SESSION 1 PLENARY

CONNECTIVITY

- *What is connectivity? Why is connectivity important?*
- *How might climate change affect connectivity? Could connectivity facilitate movement of invasive species under climate change?*
- *How important is genetic connectivity? How can it be measured and maintained?*
- *What role, if any, does government policy have in maintaining connectivity?*
- *What role, if any, does third party support (e.g., industry on public lands; private landowners; hunting, trapping and angling NGOs) have in maintaining and/or promoting connectivity?*
- *How might the Alberta and/or Canadian Section(s) of TWS work with third party groups to further their efforts?*

Fiona Schmiegelow, Professor, University of Alberta

Fiona Schmiegelow is a Professor of Wildlife and Landscape Ecology at the University of Alberta, and Director of the Northern Environmental and Conservation Sciences Program partnered with Yukon College. Since 2004, she has been based in the Yukon Territory, where she draws inspiration from the wild landscapes in which she is privileged to work and live. Fiona's research focuses on conservation of boreal systems, and spans consideration of species needs through major processes driving landscape change. Her work is highly collaborative, involving a wide range of partners from government, industry, indigenous, and non-government organizations, and she has played an active scientific advisory role in many related planning processes.

Title: *Connectivity in the Anthropocene: Unravelling the tapestry of life*

Abstract: Human modification of land and waterscapes is creating unprecedented challenges to conservation of biodiversity and ecosystem services, among other values. The concept of connectivity is an implicit integrator that requires consideration of these issues at large spatial and temporal scales. As a result, maintaining or restoring connectivity has become both a means and an end in conservation and management of natural systems. However, like the concept of habitat, it must be grounded in species- and/or system-specific considerations to be applied effectively. Moreover, from physical to functional constructs, there is an urgent need to address connectivity dynamically under the rapidly changing and highly uncertain conditions that characterize the Anthropocene. What tools do we have to address these needs? I will review the theory and practice of connectivity planning, and explore emerging trends, with an emphasis on those that bridge the science-policy interface. As fibers are to fabric, our ability to effectively manage connectivity in the Anthropocene will determine whether earth's natural systems are threadbare or rich tapestries of life. Innovations in science and an "all hands on the land" approach to stewardship will be critical to meeting this challenge.

Elston Dzus, Ecologist, Alberta-Pacific Forest Industries

Elston Dzus has been a forest ecologist with Alberta-Pacific Forest Industries Inc. for 19 years. He is interested in the interaction of human activities and ecology of various wildlife species. Much of his work has focused on understanding the complex interactions between industrial landuse and predator-prey dynamics in relation to conservation of woodland caribou. He has been an advocate for advancing ecosystem-based management and other integrated land management innovations through strategic collaborations that incorporate consideration of ecological, economic and social components. Elston holds a Ph. D. from the University of Saskatchewan. He has been active for many years with The Wildlife Society (TWS, Manitoba and Alberta Chapters) and was the Canadian Section recipient of the TWS Dedicated Service Award in 2016.

Title: *Connectivity in a working landscape*

Abstract: Connectivity spans many spatial and temporal scales. Forestry, and the energy sector, create a significant amount of human footprint in Canada's boreal, influencing the distribution of plants, animals and natural processes at both the stand and landscape level. While northeastern Alberta is a very busy landscape from an industrial footprint perspective, in many ways it is a relatively intact landscape with great potential for maintaining or restoring connectivity for many biota. Depending on the biota in question the movement and/or distribution can either be constrained or facilitated by harvest areas, processing facilities and the linear features created to move natural resources from the forest to the consumer. Planning, construction, maintenance, and reclamation/restoration practices for resource industries continue to evolve as we better understand the surficial and subsurface influences of industrial footprint on terrestrial and aquatic/hydrologic connectivity. Landuse zonation, including protected areas and other special management areas, also play an important role in influencing connectivity at the landscape level. Merging our increasing knowledge of natural processes affecting connectivity with changes to landuse practices and policies should lead to better conservation outcomes over meaningful space and time.

Nicola Koper, Professor, University of Manitoba

Nicola Koper is a Professor of Conservation Biology at the Natural Resources Institute, University of Manitoba. She received her MSc from the University of Guelph, her PhD from the University of Alberta, and held an NSERC post-doctoral fellowship at the University of Manitoba before starting her faculty position there in 2005. Her primary research focus is effects of anthropogenic development on grassland songbirds, with a particular focus on energy development and anthropogenic noise. She has won several recent awards, including the Partners in Flight award for Public Awareness, and the Jamie Smith Award for Mentorship from the Society of Canadian Ornithologists.

Title: *Impacts of oil and gas development on migratory birds: behaviour, productivity and migration*

Abstract: Connectivity impacts migratory birds across all spatial scales, from individuals that must communicate with conspecifics across a few metres to populations that migrate across hemispheres. Industrial development has a myriad of impacts across all of these spatial scales, affecting quality of stopover sites, breeding habitat, and wintering habitat. Migration research using geolocators has demonstrated that grassland songbirds that breed in Alberta are exposed to oil and gas development throughout their life-cycle, as their breeding grounds, migration pathways, and wintering grounds overlap with key oil and gas deposits. The continental connectivity these species depend on results in their regular exposure to industrial development, and this can have a variety of negative impacts. Some of these negative impacts result from interrupted connectivity at a very small spatial scale – connections between individuals and their habitats, or individuals and each other, are disrupted by the presence of infrastructure and industrial noise. Some species, such as Savannah sparrows, seem able to compensate for these disruptions, essentially allowing them to connect effectively with their environments at small and large spatial scales. Others, such as chestnut-collared longspurs, are much more strongly impacted by industry because they have difficulty in assessing habitat quality accurately. We will discuss impacts of oil and gas development on individual quality, habitat selection, stress, nesting success and nestling quality, to better understand how North America's grassland birds are impacted by their exposure to oil and gas activities throughout their life cycles.

Co-authors: Patricia Rosa, Paulson Des Brisay and Claire Curry

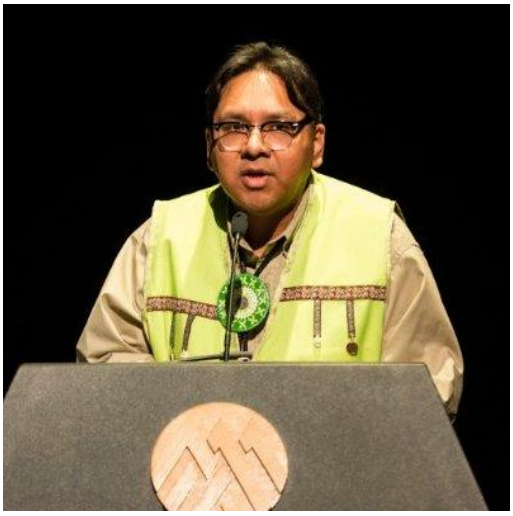
Adam Ford, Assistant Professor, University of British Columbia Okanagan

Adam Ford is an Assistant Professor and Canada Research Chair in Wildlife Restoration Ecology at the University of British Columbia. Since 2004, Adam has conducted research on the impacts of infrastructure on wildlife movement, including rodents in Central Canada to the large mammals of Banff National Park. Currently, Adam and his students work on the intersection of wildlife movement, food web ecology, and human-wildlife conflict in British Columbia, Alberta, and overseas.

Title: *Connecting ecological process in the Bow Valley: past, present, and future.*

Abstract: The benefits of connectivity to conservation and people are well known, shaping international agreements, national-level policies proposals, and the mission of non-government organizations. These broad and aspirational goals of connectivity are often realized at fine spatial scales, falling under the mandate of land use planners, bylaws, and regulations through the implementation of wildlife corridors. Wildlife corridors are areas set aside from development to facilitate connectivity between remnant patches of habitat. There are two fundamental pieces of movement ecology information required to design effective wildlife corridors: 1) a reasonable prediction of where animals are likely to move; and (2) an understanding of management options to retain or restore movement. As policy and management options are being discussed, it would be helpful for decision makers to know how different corridor designs, or dynamic land use scenarios, influence connectivity. Past research on connectivity has largely focused on describing a fixed state of landuse. Here, we develop an approach to modelling wildlife corridors under different land use scenarios for a contested area of the Canadian Rocky Mountains near Banff National Park, Alberta. We employ a novel approach to validate our connectivity models, link it to predator-prey interactions, and provide new insights on the design of effective wildlife corridors for large carnivores in a human-modified landscape.

William Snow, Consultation Manager, Stoney Nakoda First Nation



William Snow is a member of the Stoney Nakoda Nation, Wesley First Nation, as well as a Dual Citizen of Canada / United States of America, and is of Stoney Nakoda / Yuma Quechan descent. Since 2012, Bill has been the Consultation Manager for Stoney Nakoda First Nation. This work involves the assessment of industrial resources projects within Stoney Nakoda Traditional Lands that involve many consultations with industry, the provincial and federal governments, in the Southern Alberta. Bill is a graduate of the University of Lethbridge, Business Administration program, and in 2016, assisted in coordinating ceremonies for Stoney Nakoda Nation for the Bison Reintroduction at Banff National Park & Elk Island National Park, as well as for the proposed renaming of Tunnel Mountain. Also, Stoney Nakoda Nation completed a Traditional Knowledge Study of Grizzly Bears in the Kananaskis Provincial Park for Environment Canada. Bill is also an advisor to the Chiniki Lecture series at the University of Calgary, and an Advisor at for the Thinking Mountains Conference (2015 and 2018), Mountains 101 and the Canadian Mountain Network initiative at the University of Alberta. In September 2017, Bill accepted the Ted Smith Conservation Award from Yellowstone to Yukon on behalf of Stoney Consultation. Bill lives in Calgary, and works at the Stoney Indian Reserve at Morley, Alberta. In 2018, Bill also became a director with Canadian Wildlife Federation.

Title: *Stoney Nakoda Grizzly Report and Connectivity*

Abstract: In 2016, the Stoney Nakoda completed a study on Grizzly Bears in the Kananaskis Park Forest area, as part of the Aboriginal Funding for Species at Risk program, available through Environment Canada. The study utilized traditional knowledge in the process of cultural monitoring as a methodology within the report. This traditional knowledge perspective, is not based on Western Science, and offers a different understanding of Grizzly Bear behavior and habitat. One of the recommendations from the report is connectivity. Connectivity is important for environmental and cultural goals. The cultural importance of providing time and space for Grizzly Bears on landscapes, is not largely understood or properly researched from the Traditional Knowledge perspective. The Stoney Grizzly Report offers an alternative understanding and interpretation of Grizzly Bear habitat and behaviour in the Kananaskis.

