no evidence of a measurable decline in the physical parameters (body weight and antler spread) of adult bull moose, and a slight increase in physical characteristics of yearlings. The absolute decline in the proportion of trophy bulls in the harvest was ~3% (8.8 to 5.9%) as harvest increased from 1980–1987 to 2005–2009; the mean spread of trophy bulls declined 2% ($P = 0.003$). There were no differences ($P > 0.05$) in the proportion of harvested bulls within each age class between the 1980–1987 and 2005–2009 time periods. The relatively stable proportion of mature bulls (>5 years old) in the harvest across time periods (30–44%) suggests that harvest of trophy bulls has not become more selective. Given that physical characteristics of yearling bulls declined in adjacent New Hampshire and Vermont during the same time period, continued monitoring is warranted to best manage the largest, longest harvested moose population in the northeastern United States.

(STUDENT)

(25) CURRENT STATUS OF MOOSE IN NORTH DAKOTA

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Abstract: In the traditional North Dakota moose habitat of the Pembina Hills (unit M1C) and Turtle Mountains (M4), moose winter aerial counts increased until the mid-1990s, peaking at densities of 0.68/mi^2 and 1.2/mi^2, respectively. During the same period, the moose population also greatly expanded its range in to the prairie habitats of the state. Since the late 1990s, however, moose numbers in the Pembina Hills and the Turtle Mountains have declined dramatically, and a more recent decline has been observed in the Prairie Monitoring Block (M8). Moose declines may be related in part to overharvest. Prior to the closure of unit M1C to hunting, it is estimated that 27–44% of the previous winter's aerial count was being harvested annually, while on the prairie, the high visibility of moose has created the perception that moose are abundant and can sustain established harvest levels. In reality, however, moose densities on North Dakota's prairie are the lowest reported for North America (0.02–0.06/mi^2). The timing and structure of the hunting season also appears to have influenced moose reproduction; in 2012, 34% of tags issued were cow/calf only, and the hunting season corresponded with the peak of the rut. The result is population is skewed towards younger cows ($\bar{x} = 3.5$ years old), with open and late-bred cows a common occurrence. To address these concerns, in 2013, the overall number of tags was reduced. Cow/calf-only tags were eliminated, and the season opener was moved back 1 week.

(26) COMPARATIVE DEMOGRAPHY OF TWO MOOSE POPULATIONS WITH CONTRASTING PREDATOR DENSITIES

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Abstract: During the past 2 decades, Shiras moose (*Alces alces shirasi*) in western Wyoming have exhibited population declines. Recent work in the Jackson herd unit suggested that the 1988 Yellowstone fires and regional drought contributed to a considerable decline in calf recruitment, which also coincided with the recovery of grizzly bears (*Ursus arctos horribilis*) and gray wolves (*Canis lupus occidentalis*) to the Greater Yellowstone Ecosystem. Predation is presumed to have contributed to calf declines, but the relative role of these predators has yet to be evaluated. In the Sublette herd, directly adjacent to the south, moose are exposed to markedly lower abundance of apex predators. We are quantifying the relative influence of predation on the demography of these 2 herds, while accounting for the influence of winter severity, spring green-up, summer drought, habitat quality, and the effect of the Yellowstone fires. We are comparing 2 time series of demographic rates (pregnancy, parturition, neonate survival, calf recruitment, adult survival) to identify the spatial extent and intensity at which predation, habitat, and interacting abiotic factors limit population growth. Thus far, Sublette moose have exhibited low rates of pregnancy (less than 75%), which is consistent with poor habitat quality, and high neonate survival (greater than 80%). Overall, Jackson moose exhibited high rates of pregnancy (90%) and lower neonate survival (58%), however, previous work also noted a negative effect of burned habitat on demography. Our spatial analysis of individual fitness in these 2 herds will help tease apart the relative contributions of abiotic factors and predation to population performance. Quantifying the influence of restored apex predators on Shiras moose populations will hopefully aid the management of moose in montane ecosystems throughout North America.

(STUDENT)

(27) USING A SIMULATION MODEL TO HELP UNDERSTAND CAUSES OF THE MOOSE DECLINE IN MINNESOTA

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Abstract: The population of moose in northeastern Minnesota is declining. Point estimates from aerial surveys decreased 69% from 8,840 moose in 2006 to 2,740 moose in 2013. The decline is corroborated by declines in calf:cow ratios, decreased hunter success, and decreases in sightings of moose by the public. Scientists and managers typically think of populations in terms of the number of living animals, but the number of dead animals is also an important element, especially during population declines. We developed an age-structured population model to simulate moose populations and performed a sensitivity analysis on calf and adult survival. Predicted population size, calf:cow, and adult:cow ratios from the model were within 10% of observed values since 2005. In order to match population trends annual adult survival rates had to be about 0.83, and calf survival rates had to about 0.35. Changes in population were most sensitive to adult survival, but calf survival was also important. About 1,300 adults and 1,800 calves would die each year. To match the decline from 2012 to 2013, adult survival had to decline to about 0.75 and calf survival had to decline to about 0.25. This resulted in an increase to about 2,100 adults and 1,500 calves dying in 2013. Annual mortalities of 3,600 moose are significant, given that moose harvest in Minnesota in prior years was well below 500 animals. One use of models like this is to determine the effect of cause-specific mortality sources such as harvest, wolf predation, or disease on predicted population size.

(28) DETERMINING CAUSE-SPECIFIC MORTALITY IN MINNESOTA'S DECLINING MOOSE POPULATION

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Abstract: Minnesota's moose (*Alces alces*) are dying at rates much higher than elsewhere in North America. Moose numbers in northwestern Minnesota have plummeted from >4,000 to <100 animals in just the past 2 decades. Recent aerial surveys also indicate the northeastern population is also declining. Previous research in northeastern Minnesota reported a 21% average nonhunting mortality rate for radiocollared males and females, which was much higher than the 8–12% reported for moose elsewhere in North America. Specific causes of most of the non-anthropogenic mortality (89%) could not be determined, as assessing cause-specific mortality was not the primary objective of the study. Many of the deaths appeared health-related, with prime age animals dying during unusual times of the year or carcasses found intact with little evidence of scavenging. In 2013 the Minnesota DNR launched a new study to determining cause-specific mortality by deploying Iridium GPS collars on 111 moose in northeastern Minnesota and preparing an extensive network of responders highly trained in conducting field necropsies. Moose mortalities are investigated within 24 hours of death to identify proximate cause of mortality and to examine the influence of potential contributing factors. In the first 10 months of the study, 20% of moose have died; an update on causes of death will be provided.