Irena Creed, Executive Director and Professor, School of Environment and Sustainability, University of Saskatchewan

Irena Creed is Executive Director of the School of Environment & Sustainability at the University of Saskatchewan, and was the Canada Research Chair (Tier 2) in Watershed Sciences until June 2017. Irena's research group, together with collaborators from government, industry and an international network of scientists, study the impacts of global change (climate change, atmospheric pollution, and land use/land cover change) on ecosystem structure, function and services. She works at multiple scales using contemporary techniques to investigate how hydrology influences ecological and physiological processes in terrestrial (forest, agriculture) and aquatic ecosystems (streams, wetlands, lakes, rivers).

Title: *Connectivity Matters: A portfolio of connections are needed to protect wetlands and their ecosystem functions and services*

Abstract: Governments worldwide do not adequately protect freshwater ecosystems and therefore place freshwater functions and attendant ecosystem services at risk. Particularly vulnerable ecosystems are wetlands, which are being lost or degraded more quickly than any other type of ecosystem on the planet. Satellite-based measurements and process-based models were combined to estimate surface and subsurface hydrological connections at local (wetland to neighboring wetlands) and watershed (wetland to rivers) scales. The relationship between these hydrological connections, biogeochemical functions (e.g., nitrogen removal and phosphorus retention), and biodiversity functions were explored. Results show clear evidence of the interdependence of hydrologic connectivity on biogeochemistry and biodiversity. Conservation science and policy need to go beyond considering wetlands as independent objects but as integral components of wetland networks on the landscape.

Aerin Jacob, Conservation Scientist, Yellowstone to Yukon

Aerin Jacob is Conservation Scientist at the Yellowstone to Yukon Conservation Initiative (Y2Y), where she conducts and communicates applied research across the 1.4 million km2 Y2Y region. She has worked in research, conservation, teaching, and consulting across western North America, East Africa, and Central America and has advised governments about conservation planning, species at risk, climate change, and impact assessment. She was a 2015 Wilburforce Fellow, a 2016-18 Liber Ero Fellow, and serves on the board of the Society for Conservation Biology North America. Aerin earned a BSc from the University of British Columbia and a PhD from McGill University, and conducted postdoctoral research at the University of Victoria.

Title: *From Yellowstone to Yukon: Making the case for large landscape conservation*

Abstract: Although protected areas are the cornerstone of nature conservation, alone they cannot sustain healthy populations of animals that need huge areas to move – animals like grizzly bears, wolves, caribou, and wolverines. Adding in climate change, increasing habitat fragmentation, and global biodiversity loss, it is clear that a shift to "large landscape conservation" is needed. This includes protecting core habitat areas, linking them via critical corridors, and considering the social, cultural, and economic factors that enable both people and nature thrive. The Yellowstone to Yukon (Y2Y) vision is one of the first and best known large landscape, collaborative conservation projects in the world. Stretching >3200 km (1.3 million km2) across western North America, Y2Y's success is based on a combination of rigorous science, natural resource management, and community and policy engagement across multiple jurisdictions and with more than 350 partner groups. In the 25 years since the inception of the Y2Y vision, protected areas in the region almost doubled and conservation-related management designations on other lands have increased more than five-fold. Evidence from social and natural science, Y2Y, and other large landscape efforts offer lessons of how researchers, decision-makers, the private and non-profit sectors, and communities, can move forward together to achieve conservation at scale.

SESSION 2A

BIRDS AND BATS

Size Matters: Relative impacts of in situ oil sands development features on habitat use of an avian generalist and specialist

Thea Carpenter, Scott Nielsen, Erin Bayne, and Lisa Mahon

Novel in situ energy extraction processes leave an extensive network of small-scale disturbance features on the landscape, including seismic lines, winter roads, well pads and industrial facilities. Predicting avian responses to these multi-feature habitat perforations at a large scale remains challenging due to species-specific resource use strategies and the habitat heterogeneity that disturbances create. The oil sands region in northern Alberta is dominated by peatland habitats, including bogs and fens. Although peatlands contribute to enriched regional avian diversity and are sensitive to disturbance, little avian focal species work has occurred in these systems. The objective of this study is to understand how species-specific habitat-use strategies influence peatland songbirds' responses to in situ disturbance features of different sizes, shapes and structures. We examined detailed breeding season habitat use for a vegetation generalist, Dark-eyed Junco (*Junco hyemalis*) and peatland vegetation specialist, Palm Warbler (*Setophaga palmarum*) by mapping 162 territories and 7362 within-territory use locations in 11 sites that were placed across a gradient of disturbance intensity. At the territory scale, both species avoided larger, more permanent features but included fine linear features within territories approximately equal to their availability. At the within-territory scale, however, responses to disturbance features for each species varied both by feature type and behaviour at location of use. Identifying the mechanisms underlying species response patterns is critical to enhancing our predictive capacity at larger scales and developing effective management strategies.

Biosketch: Thea was born and raised in Edmonton. Since completing her undergraduate degree in 2011, she's been involved in wildlife conservation projects with organizations including the Wildlife Rehabilitation Society of Edmonton, the Beaverhill Bird Observatory, and Canadian Wildlife Service.

Mapping priority conservation areas and assessing habitat quality for Ferruginous Hawks in Canada

Janet Ng, Erin Bayne, and Troy Wellicome

Linking habitat resources and fitness is critical to understanding the effects of landscape change on wildlife populations. Landscape change from multiple land uses can result in cumulative effects, which can negatively impact habitat use and reproductive performance, even resulting in potential habitat mismatches for populations. Spatially-explicit models can be used to evaluate cumulative effects and develop habitat-based frameworks to identify, prioritize, and manage species at risk over large spatial extents. In Canada, farming, ranching, and petroleum extraction are dominant land uses within the Ferruginous Hawk (*Buteo regalis*) range and could potentially have a negative impact on their population demography. We developed nest abundance and reproductive performance models to evaluate potential additive and synergistic cumulative effects of multiple land uses. We used these models to produce spatially-explicit maps and overlayed them to identify potential habitat mismatches

where nest abundance and reproduction were negatively associated. Ferruginous Hawk relative nest abundance and nest survival were highest in heterogeneous landscapes with moderate amounts of cropland and grassland, and moderate edge density. Density of active oil wells was negatively associated with nest survival, while density of active gas wells was positively associated. We did not find any synergistic relationships between land cover and industrial development. Mapping and overlaying the predicted relative nest abundance and nest survival allowed us to identify important hawk habitats where habitat use and reproduction is high, as well as areas where management may be necessary because habitat use is high, yet reproduction is low.
Biosketch: Janet Ng's doctoral research was conducted at the University of Alberta, under the supervision of Dr. Erin Bayne and Dr. Troy Wellicome. Janet evaluated the cumulative effects of land use and climate change on Ferruginous Hawk habitat use and reproduction. Janet is with the Government of Saskatchewan's Ministry of Environment.

Long-term monitoring of changes in harvest area, weather, and insect outbreaks on boreal birds
Lionel Leston, Erin Bayne, and Fiona Schmiegelow
Multi-year wildlife monitoring studies enable ecologists to relate changes in species abundance to both management actions and variables independent of management that change over time and affect survival and/or reproductive output. We performed time-series analysis on avian point count data from a long-term study at Calling Lake, Alberta, Canada (1993-2018). In this study, we identified same-year and delayed effects of forest harvest, weather events in and outside of the breeding season and effects of insect outbreaks on individual bird species. Species associated with older boreal forests were less abundant at stations with a greater amount of harvested forest within 100-600 m in the same year. Several species associated with shrub-lands or open lands declined, while several old-forest species increased, with increasing time since harvest within 100-200 m of stations. Old-forest species were also on average more likely to exhibit positive responses to time since harvest. At a broader scale, short-distance migrant and resident species were more likely to respond positively than Neotropical migrant species to weather events associated with stronger Pacific Decadal Oscillation Index or El Niño Index conditions. Abundance of several coniferous forest songbirds in the Calling Lake study area increased 1-2 years after increasing budworm defoliation (in hectares) within 100 km of Calling Lake. Overall, our study documented decreasing effects of adjacent harvest on birds in unharvested forests over time, as well as effects independent of harvest on broad scale patterns in avian population dynamics.
Biosketch: I grew up in Vancouver, British Columbia and did my undergraduate program in Biological Sciences at Simon Fraser University. After a few years of short-term ornithological jobs, I studied Northern Cardinals at Ohio State University, grassland birds at the University of Manitoba, then boreal birds in my current postdoc.

Trends in songbird populations over ten years in Canada's Rocky Mountain National Parks
Brenda Shepherd, Jesse Whittington, Anne Forshner, Cam Gillies, Barb Johnston, Derek Peterson, and Kimo Rigola
Long-term, large-scale monitoring programs help clarify continental species trends and the effects of climate change on population trends and species diversity. National Parks along the Canadian Rocky

Mountains provide a unique opportunity to examine the interacting effects of changing temperatures and latitude on songbird trends in an area free of resource extraction. Our study used ten years of songbird recording data collected at 544 locations in Banff, Jasper, Kootenay, Waterton Lakes and Yoho National Parks that encompassed four degrees of latitude. Locations contained at least four years of data. We developed a single visit, time to first event occupancy model to account for imperfect detection. Using 10 minute surveys, we conducted a simulation study to examine the effects mean time to first detection on biases in parameter estimates. Biases were minimal when the mean time to detection was less than 8 minutes. We applied the occupancy model to 77 species that occurred at more than 5% of locations and had a naïve mean time to detection less than 8 minutes. Preliminary results suggest mean spring time temperature, latitude, and land cover were important predictors of occupancy for most species. Occupancy declined for 10% of species and increased for 52% of species. Latitude affected changes in occupancy for 3% of species, while annual changes in temperature affected occupancy rates for 17% of species. Our results highlight the cost-efficiencies of time to event occupancy models and the importance of climatic conditions on songbird communities.
Biosketch: Brenda Shepherd is a Parks Canada biologist working in Jasper National Park. Her work focuses on long-term ecological monitoring and species at risk recovery.