(29) CAUSE-SPECIFIC MORTALITY OF MOOSE CALVES IN NORTHEASTERN MINNESOTA: RESULTS FROM THE FIRST SUMMER

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Abstract: Adult survival is an important driver of large herbivore population dynamics; however, low and variable recruitment also can have a strong influence on population trajectory. The northeastern Minnesota moose (*Alces alces*) population has been exhibiting a downward trend since 2005. Neonate and seasonal survival rates and specific causes of mortality of calves are largely unknown. The greatest hazard relative to survival occurs within the first 3–4 months of life for ungulates. Our research is investigating survival rates and specific causes of mortality during this period. We tracked 73 adult female moose fitted with GPS collars (50 confirmed pregnant at capture by progesterone concentrations, 6 unknown, 17 not pregnant) beginning 1 May 2013, looking for long distance precalving movements followed by localization. We confirmed presence of calves with a helicopter capture crew. Forty-nine neonates from 31 dams (58% twinning rate) were fitted with expandable GPS collars during May 2013 and are being tracked intensely throughout their first year. We are investigating calf mortalities and estimating proximate causes of mortality on site. Thirty-six mortalities have occurred (with 4 slipped collars), leaving 9 calves "on air" to date. Natural and capture-induced abandonment by dams, predation by bears and wolves, drowning, and injury inflicted by the dam all are preliminary causes of death. Identifying specific causes of calf mortality and understanding their relations to various landscape and other extrinsic factors should yield insight into mechanisms contributing to the declining moose population in northeastern Minnesota and serve as a basis for an ecologically-sound management response.

(STUDENT)

(30) THE HABITAT OF THE WINTER TICK IN THE MOOSE RANGE OF NORTHEAST MINNESOTA

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Abstract: Winter ticks occur on moose in North America south of about 60°. Little is known about tick abundance in different habitats outside of Alberta. Knowing density of winter ticks in different habitats would potentially enable development of management strategies because winter ticks move less than 1 m from where they fall off a moose in spring. Until now, a limiting factor in finding ticks was knowing where moose were when ticks drop off. We used GPS collars collecting locations at 20 minute intervals to identify 21 bed sites and 27 foraging paths of moose in spring 2013. In fall 2013 we collected 30,000 ticks using flannel drags. Ticks were found at 16 foraging paths and at 6 bed sites ($P < 0.05$). Tick density was higher in foraging paths (8 ± 13 ticks/m^2) than bed sites (4 ± 11). Canopy closure influenced tick abundance with 12 ± 16 ticks/m^2 in open canopies (50% closure, $P < 0.005$). No ticks were found in conifer forests. GPS collars collecting 20-min locations were deployed on 22 moose in 2011 and were used to identify habitats where collared moose paths overlap in the spring and fall. Overlaps accounted for 4% (72 ha) of the paths, but not all moose in the area were collared. The most common habitat types that overlapped were mixed-wood forests (44%), bogs (21%), and conifer forests (13%). Habitats with open canopy and available forage may support higher tick loads than closed canopies.

(STUDENT)

(31) SPATIAL AND TEMPORAL ABUNDANCE OF GASTROPOD INTERMEDIATE HOSTS IN NORTHERN MINNESOTA WITH IMPLICATIONS FOR PARELAPHOSTRONGYLUS TENUIS RISK IN MOOSE

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Abstract: *Parelaphostrongylus tenuis*, a parasitic nematode that can be lethal to moose, has been documented in moose in northeastern Minnesota and has been implicated in declines in other moose populations. Terrestrial gastropods are the intermediate hosts for *P. tenuis*. Describing spatial and temporal changes in gastropod abundance will increase understanding about the risk of *P. tenuis* infection by moose at the individual and population levels. We used cardboard traps and hand searches to estimate terrestrial gastropod species composition and abundance in northeastern Minnesota. Snails and slugs were collected in 16 transects with 10 traps per transect. Cover types sampled were deciduous forest, coniferous forest, mixed forest, and regeneration. We also measured duff thickness, leaf litter thickness, tree density, soil type, common plant species, canopy cover, ground cover, and soil moisture, which may explain terrestrial gastropod distribution. Gastropods were most abundant in conifer and regenerating forests ($11.2/m^2$) while mixed forests had the lowest gastropod abundance ($7/m^2$). Gastropods were more abundant in September than in June and July and ceased to be active in November with freezing temperatures. No site characteristic had a strong effect on gastropod distribution; however, ground cover had the most significant effect on both slugs and snails. Sixteen gastropods were found climbing on vegetation up to one meter off the ground in searching over 60 m^2 of plots. Given the low numbers of snails found in vegetation, it remains hard to understand how both deer and moose acquire *P. tenuis* by ingesting snails. Spatial and temporal changes in gastropod abundance could provide different risk levels of *P. tenuis* infection for moose. Our research will help to evaluate infection risk in the most common moose habitats in northeastern Minnesota.

(STUDENT)

(32) PATTERNS IN WHITE-TAILED DEER DENSITY AND PARASITE PREVALENCE IN VOYAGEURS NATIONAL PARK: IMPLICATIONS FOR DISEASE TRANSMISSION TO MOOSE

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Abstract: The moose population in northeastern Minnesota has declined by over 50% in the past 3 years, and the moose population in northwestern Minnesota has almost disappeared. Voyageurs National Park (VNP) is a paradox in that its low-density moose population is stable despite high white-tailed deer densities. High deer densities are generally thought to increase the risk of parasite transmission from deer to moose. In particular, liver flukes (*Fascioloides magna*) and brainworm (*Parelaphostrongylus tenuis*) primarily infect deer, but these parasites can cause morbidity and mortality when incidentally infecting moose. Here, we assess how deer and moose densities are related at a local scale, and if high deer densities lead to higher infection risk. Deer and moose pellet counts were conducted across 78 survey units in and around VNP from 2009 to 2011. Data were analyzed using generalized linear mixed models (GLMM) with survey unit included as a random effect. We found that moose presence-absence in survey units was not influenced by the density of deer. Among plots where moose were present, moose pellet density was positively correlated with deer pellet density (Poisson GLMM, $N = 30$ survey unites, ß = 0.001, $P = 0.003$). This may be because some plots were poor quality habitat for both species, and other plots were characterized by habitat that was beneficial for both species simultaneously. In 29 survey units, deer pellet groups ($n =$ 10 per unit) were sampled for the presence of *P. tenuis* larvae and *F. magna* eggs. Overall, 68.8% of deer pellets were infected with *P. tenuis*, and 56.9% were infected with *F. magna*. *P. tenuis* infection was significantly higher in VNP than outside the park (76.7% vs. 40%, respectively, $P < 0.001$). Deer were slightly more likely to be infected in units with higher deer density (Logistic GLMM, $N = 295$ fecal samples, ß = 0.005, $P = 0.039$). More research is needed to understand the ecological factors leading to higher prevalence in VNP.