Effects of Hurricane Maria on the bat community on the Caribbean island of Dominica
Lisa Sims
Understanding species' responses to hurricane disturbance can help us predict future impacts and aid in conservation actions which will become progressively more important with climate change. On 18 September 2017 Hurricane Maria, a category 5 storm, made landfall on the small island (750 km^2) of Dominica, sustaining winds up to 258 kph and causing substantial damage to the vegetation across the island. This presented a unique opportunity to assess the hurricane's impact on bat community structure and composition in the Caribbean. I measured changes in diversity, abundance, reproductive rate, body condition, and habitat use using pre-hurricane data I collected during mist-netting surveys in 2016 and 2017, and post-hurricane data I collected in the same study areas in 2018. Nine species (750 individuals) were captured in the two years prior to the hurricane, with reproductive females documented for all species. Nine species (79 individuals) were captured post-hurricane, with reproductive females documented for six species across the island. A decline in the number of captures and percent of reproductively active females of several species indicates varying responses within foraging guilds. Preliminary results suggest a stronger sensitivity for species dependent on plants for food, and a failure to reproduce post-hurricane. Analysis is on-going and further results will be presented.
Biosketch: I am a professional biologist with 9+ years of experience in environmental surveys and wildlife research. My passion for bat research has involved projects in AB, SK, BC and the islands of Dominica and Cuba. I am currently completing my MSc looking at the effects of hurricane disturbance on bats.

Optimum temperatures of bat houses to enhance bat survival
Ryan Henderson

Temperatures inside bat houses can be influenced by many abiotic and biotic factors. Different colored houses should provide different internal temperatures which in turn can give the bats options depending what their optimum temperature is. The darker colour bat house was hypothesised to have a warmer internal temperature than that of the other two houses. Before construction of the bat houses 24 Maxim Integrate iButton© temperature data loggers were programmed to recorded temperature once an hour. Each bat house had 8 temperature loggers and each house received a coat of paint, the first house would be painted black, second grey, and third white. The houses were attached to the south facing wall of the old fort whoop-up in Lethbridge's river bottom, screwed into place 6-7 feet off the ground. The houses were attached close to one another. They were placed close together to ensure they all receive the same amount of sunlight throughout the day. As hypothesized the darker the paint colour on the bat house, the higher internal temperature was, on a day with an ambient temperature of 17°C the black bat house reached a temperature of 46°C. On the same day the grey and white houses had a temperature of 39°C, and 25°C respectively. The temperatures inside the bat house that have exceeded 40°C have been proven to be significantly harmful to bats by other studies. With WNS making a move westward traveling through different hibernating and roosting bat colonies, bat management is needed more than ever.

Biosketch: I am a fourth year Ecosystem Management Student at Lethbridge College. I have been an active member of the student chapter at the college, as being the treasurer in 2017 and Vice President in 2018.

SESSION 2B

BEARS AND WOLVERINE

Assessing polar bears (Ursus maritimus) use of the western Hudson Bay flaw lead polynya

Erin Henderson, Andrew Derocher, Nicholas Lunn, and Evan Richardson

Sea ice is critical for polar bear life history but its extent and duration are declining due to climate change. Polynyas are recurrent areas of open water within sea ice that are important to many species, including marine mammals, but the importance to polar bears has not been examined. The flaw lead polynya in western Hudson Bay is a major, predictable habitat feature within the home range of polar bears. Selection of sea ice features by adult female polar bears differs throughout the winter and based on reproductive status, but foraging features and sea ice conditions for energy conservation and safety are prioritized. Polynyas may provide hunting opportunities but equally, could represent barriers to movement. We assessed use of the polynya in western Hudson Bay by measuring polar bears first passage time throughout the area, and crossing rate of the polynya. We used locations obtained from global positioning system collars deployed on adult female polar bears from 2004-2017 to estimate movements through the ice-covered period (January-ice breakup). The polynya was mapped using synthetic aperture radar to differentiate between ice and water. One edge of the polynya was defined by landfast ice, while the opposite edge was dynamic with the potential for daily changes as the polynya opened and closed. We examined how use varied along the polynya length, throughout the winter,

between years, and between reproductive groups. Establishing the importance, or lack thereof, of polynyas will aid in assessing how melting sea ice may affect polar bear habitat selection.
Biosketch: I am in my third year of my Master of Science at the University of Alberta researching polar bear habitat selection in Dr. Andrew Derocher's lab.

Migration dynamics of polar bears (Ursus maritimus) in western Hudson Bay
Alyssa Bohart, Nicholas Lunn, and Andrew Derocher
Migration cycles of animals are often predictable with seasonal changes, especially when dependent on ephemeral resources such as food. In western Hudson Bay, polar bears (*Ursus maritimus*) migrate onto sea ice as it forms because they depend on ice to access prey. This seasonal feeding is required for survival during the onshore fasting period when ice is absent and prey are unavailable. Climate change is altering sea ice phenology in Hudson Bay, with break-up occurring earlier and freeze-up later, decreasing the overall ice period and increasing the on land fasting period. Because polar bears migrate individually, we expect variation in migration patterns due to spatial variation in sea ice, reproductive status and behavioural differences. The objective of our research is to determine if bears demonstrate different migration patterns influenced by biological and environmental variables and if these patterns have changed with altered ice conditions. We used locational data from satellite-linked collars deployed on adult female polar bears in western Hudson Bay between 2004-2016 to determine movement covariates and temporal variation in migration patterns. Using biological data including bear age and reproductive status, we tested the prediction of migration pattern variation based on these biological differences. Further, we used daily sea ice concentration and ice extent to test the effect of habitat on migration pattern variation. This information provides insight into individual differences within the Western Hudson Bay subpopulation and if migration patterns are changing in response to climate change.
Biosketch: Alyssa Bohart is currently a Master's student at the University of Alberta in Dr. Andrew Derocher's lab. She completed her Bachelor's degree in Honors Animal Biology in June of 2015 at the University of Alberta. Her interests include mammal and bird ecology, especially in a conservation context.

The sustainability of wolverine trapping mortality in southern Canada
Garth Mowat, Anthony Clevenger, Andrea Kortello, Doris Hauleitner, Mirjam Barrueto, Laura Smit, Clayton Lamb, Ben Dorsey, and Peter Ott
There is considerable conservation concern for wolverines throughout their range in North America. Previous researchers used population models and observed estimates of survival and reproduction to infer that current trapping rates strongly limit population growth, except perhaps in the far north where kill rates appear lower. Assessing the sustainability of trapping empirically requires both demographic and abundance data which are expensive to acquire and hence usually only achievable for small populations which makes generalization risky. We surveyed wolverines over a large area of southern British Columbia (BC) and Alberta and used spatial capture-recapture models (secr) to estimate density and then calculated trapping kill rates using provincial fur harvest data. Wolverine density averaged 2/1000 km^2 and was positively related to spring snow cover and negatively related to road density.

Observed annual trapping mortality was >8.4%/year. This level of mortality is unlikely to be sustainable except in rare cased where movement rates are high among sub-populations and sizable un-trapped refuges exist. Our results suggest current conservation risk to wolverine is high because our study area was fragmented by both human and natural barriers and few large refuges exist. We recommend wolverine mortality be reduced by at least 50% throughout southern BC and Alberta to reduce conservation risk and promote population recovery. Uncertainty in the trapping data created considerable conservation risk and we suggest BC and Alberta adopt a more certain mortality recording system for this species.

Biosketch: Garth manages the Research Section in the Kootenay Region of BC and is an Adjunct Professor at UBC-Okanagan in Kelowna. Garth has studied carnivore and ungulate population biology throughout his career with a focus on grizzly bears over the last two decades. He has been a TWS member since 1986.

Learning opportunities contribute to both problems and solutions for bear-train collisions

Colleen Cassidy St. Clair, Jonathan Backs, Alyssa Friesen, Aditya Gangadharan, Patrick Gilhooly, Maureen Murray, and Sonya Pollock

Transportation infrastructure creates both opportunities and hazards for wildlife with potential for net negative effects that can threaten vulnerable populations as ecological traps. Such traps can occur on railways that generate high rates of collisions with trains, which include grizzly bears (*Ursus arctos*), a provincially-threatened species, in Banff National Park. To identify potential targets for mitigation, we measured forage opportunities associated with the rail, monitored habitat use of bears fitted with GPS collars, and examined spatial and temporal correlates of past mortality. Rail use by bears provided access to forage that included grain spilled from hopper cars, enhanced growth of adjacent vegetation, and train-killed ungulates, but rail use also appeared to support travel through rugged topography and avoidance of people. Despite these potential benefits, bear use of the rail was surprisingly variable among individuals, while locations with higher grain deposits and use by bears did not predict sites of historic mortality. Our results support current mitigation efforts to minimize rail-side attractants and enhance alternative travel routes, but they also emphasize variation in net effects of rail use among individuals and contexts and suggest that individual learning can reduce collision risk. Wildlife managers might increase learning opportunities by installing affordable warning devices, such as the one we developed, that signal approaching trains. This approach could vastly increase the speed and reduce the costs of mitigation, relative to conventional forms used for roads based on exclusion fencing and crossing structures.

Biosketch: Colleen Cassady St. Clair is a Professor of Biological Sciences at the University of Alberta where she studies conservation behaviour. Research themes include wildlife use of human-dominated landscapes, human-wildlife conflict, and management to increase coexistence with species groups that include migratory birds, urban coyotes, habituated ungulates, and human-adapting carnivores.

Movement rates of grizzly bears in high recreation areas versus the backcountry in Kananaskis Country, Alberta

Jessica Hermann and Cheryl Hojnowski

The increasing number of outdoor recreationists is a growing form of disturbance for wildlife. However, some large carnivores spend significant time in high recreation areas, raising questions about how such individuals modify their movement behavior to avoid people. In this study, we investigated the behavior of grizzly bears (*Ursus arctos*) when they were in areas of high recreation intensity in Kananaskis Country, Alberta. We used Global Positioning System radio-collars to obtain fine-scale locations on bears whenever they were within 500 m of a human-use feature including trails, roads and facilities. We used trail counters and motion-triggered cameras to gain information about the variation in daily numbers of people in recreation areas. Using the location data, we quantified movement rates to examine environmental drivers for grizzly bears and their response to human disturbance. Further, we characterized the temporal movement behavior of bears based on the underlying landscape characteristics and related daily, weekly, and seasonal fluctuations in human activity levels. Grizzly bears travel faster within areas of high human use, therefore spend more energy on movement. Such increased movement rates as an avoidance behavior towards human activity can impact fitness as it affects bears ability to exploit foraging opportunities in high recreation areas. Our results suggest further management implication regarding the limitation of human use and preserving predictable recreation patterns to ensure a coexistence of bears and people in Kananaskis Country.
Biosketch: I'm currently enrolled in the program "Biodiversity, Ecology and Evolution" at the Georg-August-University of Göttingen in Germany. In order to achieve the Master of Science, I'm analyzing data provided by Alberta Parks and write my thesis about movement rates of Grizzly bears. I volunteer with the AB-Parks-Ecology Group in Canmore.