(33) COMPARING VECTORS AMONG WYOMING MOOSE POPULATIONS WITH VARYING PREVALENCE OF *ELAEOPHORA SCHNEIDERI*

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Abstract: Many moose herds in North America have experienced decreasing population trends. Several factors such as habitat quality, increases in minimum and maximum temperatures, parasites, and predators, have been implicated as detrimental to moose fitness and population growth. In Wyoming, several moose herds have concurrent decreasing population trends. In addition to the above factors, the arterial worm *Elaeophora schneideri* has recently been found in many moose herds throughout Wyoming. A change in prevalence from 0 to 25% and 48% respectively, has been seen in Teton and Fremont counties with a prevalence as high as 82.6% in one southwest Wyoming herd. Elaeophorosis can cause morbidity and mortality in abnormal hosts such as moose and has been found to depress population growth in elk. To better understand what drives the prevalence of *E. schneideri* in moose, we examined the tabanid vector and its relationships with potential ungulate hosts. From field-collected horse flies, there were differences in the species composition among 4 study sites. These horse flies are being tested for *E. schneideri* larvae using real-time PCR. We expect the differences in species composition of horse flies to correlate with the prevalence of *E. schneideri* among the 18 different species of horse flies identified to date. In addition, we will determine if moose are being selected for blood meals more than other animals on the landscape using species-specific primers. The results from this study will help researchers better understand the dynamics of *E. schneideri* transmission and the conditions that lead to elaeophorosis in moose.

(STUDENT)

(34) MAINE MOOSE GENERAL HEALTH SURVEY 2014

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Abstract: As part of a multi-year assessment of adult female and calf survival, radio collars were placed on 60 Maine moose during a planned study of moose health in early 2014. Samples collected at the time of capture included blood, feces, and hair. Estimates of the numbers of ticks present on moose were made. Baseline evaluations of parasite burdens, hematologic values, and trace nutrients will be reported for moose included in this study.

(35) POPULATION TRENDS OF DENALI NATIONAL PARK AND PRESERVE MOOSE, 1917–2013

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Abstract: Information on trends of the moose population in the eastern part of Denali National Park and Preserve in Interior Alaska is available for nearly a century from establishment of the park in 1917 to the present. During the 1920s, moose were described as rare, apparently due to market hunting. Moose then increased and were reported as common by the late 1930s. Murie (1944) estimated the population as 200–300, low compared to current numbers. Subsequently, moose continued to increase in the park as they did in adjacent areas to the east. Numbers fluctuated in response to severe winters; record snowfall in 1970–1971 resulted in high mortality. Peak numbers likely occurred in the early 1970s followed by a decline that lasted 2 decades. Calf survival and recruitment were very low during the decline, largely due to heavy predation on young calves by brown bears. By the late 1990s, moose numbers were only one-quarter to one-third of those present in the late 1970s. Thereafter, calf survival and recruitment increased as bear predation declined and moose numbers stabilized. Currently, moose density is moderate, body condition of adult moose is relatively high, and there is little heavy browsing on preferred browse species. It is noteworthy that the moose population increase occurred in the presence of naturally regulated bear and wolf populations, and predation did not continue to suppress moose numbers indefinitely.

(36) A TALE OF TWO POPULATIONS: CHALLENGES OF MOOSE MANAGEMENT ON THE KENAI PENINSULA, ALASKA

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Abstract: Moose on Alaska's Kenai Peninsula are an important public resource. In 2011 the state authority which sets wildlife regulations, the Alaska Board of Game, directed wildlife managers to initiate predator control programs to increase moose populations in 2 specific areas important for harvest. While close in proximity, these 2 moose populations in the northwest and southwest portions of the peninsula have differing management concerns. Before predator control was initiated in 2012, state managers initiated studies to assess limiting factors. Efforts to reduce wolf numbers were initiated in 2013 for the moose population in the northwest. A driving factor influencing the initiation of predator control programs is if the moose population falls below set size and harvest objectives. There is a need to periodically reassess how these objectives were set and if they are achievable with practical management actions. I will discuss these objectives in the context of objectives from around the state. I will also discuss the history and limiting factors of these 2 moose populations and the potential efficacy of predator control. Successful long-term and cost-effective management requires a nexus between the public, wildlife managers, regulatory authorities, and land managers. Decisions need to be driven by the biological potential of the given moose population and the feasibility of different management actions.

(37) MOOSE COLONIZATION AND POPULATION GROWTH ON THE TOGIAK NATIONAL WILDLIFE REFUGE IN SOUTHWESTERN ALASKA

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Abstract: When the ~18,000 km^2 Togiak National Wildlife Refuge was created in 1980, <35 moose (*Alces alces gigas*) occurred primarily along the eastern border. Moose numbers increased in the eastern portion of the refuge and the population expanded to the west. In March 2011, aerial surveys found a minimum of 1,626 moose. The significant increase in moose numbers is attributed to 1) immigration from an increasing population east of the refuge; 2) high productivity and survival of moose due to high quality habitat and low predation rates; 3) availability of the expanding Mulchatna caribou (*Rangifer tarandus granti*) herd; and, 4) cooperative management strategies involving local residents.

(38) MOOSE IN THE ALASKAN ARCTIC LINKED TO 20TH CENTURY WARMING

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Abstract: Twentieth century warming has shortened winters and increased vegetation productivity and shrub cover across high-latitude tundra and treeline regions, but effects on terrestrial wildlife have not been demonstrated on a large scale. During this period, Alaskan moose (*Alces alces gigas*) have extended from the boreal forest hundreds of kilometers into tundra riparian shrub habitat; similar extensions have been observed in Canada (*A. a. andersoni*) and Eurasia (*A. a. alces*). Our estimations of shrub height and extent during the early 20th century show that reduced shrub habitat and longer winters in the Alaskan tundra during this period could not sustain moose, and were therefore primarily responsible for their absence. Similar to the 20th century, the Pleistocene-Holocene transition was marked by warming, shrub expansion, and the appearance of moose in Alaska. The pan-arctic increase in northern shrub habitat and moose populations resulting from 20th century warming represents a contrasting terrestrial counterpart to the decrease in sea ice habitat and its deleterious effects on marine and some terrestrial mammals.

(39) POPULATION FLUCTUATIONS AND MORTALITY FACTORS FOR THE NORTHERN-MOST MOOSE POPULATION

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Abstract: The objective our moose monitoring program has been to track population trends of the Colville River moose population and, when possible, determine reasons for increasing or decreasing numbers. Colville River moose are the most northern moose population in America. Moose became established on the North Slope by the early 1950s. They increased slowly between 1970 and 1991 from 1,219 to 1,535 (1.1% per year). From 1992 to 1996 the population suddenly declined by 79% to 326 moose. Analysis of samples taken from captured moose as part of a mortality study indicated that bacterial disease contributed to the decline. Eight of 43 sampled cows tested positive for antibodies to the bacteria *Brucella suis* Biovar 4. Six of 30 sampled cows tested positive for antibodies to the bacteria *Leptospira interrogans* serovar pomona. In addition, there was predation, starvation, copper deficiency, weather factors, and competition with snowshoe hares. Shortly after the mortality study started both adult and calf mortality declined dramatically. Recruitment went from less than 1% in 1996 to 23% in 1997 and averaged 22% through 2006. The moose population steadily increased from 1997 to 2008 when we counted 1,116 moose (10.7% per year increase), but then declined by 51% by 2011 when we counted 545 moose. This time none of the moose tested positive for bacterial disease. There was a high wolf:moose ratio. There was malnutrition, but browse studies did not indicate overbrowsing (12% browsing rate). Browse quality and weather factors, including length of growing season, are being examined.

(40) TREE SPECIES AND TWIG DIAMETER SELECTION BY INDIVIDUAL MOOSE ALONG DAILY MOVEMENT TRACKS IN NORTHERN SWEDEN

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Abstract: The first step in understanding ecological processes is to identify patterns. Most ecological phenomena such as interactions between moose and its food plants simultaneously operate at different scales. Moose face, apart from large seasonal changes in forage quality and quantity, also problems in selecting appropriate plant parts. Winter is characterized by woody plants consumed by moose that are low in digestibility and nutrients. Distribution of these characteristics varies with twig thickness and will have both upper and lower limits. We studied GPS collared moose and along daily tracks of moose in boreal forest from 10 March to 8 April 1997. Along each stretch of individual moose tracks all twigs browsed were counted and bite diameters measured. Pine dominated as the selected species and 3–4 mm diameter twigs constitutes 33% (SD = 21)of all bites on the species. Silver birch (*Betula pendula*) and Common birch (*B. pubescens*) differed in mean cut off diameter as the latter showed distribution from 2 to 5 mm while *B. pendula* showed a distinctive cut at 2 mm. Other species selected along the tracks were *Juniper communis* and willows (*Salix* spp.). The daily variation in species selection varied over days and between individual moose.

(41) BROWSE REMOVAL AND PLANT ARCHITECTURE AS INDICES TO CHANGES IN MOOSE DENSITY

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Abstract: Managing moose populations for elevated sustained yield is aided by monitoring indices of intraspecific competition or nutritional condition to gauge density-dependent environmental feedback. In 4 areas of Interior Alaska where moose density recently changed, we evaluated magnitude of change for 4 browse indices: proportional number of current annual growth (CAG) twigs browsed, proportion of CAG biomass removed, mean diameter at point of browsing (DPB), and proportion of plants with broomed architecture. In one area where moose density doubled in 5 years following effective predation control, browse removal increased 236% for biomass and 120% for twigs, DPB increased by 16–42%, and brooming increased 150%. In 3 areas where moose density declined 31–41% over 2–4 years through elevated antlerless harvest, we found declines of 30–40% in biomass removal, 30–70% in number of twigs removed, and 13–37% in DPB, but changes in plant architecture were inconsistent among the 3 sites. Twinning rate (an index of nutritional condition) changed comparatively little between browse surveys, possibly because of a lag time influenced by female life history. Of the 4 browse indices studied, biomass removal (an index to intraspecific competition) most consistently reflected the direction and magnitude of short-term changes in moose density. Site-specific measures of habitat and animal conditions at a given moose density provide objective means for gauging the capacity of managed ecosystems to support moose of defined nutritional condition. These measures of habitat and moose conditions have been key factors used to implement harvest strategies to adjust moose densities.

(42) FACTORS GOVERNING FOOD PREFERENCES OF ALASKAN MOOSE

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Abstract: Foraging herbivores face many decisions in food selection, and the goal of this research was to determine the role of food preferences of moose (*Alces alces gigas*) in a changing landscape. We hypothesized that the net rate of energy intake would be maximized and, in using mass intake as a proxy for energy intake, examined whether energy intake is a driving variable of foraging behavior. We observed how hand-reared moose moved within simulated patches and measured the amount of food they consumed during a series of feeding trials in which 2 browse species of varying preference were offered in alternating proportions. Our results support the hypothesis that moose select foods in a manner that maximizes energy intake in mixed-species patches. They further indicate that food preferences are circumstantial based on bite size and plant density and provide information that is critical to the analysis of habitat requirements of Alaskan moose.

(STUDENT)

(43) BROWSING PRESSURE IN THE PAST - A STRONG PREDICTOR OF CURRENT BROWSING

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Abstract: Sessile plants have evolved a diverse set of responses to defend themselves against or to tolerate predation from herbivores. However, plant responses to herbivory are diverse and context-dependent, and may be limited by resource availability or modified by dominance of certain meristems. Trees previously browsed by moose (*Alces alces*) often show increases in shoot size, increase in nutrient concentration and sometimes a decrease in defense compounds, all traits that increase the probability of future browsing. This leads to a positive feedback loop between plant responses and browsing probability. Rebrowsing may increase the relative frequency of unbrowsed and repeatedly browsed trees, compared to trees with low browsing impact. This may lead to higher variation in height growth among trees, affecting successional dynamics of young forests. Rebrowsing may affect future forage availability for the moose, but also patterns of economic browsing damage to young forest stands. We have used an index of accumulated browsing, which describes the tree's architectural response to previous browsing, as a predictor of current browsing in young pine forest stands in south-eastern Norway. We have also investigated how the relationship between accumulated browsing and current browsing interacts with tree species, habitat productivity and moose density. We found browsing incidents as well as browsing pressure (percent utilization) to increase with previous browsing for all tree species. Available shoots per tree increased with increasing accumulated browsing pressure, whilst bite diameters by moose showed no relation with previous browsing.

(44) ESTIMATION OF HORIZONTAL COVER

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Abstract: We developed a method that provides ecologists with an objective and efficient means for point sampling horizontal cover. This method produced estimates significantly ($P < 0.05$) more precise than density board, cover pole and checkerboard methods, greatly reducing variability between observers. The method was most versatile in application, most efficiently used by 1 person, and significantly ($P < 0.05$) faster than the other methods. Factors affecting variability of measurements and application of data were reviewed.