Evaluating two non-invasive genetic sampling approaches to population monitoring for the future of provincial grizzly bear management
Anja Sorensen, Isobel Phoebus, and Gordon Stenhouse
Traditionally in Alberta, barbwire hair snags have been the primary technique to non-invasively collect grizzly bear DNA and conduct spatially explicit capture-recapture population estimates. However, hair snag sampling is a labor intensive and costly approach for long-term population monitoring. Over the past five years, in collaboration with the Scandinavian Brown Bear Project, our research team has been investigating the applicability of DNA extraction from grizzly bear scat. In 2018, a repeated barbwire hair snag population inventory was conducted as part of an ongoing project within a portion of Weyerhaeuser's Drayton Valley Forest Management Area. This provided a unique opportunity to implement and compare a concurrent population inventory using a scat-based genetic sampling approach. To our knowledge, this is the first direct comparison of grizzly bear hair and scat DNA sampling techniques in North America. The outcomes of this work will allow us to determine whether a scat sampling approach could facilitate public and industry participation in cost-effective, science-based monitoring of grizzly bear populations in landscapes where we live and work.
Biosketch: Anja Sorensen completed her Masters at the University of Saskatchewan, evaluating niche overlap between elk, mule deer and white tailed deer. She initially joined fRI Research in 2014, and has been a Wildlife Research Biologist on the Grizzly Bear Program for the past five years.

SESSION 3A

HUMAN-WILDLIFE INTERACTIONS

The utility of river corridors for conservation of moose in the Oil Sands Region
Stan Boutin
The concept of corridors as a conservation tool to mitigate habitat loss and fragmentation has become widespread. Corridors have been defined as linear habitats that provide connectivity between important areas or entities in a species' range and river valleys are often associated with the corridor concept. Given the growing prevalence of oil sands mining near the Athabasca River, there is concern that the river and any corridor function it may have to facilitate the condition of wildlife populations in the region, would be compromised as surrounding habitat is being converted to mining area. If this were the case, a possible mitigation measure would be to institute "setback from river" conditions for mining operations so as to maintain corridor function. The scientific purpose of the Wildlife Effectiveness and Connectivity (WHEC) program was to obtain the information necessary to determine the overall efficacy of setbacks for corridors as a conservation tool and make recommendations on appropriate widths. Based on a thorough assessment process and consultation, moose and wolves were selected for detailed study and I report findings for moose. We obtained over 133,000 locations of 25 female moose in a study area that included the active oil sands mines north of Fort McMurray. Moose used and selected habitats that were well distributed throughout the study area and not confined to the major river valleys. Contrary to expectation, moose did not show seasonal migrations into and out of river valleys. Moose showed no evidence for avoidance of areas near mines. Based on the WHEC studies, river valleys in the Athabasca Oil Sands Region do not represent natural corridors for mammal species in the region. At present, there is no indication that the pattern of mines on the landscape has led to some wildlife populations being isolated because continuous accessible habitat exists to the east and west of the mines that allow populations to remain contiguous. We have made a strong scientific case for abandoning the designation of setback distances from the Athabasca River and its main tributaries as an important conservation tool in the Oil Sands Region.
Biosketch: Stan is a Professor and Alberta Biodiversity Conservation Chair at the University of Alberta.

Factors affecting spatial and temporal variation in human-carnivore interactions
Emily Sunter and Adam Ford
Coexistence with large carnivores is problematic when their ecological requirements intersect with infrastructure and people. In landscapes where carnivore persistence is a management objective, coexistence may mean human-carnivore interactions will occur. Past research has largely focused on conflict interactions, leaving a significant knowledge gap in our understanding of coexistence beyond conflict. I am addressing this gap by analyzing the spatial ecology of both incidents (i.e., conflict; physical attacks, property damage, bear consumption of human food) and sightings (i.e., animal, property, and person remain unharmed) together. My study takes place in Alberta's Bow Valley where multiple species of large carnivores, including black bears (*Ursus americanus*) and grizzly bears (*Ursus arctos*), co-occur with people in a diverse and evolving landscape. I am examining more than 1500 human-bear

interaction records from public agencies that occurred in 2016-17. I will build a predictive map of human-bear interactions and their outcomes, using environmental and human development covariates as predictors. Preliminary results suggest that human-bear interactions are most common in the spring/summer (93%), and that the vast majority (~84%) of interactions are sightings. Of the 16% of incidents, only 7% resulted in people taking extreme evasive action, and <2% resulted in harm to a person or bear. This research will provide further insight on how to strengthen policies that prevent incidents from occurring and will help ensure the Bow Valley continues to support viable bear populations while improving human safety.
Biosketch: Emily is a UBCO MSc student with a passion for human-wildlife coexistence. She has a BSc in Forest Science from UBC Vancouver and her current work focuses on interactions between people and large carnivores in Alberta's Bow Valley.

Moose population dynamics during 20 years of declining harvest in British Columbia
Gerald Kuzyk, Ian Hatter, Shelley Marshall, Chris Procter, Becky Cadsand, Daniel Lirette, Heidi Schindler, Michael Bridger, Patrick Stent, Andrew Walker, and Michael Klaczek
Licenced moose harvest in British Columbia declined by approximately half over a 20-year period from 1996–2015. To better understand moose population change coinciding with this period of declining harvest, we modeled population dynamics within 31 Game Management Zones (GMZs). Data from aerial surveys (180 density and 159 composition surveys) combined with licensed harvest was used to develop 4 competing statistical models. To assess population dynamics we used constant parameters and temporal trends in calf:cow ratios at 6 months, juvenile survival from 6–18 months, or cow survival. Results from models indicated moose populations declined ($\lambda < 1$) in 7 GMZs (23%) from 1996–2005 and in 22 GMZs (71%) from 2006–2015. Over the 20-year period, the best model was fit with declining trends in calf:cow ratios in 8 GMZs, declining juvenile survival in 6 GMZs, and declining cow survival in 8 GMZs. Population growth rate was slightly reduced where licenced cow and calf hunting occurred. Total licenced bull harvest influenced bull:cow ratios that were significantly lower in 2006–2015 ($x = 37:100$) than 1995–2005 ($x = 48:100$). Provincial moose numbers and harvest were correlated ($r = 0.81$) suggesting declining harvest was related to declining population trends.
Biosketch: Gerry spent many years working on ungulates and predators in the Yukon and Alberta and has been the Provincial Ungulate Biologist for BC for the past 12 years.

Evaluating the risks and impacts of rapidly expanding invasive wild pigs across the Canadian landscape
Ryan Brook
Wild pigs (*Sus scrofa*) are a free-ranging invasive species that are comprised of hybrids of Eurasian Wild Boar and domestic pigs that escaped or were released from meat and penned shoot farms across Canada and have rapidly expanded their range to > 750,000 km^2. They are one of the most prolific and destructive large mammals on earth. Here I outline my research program aimed at characterizing: (1) the genetic status of wild pigs in Canada, (2) crop damage patterns and trends, (3) spatial overlap of wild pigs and livestock at multiple scales, (4) disease status of wild pigs and specific risks to livestock, (5) impacts on native ecosystems and species at risk, (6) distribution, density and spread, (7) social perspectives, and (8) current management strategies. Methods include GPS satellite collaring, trail

camera networks, citizen science trail camera images from hunters, telephone surveys, interviews, bounty data, stakeholder mapping workshops, and necropsies of harvested animals. Results show that wild pigs are expanding rapidly, especially in Alberta, Saskatchewan, and Manitoba. Rural Canadians have highly variable awareness of the presence of wild pigs in their province, with respondent awareness increasing with increased wild pig distribution. Management efforts are limited, largely uncoordinated, and few provinces have formalized strategies and none have monitoring programs. Few conservation organizations are engaged in monitoring or control efforts. Given the overall lack of action, rapid and widespread expansion of wild pig populations in Canada is expected to continue and the window for potential eradication is closing rapidly.
Biosketch: Dr. Ryan Brook is an associate professor at the University of Saskatchewan. His interdisciplinary research team is focused on the wildlife-livestock interface, working with aboriginal people, linking traditional and local knowledge with science, youth engagement in field research, and he has side hustles in the arctic and the jungle.

Plains bison reintroduction in Banff National Park
Saundi Norris
Bison are a keystone species that was extirpated from the area that is now Banff National Park (BNP) over 140 years ago. Historically, bison played a critical role in the local ecosystem through grazing, wallowing, trampling, and serving as prey or carrion for a variety of species. Bison were also very important to the livelihood of people in the area. As part of its larger mandate to maintain and restore ecological integrity, Parks Canada is undertaking a 5-year pilot bison reintroduction project to assess the long term feasibility of bison restoration in the region. In 2017, bison were translocated to a soft-release pasture in a remote backcountry area of BNP where they were held for 1.5 years and calved twice during this time. Bison were released from the soft- release pasture in July 2018; 34 bison are now free-roaming in the 1200km 2 bison reintroduction zone in BNP. We present an overview of project strategies from the translocation phase through to release; highlight evaluative research and monitoring currently underway and share emerging lessons that may contribute to the science and practice of large mammal reintroductions.
Biosketch: Saundi Norris is a Resource Management officer in Banff National Park and currently working, alongside a dedicated team, on the bison reintroduction project. Over past 25 years, she has studied a breadth of carnivore and ungulate species within the Central Rockies of Alberta and BC as well as Nunavut.

SESSION 3B

TOOLS AND TECHNOLOGY

Decision support tool for cumulative effects management based on multi-species monitoring data
Peter Solymos, Ermias Azeria, Brandon Allen, David Huggard, Jim Schieck, Shannon White, and Erin Bayne
Natural resource development in Alberta impacts species and their habitats in many different ways. Some sensitive species might show declines while other generalist or non-native species take advantage

of anthropogenic activities. Understanding the consequences of resource development and managing the trade-offs between economic benefits and biological conservation requires a rigorous scientific approach. We used species data of 911 species including mammals, birds, vascular plants, bryophytes, lichens, and soil invertebrates. Data were collected and collated by the Alberta Biodiversity Monitoring Institute, the Boreal Avian Modelling Project, and Environment and Climate Change Canada. We developed statistical models that incorporate species' land cover (vegetation, soil, human footprint) associations and their responses to spatial and climatic gradients. We produced summaries for each species that can be accessed at abmi.ca/data. The summaries include fine scale predictive maps for each species under current landscape conditions, and under "reference" conditions (where human footprint is replaced by the most likely land cover type that would have been present if no human disturbance had occurred), and summaries of anthropogenic impacts on species populations by 5 industrial sectors (agriculture, forestry, energy, urban/rural, transportation). We also created tools to facilitate the use of these results in cumulative effects management. In the presentation we will showcase examples where the results and tools have been successfully used, such as the Government of Alberta's Biodiversity Management Framework, and scenario based applications in forest management and climate change contexts.

Biosketch: Dr. Péter Sólymos is a statistical ecologist with a focus on developing and applying computational techniques for big data sets to better inform biodiversity conservation and natural resource management over large spatial scales.

Evaluating camera trap surveys as an effective means of monitoring remote ungulate populations

Joanna Burgar, Jason Fisher, and Cole Burton

Camera trap surveys are increasingly being used for wildlife monitoring but their effectiveness at monitoring remote ungulate populations has yet to be determined. To do so we are conducting a multi-year camera trap study within the Richardson caribou range, an area predominantly disturbed by wildfire (65%) and also human-use (36%). To capture this variability we deployed 58 cameras using a 2 factorial design: in/out of wildfire; on/off seismic lines. Thirty cameras were deployed in November 2017 and 28 cameras were deployed in November 2018. We are using hierarchical Bayesian spatial models to estimate the densities of boreal woodland caribou (*Rangifer tarandus caribou*) and moose (*Alces alces*). Preliminary results suggest inter-annual variability and spatial segregation of ungulates within the study area. Incorporating the Government of Alberta's telemetry data, we estimated caribou density using spatial mark-resight models during the winter, pre-calving and calving periods. Density estimates were similar between periods with slightly higher densities during the winter and lower densities during the pre-calving periods. Simulations suggest that estimate uncertainty will decrease once we have data from the full suite of cameras. We used spatial count models to estimate moose densities during the summer period, and found our estimates were comparable to provincial aerial moose survey distance sampling estimates from 2018. Camera trap surveys can be an effective tool to monitor remote populations, producing density estimates similar to other survey methods, with the added benefits of capturing inter-annual variability in density and space-use of key species, while also surveying the broader boreal mammal community.

Biosketch: Joanna Burgar is a post-doctoral researcher at UVic (ACME lab) and UBC (WildCo lab). Her interest is wildlife conservation across disturbed landscapes and it transcends a particular species, ranging from lemurs in Madagascan forests, Australian bats in a post-mining restored landscape, and ungulates in the Oil Sands.

Using technology to track invasive species
Delinda Ryerson
The Alberta Invasive Species Council (AISC) is the only non-profit organization in the province, dedicated entirely to informing and educating Albertans about the destructive impacts invasive species have on our environment, economy, and society. The AISC endeavors to foster partnerships to collaboratively develop integrated, long-term invasive species monitoring programs, and to engage and empower people to act against invasive species in Alberta. Alberta is known for its water, land and wildlife, but our mountains, prairies, forests and even croplands are threatened by harmful invasive species. Hunters, anglers, biologists, landowners and other outdoor enthusiasts all have the ability to identify invasive species, but they may not know who to contact to report infestations to. The AISC is home to the Early Detection Distribution Mapping System (EDDMapS) for Alberta. This presentation will give you an overview of why early detection and rapid response is important, and how with EDDMapS Alberta, we can all work together to reduce the spread of invasive species, and their detrimental effects on the delicate balance of our ecosystems.
Biosketch: Delinda has been managing natural resources, environmental projects, and people for more than 20 years. Driven by her love of nature, she is a conservation biologist, and fervent advocate of scientifically-informed use of natural areas and resources. Delinda joined the AISC team as their Executive Director in January 2017.

Acoustic based estimates of fisheries productivity in northern boreal lakes: implications for offsetting
Michael W. Terry and Mark Poesch
Despite covering less than 1% of the Earth's surface freshwater ecosystems support a disproportionately large number of species, containing more species per unit area than both marine and terrestrial ecosystems. Alarmingly, these ecosystems also face the highest level of threat and freshwater fishes have subsequently exhibited the highest rates of extinction among all vertebrates during the 20th century. In an effort to counter this trend fisheries managers in the Alberta oil sands have turned to the construction of new lakes (i.e. compensation lakes) to offset for any residual impacts to the productivity of the affected fishery. However, these novel systems are being implemented despite numerous conceptual and practical challenges, including how to quantify the amount of offset that is required to ensure no net loss in fisheries productivity is achieved. This study will demonstrate the role of active acoustics in developing criteria for evaluating and enhancing offsetting projects in the region. Acoustic data collected from six natural lakes in the Alberta oil sands will contribute to (1) establishing a baseline for fisheries productivity, and (2) help evaluate behavioral and physiological responses of organisms to their environment. Preliminary analysis highlights fish distribution is not stochastic and a comparison of von Bertalanffy growth functions showed a significant difference in growth of species between lakes.

Understanding the mechanisms behind the observed patterns will help guide adaptive management strategies and ensure the long-term sustainability of freshwater resources in the region.
Biosketch: Michael is a graduate student in Mark Poesch's lab at the University of Alberta.

Welfare practices in wildlife capture: Narwhal (Monodon monoceros) handled for satellite tagging
Sandra Black, Jack Orr, and Steven Ferguson
Capture events in wild animals are inherently stressful, and effects on individual animals must be weighed against the value of the resultant data and the potential for using less invasive methods to obtain similar data. Constant vigilance and improvement of methods is a primary responsibility of any researcher engaged in work that requires capture and handling of wild species. Narwhal are an iconic species of great cultural, ecosystem and and economic significance. For decades, these small whales have been captured to attach satellite tags, providing information about movements, population numbers and stock composition. Since 2004, blood samples, physiological parameters, physical exams and behavioural observations have been collected on a total of 62 captured narwhal to assess levels of physiological stress and recovery. During the 13 years of this study, protocols and limits for weather and available light were improved, resulting in a decreased average handling time, from 42 minutes in 2004-2008 to 34 minutes from 2009-2016. Skin injuries as a result of entanglement in the nets are catalogued and behavioural observations, respiratory rates and end tidal carbon dioxide levels are reported. Paired blood samples collected early and late in the handling period were analyzed for blood gases, pH, bicarbonate, lactate and base excess in the field. Net capture of narwhal causes a behavioural response which leads to physical exertion, anaerobic muscle activity, acidosis and some skin injuries from the net. This handling process provides a good example for adapting protocols to minimize animal distress and injury.
Biosketch: Dr. Sandie Black is a clinical veterinarian at the Calgary Zoo, and a wildlife researcher. She is currently also a PhD student at the University of Calgary, studying the effects of cumulative impacts in narwhal in the Canadian Arctic.

SESSION 4A

CARIBOU RESEARCH AND MANAGEMENT

A burning question: Using fine-scale step selection to understand the impact of wildfire on woodland caribou in Alberta.
Sean Konkolics, Rob Serrouya, and Stan Boutin
The Canadian Federal Recovery Strategy classifies areas burned by wildfire in the last 40 years as disturbed habitat for woodland caribou. This delineation of fire disturbance has major economic and social implications for a variety of stakeholder groups including indigenous peoples, resource extraction, forestry, and land-managers across Canada. Yet, detailed research about the relationship between post-fire forest regeneration and caribou habitat selection is lacking. Previously, studies used coarse mapping techniques that are unable to account for unburned residual patches, which could provide viable habitat

for caribou. We developed updated fire maps and used multi-scale step selection functions to assess the importance of burns and non-burned residual patches for 203 individuals across 6 Alberta caribou populations. We found that caribou avoided both the burn complex and non-burned residual patches in all seasons. Individuals continued to avoid these burned landscapes for up to 40 years, though some individuals used older burns (30-40yrs) more randomly. Additionally, there was no functional response to the availability of burns, suggesting that there is no threshold at which caribou will show preference for burned areas. Collectively, these results demonstrate that post-fire landscapes and the corresponding residual patches effect caribou spatial distribution and may be sub-optimal habitat in Alberta. This study provides insight to the role of non-burned residual patches to caribou ecology and offers important information for herd-level management decisions and defining critical habitat under the federal mandates. With projected increases in wildfire frequency, understanding the relationship between caribou and burned landscapes is imperative for successful recovery.
Biosketch: I am a second-year master's student in Stan Boutin's lab at the University of Alberta. My research interests are focused on habitat selection and movement ecology of large mammals. Outside of wildlife research, I enjoy hiking, mountain biking, the outdoors, friends, family, and gaining new experiences.

Seasonal patterns in body condition of adult, female woodland caribou: Evidence for a summer nutritional bottleneck with implications to mortality risk in southern Northwest Territories
John Cook, Allicia Kelly, Rachel Cook, Brad Culling, Diane Culling, Ashley McLaren, and Nicholas Larter
Classic perceptions are that harsh weather and poor nutrition in winter cause poor body condition and elevate mortality in late winter and early spring. Using repeated-measures sampling in December and March of winters of 2017 and 2018, we estimated body fat of adult female caribou using ultrasonography and condition scoring, and, in other seasons, used marrow fat from bones of dead caribou, to estimate annual cycles in body fat. Change in body fat and body mass overwinter for most caribou was slight, averaging only -0.55 (S.E. = ±0.19) percentage points and -2.8 kg (±0.67), and was strongly correlated to autumn levels. However, body fat declined after March to an annual minimum by early summer. These results indicate that 1) woodland caribou are resistant to overwinter declines in body condition; 2) body condition in March is largely dictated by condition in late autumn and thus by nutritional resources available the previous summer and autumn; and 3) the annual bottleneck in nutrition occurs in late spring and summer, not winter. Barren-ground caribou studies (n = 5) also reported minima in late spring/early summer, suggesting that a nutritional bottleneck during this time is a widespread phenomenon. Long-term studies in southern NT identified peaks in adult female mortality (n = 169) from April through July, and similar seasonality of mortality was documented elsewhere in western Canada. In aggregate, these patterns of mortality and body condition suggest that low body condition in summer functions as an important predisposing cause of mortality of adult female caribou.
Biosketch: Dr. Cook is an ungulate researcher specializing in nutritional ecology for over thirty years, with research focus on bighorn sheep, elk, and, recently, woodland caribou. His caribou research focuses on linking fine-scale nutrition/foraging data using tame caribou with measures of body condition and productivity of wild caribou at broad scales.