(45) EFFECTS OF CLIMATE AND GROWING CONDITIONS ON BROWSE QUALITY

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Abstract: In previous work, we have observed high variation in the nutritional quality of important moose browses across the state of Alaska. To decipher the factors that might affect these differences in browse quality, we are conducting a "common garden" experiment on clones of *Salix alaxensis* and *S. pulchra* at the Matanuska Experimental Farm in Palmer, Alaska. We have treated these species to varying levels of soil moisture, soil fertility, soil temperature, solar radiation, and utilization to determine the effects on leaf nitrogen and tannins. Here, we describe our methods and hypotheses.

(46) AN EVALUATION OF USING VAGINAL IMPLANT TRANSMITTERS IN MOOSE

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Abstract: Birth rates and calf survival typically drive population dynamics in moose. Because early mortality is often high, detecting parturition and monitoring calves soon after birth is critical for accurately determining productivity and early survival. However, aerial determination of parturition, twinning, and early calf survival are often difficult in forested habitats. While vaginal implant transmitters (VITs) have been commonly used in many domestic and wild ungulates, an evaluation of VITs in moose has not been extensively reported. From 2006 to 2013, we put >300 VITs in moose from different locations across Alaska during mid-gestation (typically February–March). Retention rates were high and there was no evidence of significant tissue damage or negative effects with future pregnancies. VITs greatly improved productivity surveys by reducing aerial search times and facilitated captures of neonates.

(47) PREVALENCE AND SPECIATION OF LUNGWORMS IN MAINE MOOSE

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Abstract: In recent years, moose populations have been declining within some portions of the United States and Canada. A study conducted in 2012 by the University of Maine Animal Health Laboratory suggested that a novel lungworm species of the genus *Dictyocaulus* may contribute to moose mortality in Maine. In some species, lungworm infections are known to weaken the immune system of the host and cause parasitic bronchitis. The baseline "normal" prevalence for lungworms for a healthy population of moose has been described as 12% in Swedish studies. We hypothesized that a potentially novel *Dictyocaulus* species is present in less than 12% of the Maine moose population causing visible pathology in a subset of moose. This study analyzed 90 sets of moose lungs collected from 6 separate Wildlife Management Districts (WMD) during the 2013 moose-hunting season; 28 showed lungworm infections, yielding an overall prevalence of 31.1%. Lungworm burdens greater than 50 worms per lung-set typically correlated with "checkerboard" pathology of healthy tissue adjacent to necrotic tissue on lung surfaces distal to colonized bronchial tubules. This suggests that a heavy worm burden causes significant lung pathology in Maine moose. Morphologic analyses showed that moose are probably only infected by one species of lungworm at a given time; most appeared consistent with the genus *Dictyocaulus*. A comparative analysis with PCR and DNA sequencing was conducted using primers targeting the ITS2 gene sequence to confirm morphological results. Gathered sequences were aligned using the CLUSTAL program to compare moose lungworm species profiles.

(STUDENT)

(48) WHAT IS LIMITING MOOSE ABUNDANCE IN CENTRAL BRITISH COLUMBIA?

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Abstract: Moose abundance has declined in many areas of central British Columbia over the last 10 years. The magnitude of those declines differed among areas. During the same time period a mountain pine beetle outbreak killed most of the pine trees; consequently logging and associated road building rates were greatly increased to salvage some value from the dead trees. This led to the suggestion that moose declines were ultimately related to the mountain pine beetle epidemic. However, moose declined in some areas where there were few pine trees and did not decline at the same level where there were dead pine. We built a stage and sex specific demographic model to test various hypotheses for population declines of moose across multiple areas in central British Columbia. No clear relationships were found between moose population changes and salvage logging, hunter kill, predation, or weather. As a result, the province has initiated a 5-year study to determine if landscape changes from mountain pine beetle and associated salvage logging have influenced moose population growth rates. Adult female moose are being instrumented with GPS radio collars to determine proximate and ultimate factors affecting their rates and causes of mortality in study areas containing a gradient of mountain pine beetle affected forest and associated salvage logging.

(49) DEMOGRAPHICS MONITORING OF MOOSE IN GAME MANAGEMENT UNIT 25D, YUKON FLATS NATIONAL WILDLIFE REFUGE, ALASKA

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Abstract: A long-term moose (*Alces alces*) monitoring effort was initiated in 2013 by the U.S. Fish and Wildlife Service and Alaska Department of Fish and Game in Game Management Unit 25D West, Yukon Flats National Wildlife Refuge. This effort was motivated by 3 factors: 1) moose are an important food resource for people in this system, 2) moose are the sole ungulate prey of wolves (*Canis lupus*) and bears (*Ursus americanus and U. arctos*), and 3) densities of moose are among the lowest in North America. This monitoring complements population count surveys of moose, and past research that provided a mechanistic understanding of factors contributing to a low-density moose population. The objectives of this effort are to monitor demographics, such as calf production and recruitment, survival of females and their offspring, and indicators of the nutritional health of this low-density moose population, including parturition and twinning rates, age at first reproduction, and short yearling (10-month-old) mass. Home range, distribution, and causes of adult female mortality will also be obtained. During 4–12 November 2013, 38 female moose were captured and radiocollared along the Yukon River near Beaver, Alaska and southward to the White Mountains. Radiotracking flights have been conducted monthly, and will continue long term with increased frequency during the calving season. Additional capture operations will be conducted as needed to maintain a minimum sample, and to radiocollar additional short yearlings. Preliminary results of this capture and monitoring effort are presented, including age distribution of radiocollared moose in a low-density system.

(50) EVALUATING COMPETITION BETWEEN HUMANS AND WOLVES BY EXAMINING LANDSCAPE USE

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Abstract: In the Yukon Flats of Alaska, moose (*Alces alces*) are at some of the lowest densities in the world. This is likely due to strong top down limitation from wolves (*Canis lupus*), and black (*Ursus americanas*) and grizzly (*Ursus arctos*) bears. Despite low densities, moose are an important resource for subsistence. The first phase of this research is to create a conceptual model that evaluates the spatial relationship between moose, wolves, and subsistence hunters occupying the same landscape. Wolf data for the model is comprised of 5 collared packs which are focused in the Beaver, Alaska region. GPS and Doppler fixes for individuals in the wolf packs extend through fall and winter 2009–2010 ($n = 9$) and 2010–2011 ($n = 2$). These wolf data overlay with human landscape usage (e.g., moose harvest, travel corridors, traplines) from 12 interviews conducted with local villagers in the Beaver region; the human landscape usage data will help us create a human home range. To examine landscape usage by wolves and humans, this research model will include landscape classification type, elevation, slope, and travel corridors including known trails or waterways. Feedback and discussions on the conceptual model will help me identify appropriate techniques to analyze empirical data which consist of the moose-hunter use maps and locations of radiocollared wolves. Ultimately, I hope this research advances understanding on human-wolf competition, via landscape use, for a common resource: moose.