Identification and evaluation of woodland caribou birth sites in northern Ontario

Phil Walker, Art Rodgers, Jen Shuter, Brent Patterson, Ian Thompson, John Fryxell, John Cook, Rachel Cook, and Evelyn Merrill

Studies in Ontario have derived annual resource selection functions of adult caribou, but an understanding of what influences selection during parturition is limited. We used a movement-based, statistical approach to predict parturition events of 22 GPS/video-collared caribou within three distinct regions in northern Ontario. Movement-based parturition events were correctly predicted within 1.5 + 1.6 days compared to observations on video collars. We applied the model to 190 GPS-collared caribou with unknown parturition events that were monitored from 2010 to 2013. Mean parturition rate was 82% and median birth across years was 19 May. We evaluated the effects of female age and body condition, study area, and previous fall and winter weather on calf birth date. Timing of birth was significantly later in Cochrane compared to Pickle Lake and Nakina. Median time spent in a localized calving area ($408m^2$ + $456m^2$) was 12.1 days (2.3-35.9). Proportion of undisturbed, closed canopy, and lowlands habitat within the calving areas was 0.91, 0.85, and 0.59, respectively. Characteristics of parturition areas will be used to derive multi-scale resource selection functions for parturient caribou to help guide a larger effort evaluating the influences of forest management on nutritional resources within caribou calving areas.

Biosketch: I am currently a PhD. student at the University of Alberta. I enjoy spending time outside, especially when I am taking photos of wildlife.

Ecological genomics and conservation of caribou in Alberta and western North America

Maria Cavedon, Bridgett vonHoldt, Stefano Mariani, Mark Hebblewhite, Helen Schwantje, and Marco Musiani

Caribou are a globally declining species and, in Alberta, as well as all North America, there is an urgent need to set a clear path for their recovery and protection. A fundamental step toward caribou management and conservation in Canada has been the delineation of 12 Designatable Units (groups of populations with similar, discrete and evolutionarily important characteristics); however genomic analyses were demanded by the Committee on the Status of Endangered Wildlife Species in Canada to fill knowledge gaps. We applied an ecological genomic approach to caribou populations throughout western North America and detected signatures of selection on alleles associated with environmental variables along a North-South gradient. Our population structure analysis supported DUs designation with some exceptions, indicating the robust basis of DUs' classification scheme, but also highlighted the possibility for refinement. For example, caribou belonging to the Little Smoky population have characteristics that are intermediate between the Boreal and Mountain ecotypes, as a significant portion of the population has Mountain traits including migration and/or harboring mtDNA haplotypes that did not evolve in the boreal forest. Our results also indicated strong linkages between genetic and ecological factors and behavioral traits, including migration. Overall, our study represents the first genomic research applied to the conservation of caribou in Alberta and in western North America. We provide new insights and specific suggestions for caribou groups that have evolutionary connections and for which management efforts should foster connectivity.

Biosketch: Maria did her undergrad on Forestry at Padua University (Italy), a Master's on Wildlife Management and Conservation also at Padua University. Then, she worked for the Adamello Brenta Nature Park on various species and now is a PhD candidate at the University of Calgary focusing on caribou conservation genomics.

Close encounters of the fatal kind: Predators and landscape features associated with central mountain caribou mortalities

Tracy McKay, Bryan Macbeth, Barry Nobert, Karine Pigeon, and Laura Finnegan

Increased mortality risk associated with landscape disturbance is linked to declines in central mountain caribou populations. In multi-predator systems, quantifying the role of different predator species in caribou mortalities and assessing how disturbance contributes to predation risk could help inform caribou habitat restoration. We used field investigations of caribou mortalities and GPS collar data from two central mountain herds in Alberta and British Columbia to investigate predation-caused caribou mortalities, and to assess the influence of terrain and disturbance features on predation risk. We worked together with forestry companies, provincial governments, and wildlife veterinarians to develop mortality investigation protocols, visit mortality sites, and collect mortality and landscape disturbance datasets. From mortality site investigations, we determined that cougars (17%), wolves (22%), and grizzly bears (33%) were responsible for predation-caused caribou mortalities, with multiple predators involved in 33% of mortalities. Terrain was the best predictor of mortality locations; mortalities generally occurred in valley bottoms and near streams. Linear features were the best predictors of habitat use during the 24-hours, 7-days, and 30-days prior to mortalities; caribou that died used areas with higher pipeline densities but lower road densities. Our mortality site investigations provide new information regarding the caribou predator guild in our area, highlighting the importance of considering a multi-predator system in caribou predation risk. Our results support current efforts in western Canada to restore linear disturbances preferred by predators. Overall, results from this project provide governments and managers with better information for predator management and caribou habitat restoration.

Biosketch: Tracy has worked for the fRI Research Grizzly Bear Program and for Parks Canada before starting with the fRI Caribou Program in 2016. Tracy believes strongly in conservation, and she can be found outside in her natural habitat whenever she gets the chance.

Behavioural responses of southern mountain caribou to commercial backcountry skiing activities

John Wilmshurst and Steven Wilson

Helicopter- and snowcat-supported backcountry skiing is a unique industry that is widespread throughout southern mountain caribou habitat in British Columbia. We analyzed standardized caribou encounter data collected by operators under an agreement between the BC government and Helicat Canada. Average reported encounter rates were low for helicopters (0.5%) and skiing groups (0.1%); however, encounters were likely underreported due to factors that affect caribou sightability. Although helicopters encountered caribou more frequently than skiing groups, caribou were detected from helicopters at greater distances than by skiers. We used Bayesian Network models to assess the independent contribution of different factors to the behavioural response of caribou to encounters.

Encounter distance was the most important factor in both helicopter and skiing models. Larger groups of caribou responded more strongly, but the independent effect of this factor was small. Larger helicopters elicited stronger reactions from caribou than smaller machines and was responsible for 24% of the modelled variation in caribou response. Encounters with helicopters at distances of 100–500 m had a 75% probability of eliciting a concerned-to-very-alarmed response from caribou, while skiers at a similar distance had a 58% probability of eliciting the same response. The probability of concerned-to-very-alarmed responses dropped to 1000 m. These results indicate that initial encounter distance is the key variable to manage risk to caribou of helicopter and skiing encounters. Ongoing feedback on the effectiveness of management practices is critical to ensure the continued viability of industries operating in caribou habitat.

Biosketch: Private consultant, professional editor, adjunct professor with the University of Saskatchewan, and Executive Director of the Alberta Chapter of the Wildlife Society. I specialize in ungulate ecology and conservation and also dabble in remote sensing and grassland community ecology.

Sharing the landscape: How the Regional Industry Caribou Collaboration are working together

Margaret Donnelly, Amit Saxena, Caroline Hann, Jon Gareau, Lori Neufeld, Mark Boulton, Michael Cody, Peter Millman, Rochelle Harding, Rob Serrouya, and Melanie Dickie

Woodland caribou inhabit landscapes with a variety of natural and human-made disturbances which are linked to widespread declines across much of their range. Historically, each stakeholder managed their own resource development areas separately. However, responding to caribou decline requires a response to cumulative impacts and management at larger scales, including across stakeholder boundaries. The Regional Industry Caribou Collaboration (RICC) is a group of energy and forestry companies that recognize this need, and as such we lead research and habitat restoration programs aimed at informing and contributing to caribou recovery in northeastern Alberta. We will provide an update on our collaborative habitat restoration progress, learnings and current goals in the face of changing management levers and our plans for the future. To date, RICC members collaborated on restoration of over 1000 km of seismic lines and in 2018 plans are underway for two additional large-scale projects. Through engaged collaboration among members, we demonstrate the economies of scale and effectiveness that are essential for caribou recovery. In addition, knowledge sharing and coordination with other stakeholders and academia provides a net benefit to caribou as well as each participant.

Biosketch: Margaret Donnelly is an Ecologist at Alberta Pacific Forest Industries Inc with a background in sustainable forest management. Margaret works closely with colleagues from the energy sector to inform best practices related to woodland caribou and biodiversity at large.

Evaluating actions to reduce threats to caribou herds in Jasper National Park

Lalenia Neufeld

In southern mountain woodland caribou habitat in Jasper National Park (JNP), wolf access is thought to be facilitated by packed linear features from valley bottom that lead into deep snow refuges in the subalpine. Facilitated access artificially increases predation risk to caribou by increasing wolf use of caribou habitat, travel speeds, and hunting efficiency. In 2009/10, JNP closed a popular backcountry

skiing valley from November to mid-February with the aim of reducing facilitated wolf access into caribou habitat, and by 2014/15 we replicated this conservation action across all caribou habitat in JNP. We monitored wolves since the implementation of the closure in 2009/10 and used GPS data to evaluate patterns of wolf habitat use of caribou habitat during and post-closure using step selection functions. We predicted that closures would reduce selection of high elevation caribou habitat and present results and conclusions related to these conservation actions. We discuss the importance of wolf density in wolf habitat use of 'marginal' wolf habitat, and the effectiveness of closures in light of decreasing wolf density within JNP.
Biosketch: Layla is a wildlife biologist with Jasper National Park whose work focusses on caribou/wolf ecology in protected areas.

Linear features and caribou declines: Understanding the mechanisms and predicting restoration efficacy
Melanie Dickie, Robert Serrouya, Craig DeMars, and Stan Boutin
Linear features (LFs) can alter predator-prey dynamics in 3 ways: 1) By allowing incursions of predators into habitat that was previously a refuge; 2) by increasing movement rate and thus foraging efficiency of predators; and 3) by creating forage for alternate prey due to the removal of the forest canopy. Each of these mechanisms is thought to contribute to the decline of woodland caribou. Empirical support for these mechanisms varies, and it is important to quantify these if recovery actions are to be successful. Additionally, the effect of climate change in facilitating the expansion of alternate prey (particularly white-tailed deer) may dwarf effects from all 3 of these mechanisms and would present an alternate hypothesis to the federal boreal caribou recovery strategy. We explore the degree in which each of these mechanisms has been supported and how we plan to work with industry, academia and government to fill gaps in our current understanding. We present an experimental design using camera traps and radio telemetry to contrast the effects of all these mechanisms and use simulations to understand the possible implications of LF restoration to caribou populations. Unless the relative magnitude of linear features compared to climate are quantified, recovery actions cannot be expected to succeed.
Biosketch: Melanie is the coordinator of the ABMI's Caribou Monitoring Unit. Melanie conducts a variety of research programs to support caribou management, ranging from monitoring multi-species response to caribou management strategies, prioritizing areas for habitat restoration, and understanding how human disturbances alters predator and prey populations.