(STUDENT)

(51) REPRODUCTIVE FAILURE IN MOOSE (*ALCES ALCES*) DUE TO EMBRYONIC MORTALITY AND UNFERTILIZED OOCYTES

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Abstract: Knowledge on reproductive success is vital for successful management of large ungulates, and is often measured by means of observing surviving offspring. In harvested ungulates, postmortem investigations of reproductive organs are used to estimate reproductive potential by obtaining ovulation rates and fetus numbers. However, there are differences in numbers of offspring observed, fetal/embryo counts, and ovulation rates. We hypothesize that the discrepancy between estimated reproductive potential and reproductive outcome in large ungulates is not only due to ova loss, but also due to embryonic mortality. We investigated reproductive status in early pregnancy by sampling hunter-harvested moose (*Alces alces*) in southern Sweden from 2007 to 2011. In all, 213 reproductive organs were examined postmortem, and in confirmed pregnant moose (n = 53), 25% (19 of 76) embryos were nonviable and 6% of ova were unfertilized. The discrepancy between the ovulation rate of all pregnant moose (1.49) and the number of expected offspring per pregnant female, when embryonic mortality and unfertilized oocytes were accounted for (1.08), was 27.5%. An association between inflammation of the inner mucous membrane (endometritis) of the moose uterus and embryonic mortality was observed. This is the first comprehensive report of embryonic mortality and endometritis in moose. The observed discrepancy between ovulation rates and early embryonic development/survival shows that ovulation rates are indicative but not accurate estimates of moose reproductive rate. The use of ovulation rates as a sole estimator of future offspring rates may lead to overharvest of a managed moose population.

(STUDENT)

(52) THE IMPACT OF SUPPLEMENTARY FEEDING STATIONS FOR MOOSE ON SHOOT SIZE IN SCOTS PINE, NORWAY SPRUCE, AND DOWNY BIRCH

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Abstract: Supplementary feeding of moose (*Alces alces*) in Scandinavia during winter time is becoming increasingly common. Browsing surveys have shown that moose browsing pressure is high at feeding stations, and decreases with increasing distance from feeding stations. However browsing pressure on Scots pine (*Pinus sylvestris*) has been observed to first increase but then decrease with time since establishment of feeding stations. We hypothesized that this may be caused by reduced shoot size in trees at feeding stations due to high browsing pressure over a long time period. We investigated this hypothesis by sampling current annual shoots from Scots pine, downy birch (*Betula pubescens*), and Norway spruce (*Picea abies*) at feeding stations and at increasing distance from feeding stations, and measuring shoot morphology and dry mass. Contrary to our hypothesis, we found that shoot size was higher at feeding stations than at further distances from feeding stations. For pine and birch, diameters, length and dry mass of shoots was higher at feeding stations, while spruce showed less consistent responses. The larger shoot size was to some degree linked to plant compensatory responses to previous browsing, as trees with a high accumulated browsing pressure had larger shoot diameters. In addition, high input of nutrients through moose dung and urine locally at feeding stations, may lead to larger shoots. Our results do not explain the decrease in browsing pressure by moose over time at feeding stations, suggesting that this might be linked to shoot chemistry rather than morphology.

(53) DECIPHERING GPS COLLAR DATA FROM CAPTIVE MOOSE

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Abstract: Advancements in GPS collars have significantly increased our ability to collect a wide range of data (i.e., temperature, activity) associated with a GPS location. Deciphering this data can be troublesome as collar manufactures continually improve their collars and associated sensors. Furthermore, discrepancies in collar temperature and local weather stations indicate that animals or their associated habitat is influencing the collar temperature sensor. We used 1 captive moose, over 2 years, to test differences in Telonics GEN 3 and Telonics GEN 4 GPS collars. Collar temperature was on average warmer than the local weather station for both collar models during summer and winter, implying that the moose's radiant heat was increasing the temperature reading on the collar. Comparing between seasons, collar temperature was warmer in summer than winter when compared to the weather station. Differences between collar and weather station temperatures were greatest from midnight to 06:00, indicating that during the coldest part of the day there was the greatest variation between collar temperature and the weather station. We also assigned habitat values to each GPS location, and we found differences in habitat selection based on season, solar radiation, and ambient temperature measured at the weather station. Summer habitat use was influenced mainly by solar radiation and thermal break points in temperature (14°C and 20°C); whereas winter habitat selection was influenced only by thermal break points in temperature (−5°C). Future studies using GPS collars and associated sensors need to validate how the animal and its associated habitat may influence data collected.

(54) ESTIMATING MOOSE ABUNDANCE IN LINEAR SUBARCTIC HABITATS WITH DISTANCE SAMPLING AND A KERNEL ESTIMATOR

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Abstract: Moose (*Alces alces*) have recently colonized previously unoccupied habitat along the tributaries of the lower Kuskokwim River of western Alaska. A new survey area was created to encompass these narrow (0.7–4.3 km) riparian corridors that are bounded by open tundra and routinely experience winter conditions that limit snow cover and depth for traditional surveys. We tested a line-transect distance sampling approach as an alternative to estimate moose abundance in this area. Additionally, we compared standard semi-parametric detection functions available in the program Distance to a nonparametric kernel estimator not previously used for moose distance data. A double-observer technique was used to determine that the probability of detection at the minimum sighting distance was 1.0. The top model in Distance had an estimated average probability of detection of 0.70 with an estimated abundance of 352 moose (95% CI = 237–540). The CV for the semi-parametric model was 20% and had an estimated bias of 1.4%. The nonparametric kernel-based model had an average probability of detection of 0.73 and an estimated abundance of 340 moose (95% CI = 238–472). The CV was 18% for this model and an estimated bias of <0.001%. Line-transect distance sampling with a helicopter worked well in these narrow riparian corridors with low snow conditions. The kernel estimator also performed well compared to the standard semi-parametric models used in program Distance. These results validate a viable alternative to standard moose surveys, and offers more options to managers surveying moose in areas with similar conditions.