Improving efficiency and effectiveness of caribou habitat restoration through an innovation roadmap
Matthew Pyper and Kate Broadley
Restoration of linear features has been acknowledged as a critical component of woodland caribou conservation for over 20 years. However, recent efforts by governments, industry, Indigenous communities, and local stakeholders have helped to advance restoration as a viable tool in the caribou conservation toolbox. Restoration is not cheap though. Current cost estimates for the restoration of linear features, such as seismic lines, are approximately $8,000 to $12,000 per kilometre. To ensure that habitat restoration remains a viable long-term solution within woodland caribou ranges, there is a need to explore opportunities to reduce restoration costs while maintaining and increasing the ecological effectiveness of restoration techniques. In this presentation we will summarize key learnings, from

scientific research and operational implementation, related to restoration planning, operations and monitoring. We will focus on learnings that can help improve restoration efficiency and effectiveness in the short term. We will also showcase initial steps to develop an innovation roadmap that aims to identify key opportunities for innovation to dramatically reduce the cost and uncertainties associated with restoration in woodland caribou habitat.

Biosketch: Matthew Pyper is an Ecologist and Science Communicator who has worked on over 150 Science Communication products related to forest management, land reclamation, habitat restoration, and conservation biology. He is a graduate of the University of Alberta where he completed a Masters degree in Forest Ecology and a Bachelor's degree in Environmental Biology. Matthew is the co-owner of Fuse Consulting where he and his team work everyday to find creative, engaging ways to connect science to diverse audiences.

SESSION 4B

MAMMALS

The Waiting Game: Elk maintain fine-scale spatial avoidance of predators across various temporal scales

Mitchell Flowers, Mateen Hessami, Mark Hebblewhite, and Evelyn Merrill

Ungulates avoid predation by being vigilant, grouping up, or avoiding areas recently used by predators. Understanding fine-scale temporal dynamics in elk use across a risky landscape may explain how they avoid predator encounters altogether when coping with frequent changes in predation risk. We used a time-to-event modelling approach with data from 44 remote cameras distributed across the Ya Ha Tinda in winter and summer (2016–2018) to assess how soon elk revisited a site after predators were present. Cameras were distributed evenly among open, closed, and edge habitats at various distances from human activity. Using a Cox proportional hazards model and controlling for seasonal changes in elk movement rates, we tested whether elk stayed away from areas recently visited by predators and how interactions between elk group size/composition and site characteristics (e.g. distance to roads and ranch operations, vegetative cover, and topography) might further influence return times. Wolf presence reduced the likelihood of elk re-visiting sites in summer by 69% (Hazard ratio or HR=0.31, $p<0.01$) and by 65% in winter (HR=0.35, $p<0.005$), and this effect was reduced in open grasslands during winter. Elk visitation was lower among sites closer to the road in both summer and winter (HR=0.42 and 0.34, respectively). In summer, elk visitation was also less likely after the presence of grizzlies and shorter when elk were in larger groups. We illustrate a novel and non-invasive approach for determining how landscape features and human disturbance can alter the relative importance of space and time in shaping predator-prey interactions.

Biosketch: Mitchell is an M.Sc. student at the University of Alberta focusing on the predator-prey dynamics of elk and their predators at the Ya Ha Tinda. He is a proponent of non-invasive techniques in wildlife research and hopes to become professionally involved with large carnivore management.

Using predator scat contents to predict predation risk for elk (Cervus elaphus) in a multi-predator community

Kara MacAulay, Eric Spilker, Jodi Berg, Mark Hebblewhite, and Evelyn Merrill

There is evidence that prey perceive the risk of predation, as they navigate a “landscape of fear” and alter their behaviour in response. Previous approaches to mapping spatial risk use predator and prey space use to estimate potential encounters, yet this approach does not account for attack success resulting in mortality. Locations of prey kill sites represent mortality in space, but obtaining this data can be expensive and requires time to accumulate adequate sample sizes. In this study, we illustrated the feasibility of using predator scat locations and their contents to quantify spatial predation risk from multiple predators for the Ya Ha Tinda elk herd, inhabiting the east slopes of the Rocky Mountains. We derived scat-based resource selection functions (RSF) for cougars, wolves, bears and coyotes based on surveys with scat detection dogs and used the models to predict the relative probability of a predator-specific scat occurring across the landscape. We combined this metric with the relative probability of a scat in space containing elk based on DNA analysis. We evaluated the approach by comparing both the scat-based RSF and the combined model based on scat contents to an RSF based on elk kill sites. In addition to measuring spatial risk from multiple predator species through non-invasive sampling, this study adds to a 17-year project investigating the changing migratory dynamics of the Ya Ha Tinda elk herd.

Biosketch: Kara received a B.Sc. degree in Biological Sciences from the University of Lethbridge, and recently completed a M.Sc. degree in Ecology at the University of Alberta. She is currently working as a research assistant in Dr. Merrill's lab at the University of Alberta.

Is there differential parasite exposure in a partially migratory elk population?

Jacky Normandeau, Evelyn Merrill, Susan Kutz, and Mark Hebblewhite

Most ungulate studies focus on forage-predation interactions, but parasites can have significant impacts on body condition, fecundity, and survival in ungulates. The interaction between migration to different summer ranges and parasite exposure is not well understood but may differ due to patterns in host concentration increasing fecal contamination in suitable areas and extent of secondary host habitat necessary for transmission. We studied parasites in a partially migratory elk (*Cervus elaphus*) herd that winters at the Ya Ha Tinda bordering Banff National Park in Alberta and migrates to 3 allopatric summer ranges. We predicted that eastern migrants would have higher infection by giant liver fluke (*Fascioloides magna*) because they are concentrated along the Red Deer river and exposed to wetlands as snail secondary host habitat. We collected pellets of unknown elk within each summer range in 2017 and 2018, and of known, individual GPS-collared elk in spring of 2018 because giant liver fluke egg excretion in pellets occurs ≥ 6 months after exposure. Eggs were isolated from pellets and identified via morphology microscopically. During the summer, parasite diversity was higher in western migrants likely due to exposure to a variety of habitats and parasite infective stages, but giant liver fluke egg counts were higher in eastern migrants. Giant liver fluke egg counts of collared elk were associated with wetland use, which was higher on the summer range of eastern migrants. Our study contributes to understanding exposure to environmentally transmitted parasites in a partially migratory ungulate population.

Biosketch: I am a Master's student in Dr. Evelyn Merrill's lab at the University of Alberta. I study elk migration, parasites, and behavior at the Ya Ha Tinda Ranch, AB which borders Banff National Park. I'm

originally from Uxbridge, ON and I received my B.Sc. in Biology from Wilfrid Laurier University in Waterloo, ON.

Temporal dynamics of terrestrial vertebrate use of forest-wetland edge in Uganda
Camille Warbington and Mark Boyce
In Uganda, forests bordered by wetlands are under threat from human activities of cattle farming and charcoal production. As human impacts increase, understanding the effects on various wildlife species is important for management decisions. Beginning in 2015, we placed trail cameras in areas of forest within 20m of wetland edge to determine what species are using the forest as a travel corridor, for foraging, or other uses. We determined the proportion of camera-days with a detection of at least one animal for each species in each year of the study. From 2015 – 2017, we detected over 20 species of terrestrial vertebrates using the forest. For species that had sufficient sample size, we conducted a proportions test between years to see if the number of days with a detection varied temporally. We found that for sitatunga, detections decreased every year, while detections increased each year for bushbuck and hippopotamus. We also found evidence for a relationship between river level and the proportion of days with a detection of warthog. For many other species, including domestic cattle and humans, detections increased during 2017 only. River-wetland edge in Uganda appears to be important for many terrestrial species, including humans and livestock; consequently, managing such ecosystems for multiple uses will become imperative in the near future.
Biosketch: Camille Warbington is a PhD candidate from the University of Alberta. She obtained her MS at the University of Wisconsin - Madison, and her BSc at the University of Georgia. Her current research focuses on the ecology of sitatunga, a unique semi-aquatic antelope species endemic to wetlands of sub-Saharan Africa.

Risk effects have nutritional, demographic, and evolutionary consequences on prey
Darcy Visscher, Philip D. DeWitt, Matthew S. Schuler, Richard P. Thiel
Animal populations are regulated by the combined effects of top-down and bottom-up processes. Prey often reduce predation risk at the cost of lower resource intake; however risk effects can sometimes mask bottom up limitation. We show how risk effects and bottom-up processes reduce the nutritional condition, growth rate, and recruitment of wild North American porcupines *Erethizon dorsatum*, demonstrate how the accumulation of risk has lifetime and evolutionary consequences. The nutritional state of porcupines was suppressed by poor summer forage conditions and predation risk from fishers *Pekania pennanti*. Individual porcupines experiencing predation risk grew slower and gave birth to fewer offspring. Simulations show that predation risk alone can lead to population declines, and that a female can replace herself by investing more energy into reproduction or adult survival; females that only invest energy in juvenile survival cannot. We show how the accumulation of risk can reduce lifetime reproductive success in natural ecosystems. Estimating the contribution of predation risk, and how evolutionary responses can mediate consequences associated with risk, is required to understand predator–prey systems.

Biosketch: Darcy is generally interested in the role that landscapes and individual behaviour play in structuring ecological processes. In particular, he is interested how animals trade-off foraging reward and risk, both predation and human disturbance, in urbanizing environments.