(55) MOOSE ON THE MOVE: PARASITE PLAGUED MOOSE MAY BE SEEKING REFUGE IN THE NORTH CASCADES

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Abstract: Since the first sighting in Pend Oreille County in 1955, the moose population of Washington State has steadily increased with the majority of recorded sightings concentrated on the far eastern section of the state near the city of Spokane. Historically moose sightings have been extremely rare in the North Cascades region. However, since 2011 there has been a significant increase in sightings and sign. Not only are there more moose appearing in the North Cascades, but observation suggests that they are healthy and free of the obvious tick infections that have led to sharp declines in populations in neighboring states and Canada. The 2 juvenile males that have been observed in the region both have full, even coats; appear to have normal body weight, and did not engage in the "scratching" behavior that has led to fur loss and infection in other populations. Winters in the North Cascades still yield multi-day periods of sub-freezing temperatures which could be keeping ticks and other parasites at bay. There is abundant habitat for moose in the region with bountiful lakes surrounded by plentiful riparian vegetation and sheltering trees. Although observation alone cannot yield information about other parasites such as liver flukes and brain worms, the absence of obviously unhealthy moose in the state of Washington and now in the western region of the North Cascades could indicate that moose may have found (at least a temporary) safe haven.

(STUDENT)

(56) MOOSE (*ALCES ALCES*) BROWSE AVAILABILITY AND USE IN RESPONSE TO POST-FIRE SUCCESSION ON KANUTI NATIONAL WILDLIFE REFUGE, ALASKA

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Abstract: In Interior Alaska, moose habitat is often associated with early or mid-succession stands created by natural disturbances such as wildfire and flooding. Moose prefer disturbed areas because succession creates dense stands of deciduous regrowth that is an important winter food source. The relationship between moose and fire is well documented in parts of Alaska that are easily accessible and where moose are valued for harvest by humans. However, habitat in more remote areas of Interior Alaska is less studied, particularly those areas where moose populations are not constrained by habitat availability and quality. Kanuti National Wildlife Refuge is characterized by low moose densities (<0.3 moose/mi^2) and a well-documented fire history. The Comprehensive Conservation Plan for Kanuti National Wildlife Refuge directs refuge staff to "obtain baseline information about late winter availability and use of moose forage species." The goal of this project is to evaluate the effects of burn age, plant community composition, and landscape characteristics on moose habitat, forage resources, and resource use by moose on the refuge. Preliminary results suggest overall browse use is low, consistent with low moose densities, and that browse use is highest in a 24-year-old burn despite greater browse biomass availability in a 9-year-old burn. Moose telemetry and survey data may provide greater insight into animal use of post-burn habitats on the refuge.

(STUDENT)

(57) BALANCING MOOSE POPULATION HEALTH AND HARVEST OPPORTUNITY: A COMPARISON OF FEMALE HARVEST SCENARIOS

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Abstract: Management of harvested moose populations at the upper end of their nutritional limitation requires a balance between population health and harvest opportunity. Female harvest strategies are often used to moderate population growth, improving population health and increasing harvest opportunity. Yet, population dynamics are highly sensitive to the harvest of adult females; therefore, a conservative harvest strategy should be used. Using a stage-structured population model we compared 2 female harvest strategies designed to mitigate nutritional stress by decreasing intraspecific competition for an Interior Alaska moose population. Harvest rates for both non-accompanied (cows ≥1 year that are not accompanied by calves) and cow-calf pairs were held constant (6% of female population) in order to achieve our population objective by the end of a 5-year period. Both harvest strategies produced the desired decrease in population size within 5 years, yet 54% more moose (11% more biomass) could be harvested when calves were included in the harvest. In addition, harvest of cow-calf pairs resulted in a lower overall harvest of yearling and adult females compared to harvest of non-accompanied females, leaving the population far more resilient to disturbance events. Although the cow-calf pair harvest strategy provided more harvest opportunity and a more robust age structure, this harvest strategy may not always be acceptable to hunters. We recommend incorporating modeled harvest scenarios into public outreach and education efforts to improve understanding and acceptance of female harvest strategies by the public. Overall, population models provide a useful management tool for exploring possible harvest strategies aimed at reducing populations when deemed necessary for sustained, long-term yield.

(58) MOOSE WINTER FORAGE PATTERNS AND DAMAGE TO NATIVE TREES AND SHRUBS IN RELATION TO THE RELATIVE ABUNDANCE OF NON-NATIVE CHOKECHERRY TREES IN URBAN FORESTS OF ANCHORAGE, ALASKA

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Abstract: Colonization of new habitats by non-native species sometimes leads to alterations of habitats that do not favor native species. In Alaska, cyanogenic non-native chokecherry trees (*Prunus padus* and *virginiana*) have spread from ornamental plantings into forests used by moose, and *P. padus* dominates some areas of urban forests. We studied variations in impacts winter foraging moose have to native trees and shrubs in areas of varying relative abundance of chokecherry trees. Data was collected with Anchorage schools and volunteers. Data accuracy was ensured with a combination of training, mandatory field checking of data, and easy to use electronic forms for data submission. Data collected included the ratio of bites to available browse, tree architecture, diameters of bites and current annual growth and relative abundance of chokecherry trees in plots. In 2013, relative abundance of chokecherry trees in plots ranged from 0-91%. Data collected in 2013 shows that when the relative abundance of chokecherry is high (>25%) native tree species were bitten nearly twice as much, and exhibited a broomed architecture nearly twice as often as in plots with low (<25%) chokecherry abundance. These data suggest that moose may more quickly over browse habitat when chokecherry are abundant. Eradication of chokecherry trees from urban forests is unlikely. However, communities with few planted and wild chokecherry should consider eradication. To maintain quality moose habitat the relative abundance of chokecherry trees should be kept to a minimum, and we should encourage establishment of native trees and shrubs.

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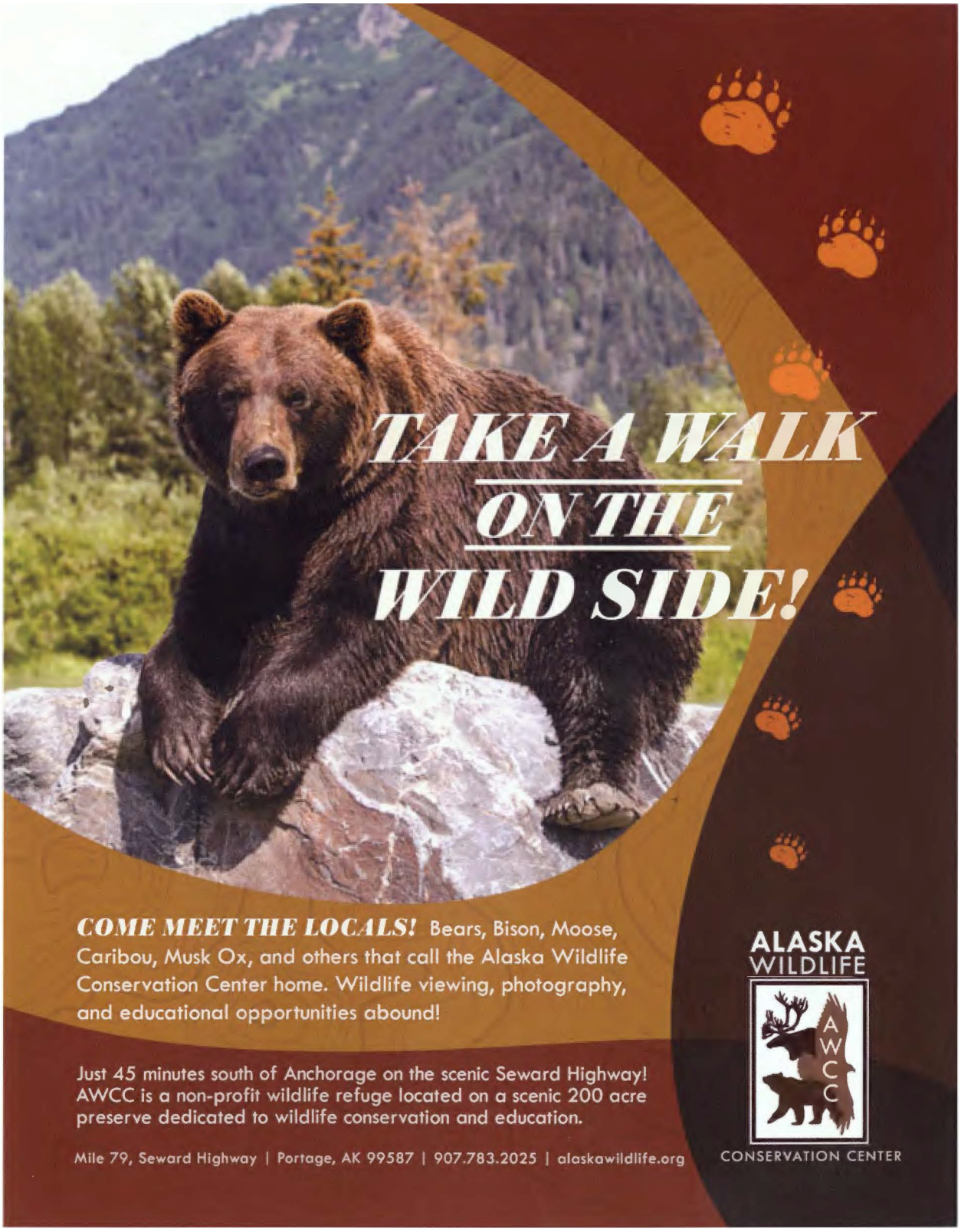
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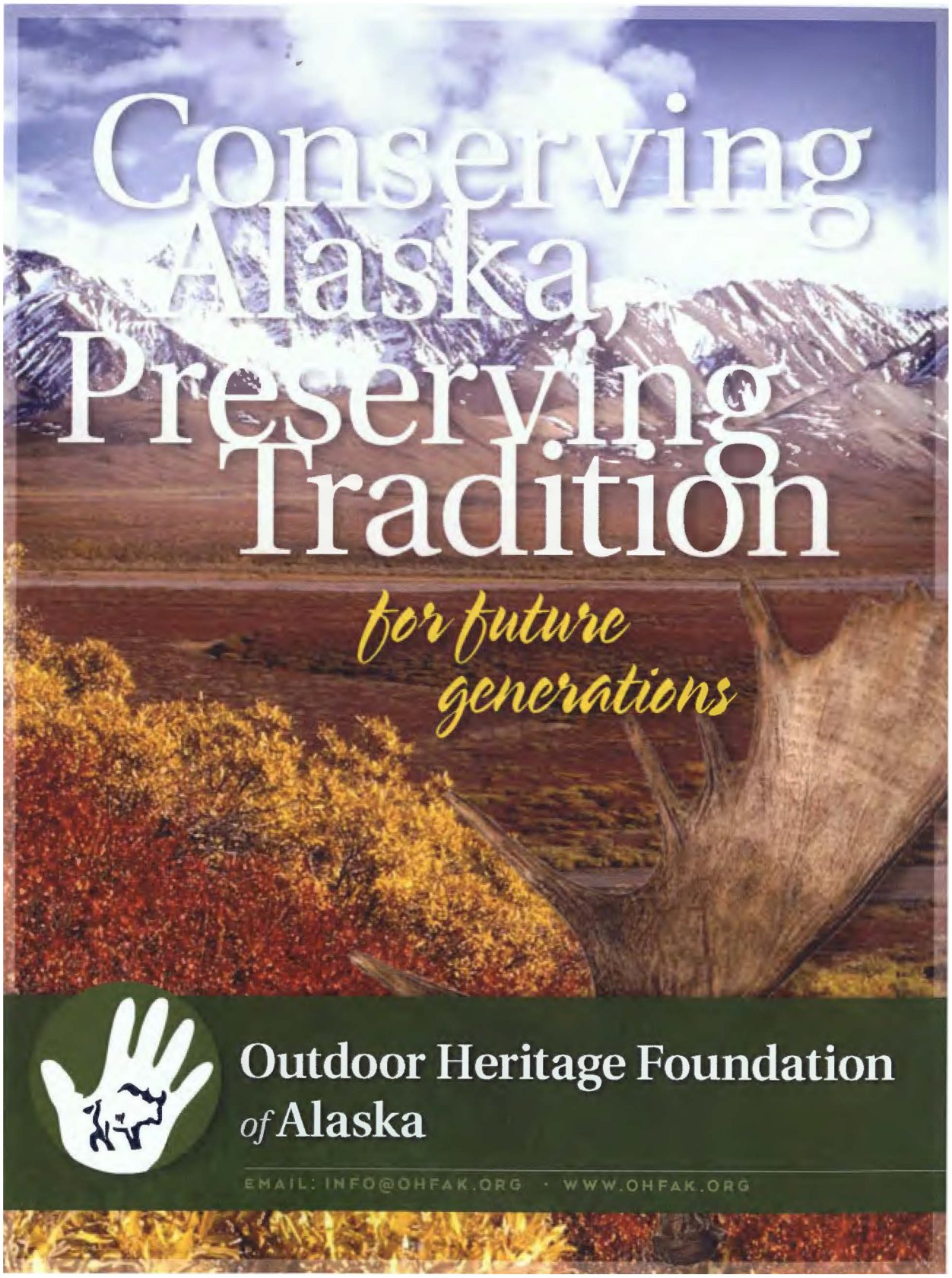
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