The effect of environmental change on predator-prey dynamics

Michael Peers, Yasmine Majchrzak, Allyson Menzies, Emily Studd, Rudy Boonstra, and Stan Boutin

Predicting the impacts of climate change on community structure remains challenging due to the complexities in understanding how climate disruption will alter predator-prey dynamics. Predator species may be increasingly favoured if consumption rates are increased under climate change through improvements in variables such as hunting success. However, in multi-predator systems, changes in climate may result in either similar or inverse relationships in the consumption rate of each predator species, which will influence the overall mortality risk on prey. These intricacies of climate change remain largely unexplored, mainly because of the difficulties of monitoring detailed changes in climate conditions coupled with cause-specific survival of the target species. Snowshoe hares (*Lepus americanus*) are a keystone prey species of the boreal forest, and the numerical response of several predator species are associated with their fluctuating abundance. Hares have a lower foot load relative to other species providing them with an advantage in soft, deep snow over their predators. Increased temperatures and the frequency of freeze-thaw events may increase susceptibility of hares to predation throughout their range by reducing snow depths and increasing snow hardness. Cause-specific survival of snowshoe hares in the Yukon, Canada was monitored for four winters along with daily climate conditions such as temperature, snow depth and hardiness. We demonstrate complexities of climatic drivers on hare mortality risk from their two main predators, Canada lynx.

Biosketch: Michael Peers is a PhD candidate at the University of Alberta examining how climate change may impact snowshoe hare demography.

The role of food in the snowshoe hare cycle

Yasmine Majchrzaki, Michael Peers, Allyson Menzies, Emily Studd, Rudy Boonstra, and Stan Boutin

Understanding the causes behind population cycles is a fundamental issue in ecology. The primary objective of this project is to examine the effects of food limitation on the ecology of adult snowshoe hare (*Lepus americanus*). In previous studies examining the causal mechanisms of the hare cycle, food addition was administered on a large scale, which can be problematic due to increased immigration to the area by other hares and unequal access to food. Individual-based food addition solves both of these problems and is therefore an optimal method for investigating the role of food in the snowshoe hare cycle, and uncovering the mechanisms behind their fluctuating abundance. To accomplish this, we are radio-collaring hares in the Kluane lake area of the Yukon, Canada. Treatment hares are individuals fed throughout the winter with known amounts of rabbit chow from selective feeders. These feeders allow controlled access to only the specific pit tagged individuals. We then monitor daily survival, movement and foraging activity of each individual in the control and supplemented treatment using VHF telemetry and GPS collars fitted with accelerometers. If food limitation is a key mechanism in the hare cycle, we expect to see dramatically different responses between the two treatments, with supplemented animals showing increased survival rates, less risky behavior, and higher quality offspring. Preliminary analysis

supports our predictions as the two treatment groups have differed significantly in survival, reproduction and behaviour. These results suggest our current understanding of the fundamental drivers of the cycle may need to be re-evaluated.
Biosketch: I am a PhD student at the University of Alberta studying population dynamics of the snowshoe hare cycle, with a particular focus on bottom up effects.

SESSION 5

ON THE MOVE

Immigrant female red squirrels pay a fitness cost after settlement but males do not
April Robin Martinig, Andrew McAdam, Ben Dantzer, Jeffrey Lane, Murray Humphries, and Stan Boutin
A central assumption of hypotheses for the evolution of animal dispersal is that dispersal incurs a cost, which is later compensated for through increased fitness. The empirical data needed to test this assumption are logistically challenging to collect. Using 30 years of demographic and genetic data from a population of North American red squirrels (*Tamiasciurus hudsonicus*) in southwestern Yukon, Canada we asked whether lifetime breeding success and longevity differed between residents and immigrants and their offspring. Immigrant females had lower lifetime breeding success and longevity than residents, while immigrant males had both higher lifetime breeding success and longevity, which was further supported by females producing more offspring sired by immigrant males. Daughters and sons born to immigrant females and sons born to immigrant males suffered lower lifetime breeding success relative to offspring born to residents. Our results suggest that dispersal benefits are sex-dependent and generally realized within, rather than across, generations. This is in contrast to theoretical models that predict compensation is necessary for the maintenance of dispersal and is suggestive of immigrants of both sexes dispersing for reasons that differ from why residents may stay. While immigrant females may be making the best of a bad lot, immigrant males appear to be able to compensate, while offspring of immigrants that settle locally remain at a disadvantage. To our knowledge, this is the first empirical demonstration of an intergenerational effect of immigration, making an important conceptual advance in our understanding of the drivers of dispersal.
Biosketch: I grew up in Ottawa, completed my B.Sc in Ecology and B.Sc. in Primatology at the University of Calgary, finished my M.Sc. in Montreal at Concordia University, and am now doing my Ph.D. at the University of Alberta. You can find updates on my research on my website (martinig.weebly.com).

Migratory connectivity: Connecting Common Nighthawk populations across the annual cycle
Elly Knight, Autumn-Lynn Harrison, Amy Scarpignato, Peter Marra, Steven Van Wilgenburg, Mark Brigham, and Erin Bayne
Conservation of migratory species is complicated by the varying environmental conditions that populations experience across the annual cycle. Understanding migratory connectivity - the strength of the connections between populations across seasons - is thus an important first step towards understanding when and where within the annual cycle conservation efforts are required. The Common

Nighthawk (*Chordeiles minor*) is a long-distance migratory bird with one of the largest breeding ranges in North America. The Common Nighthawk is declining, along with other aerial insectivore species in North America. We previously showed that males breeding in northeastern Alberta migrate to Brazil; however, the strength of migratory connectivity and migration routes for the rest of the breeding range remain unknown. To address this knowledge gap, we deployed Argos-GPS tags on 11 individuals from additional populations of Common Nighthawks across Canada and the US. All tagged birds appeared to migrate to the central flyway and then used a single migration route to South America, including populations breeding west of the Rocky Mountains. We thus found little migratory connectivity between populations during migration. The connectivity on the wintering grounds was also low, but individuals returned to the same breeding territory the following year. Our results suggest that variation in population trends for this species may be due to limitations on the breeding grounds or interactions between population-specific attributes and environmental conditions at other stages of the annual cycle.

Biosketch: Elly Knight is a fourth-year PhD Candidate at the University of Alberta studying the intersection between movement and habitat use of the Common Nighthawk. Elly is interested in avian conservation and has over a decade of experience in field ornithology.

Evaluating impact of reintroduced bison in Banff National Park

Lorina Keery, Mark Hebblewhite, Karsten Heuer, and Evelyn Merrill

Plains bison (*Bison bison bison*) have been absent from Banff National Park (BNP) since its establishment, primarily due to over-hunting. Reintroducing bison to BNP is an important step to restore the full diversity of species and natural processes in the Park's ecosystem. The reintroduction of a dominant ungulate is expected to have a significant impact on the ecosystem through grazing and physical disturbance. My research assessed what impact reintroduced bison had in the 18 ha soft-release pasture system. I examined a) bison diet in relation to forage availability b) forage selection patterns and c) how bison select for and use different land cover types. I also monitored the impact bison had on vegetation using a before-after control impact (BACI) experimental design. Data were collected in 2016 and 2017, before and after the bison were reintroduced. When bison grazed naturally, grasses consisted of 87% of their diet with forbs representing a minor component of their diet (0.4%). Consistent browsing on shrubs was observed throughout the year, comprising 12% of bison diet during the winter. Bison browsing consisted primarily of *Salix spp* (7%) with minimal browsing observed on other dominant shrub species. The results of this study will help Parks Canada managers develop monitoring programs and anticipate bison grazing impacts when the bison are free-roaming.

Biosketch: I am currently working on my Master's of Science at Royal Roads University in partnership with Banff National Park on the bison reintroduction project. I completed my undergraduate studies in Environmental Science in the biology stream at Simon Fraser University.

SESSION 6A

SPEED TALKS – SESSION 1

Genetic tagging in the Anthropocene: scaling ecology from alleles to ecosystems
Clayton T. Lamb, Adam T. Ford, Michael F. Proctor, J. Andrew Royle, Garth Mowat, Stan Boutin
The Anthropocene is an era of marked human impact on the world. Quantifying these impacts has become central to understanding the dynamics of coupled human-natural systems, resource-dependent livelihoods, and biodiversity conservation. Ecologists are facing growing pressure to quantify the size, distribution, and trajectory of wild populations in a cost-effective and socially-acceptable manner. Genetic tagging, combined with modern computational and genetic analyses, is an under-utilized tool to meet this demand, especially for wide-ranging, elusive, sensitive, and low-density species. Genetic tagging studies are now revealing unprecedented insight into the mechanisms that control the density, trajectory, connectivity and patterns of human-wildlife conflict for populations over vast spatial scales. Here we outline the application of, and ecological inferences from, new analytical techniques applied to genetically-tagged individuals, contrast this approach with conventional methods, and describe how genetic tagging can be better applied to address outstanding questions in ecology. We provide example analyses using a long-term genetic tagging dataset of grizzly bears in the Canadian Rockies. The genetic tagging toolbox is a powerful and overlooked ensemble that ecologists and conservation biologists can leverage to generate evidence and meet the challenges of the Anthropocene.
Biosketch: I am a PhD Candidate and Vanier Scholar at the University of Alberta. Seeker of wilderness, by foot, bike, and skis.

Shifting strategies: Calving and calf survival in a partially migration elk herd
Jodi Berg and Evelyn Merrill
Migration in large herbivores is advantageous when it affords access to high-quality forage and reduces predator exposure, but recently there have been dramatic declines in both migratory behavior and migratory populations across the globe. The Ya Ha Tinda elk herd has declined by 70%, and the migratory patterns are shifting towards residency and newer, low-elevation migration. During two time periods (2002–2006, 2013–2016), we assessed whether differences in selection for forage and avoidance of predation risk during calving contributed to shifts in the migratory strategies across time. Elk (n = 131) in all strategies consistently selected for forage, with limited evidence for trading off forage due to predation risk. Selection for forage exposed western migrants to high risk of bears, residents to high risk of wolves, and eastern migrants to low bear and wolf predation because they used areas of high human activity. We next examined intrinsic factors (e.g., sex, maternal condition) and the spatiotemporal scale at which multiple carnivore species, forage availability, habitat cover, and human activity affected calf survival for elk (n = 94) following two of the migratory strategies. Results were consistent with the recent decline in western migrants and increase in eastern migrants, showing that large-scale movements between summer ranges drive differences in survival as opposed to intrinsic factors or maternal effects. Our results are important to understanding the adaptability of migratory elk in the face of dynamic landscape conditions and what this means for persistence and conservation of migratory populations and behavior.
Biosketch: Having recently (and successfully!) defended my PhD, I'm now with the University of Wyoming Cooperative Fish and Wildlife Research Unit and Idaho Department of Fish & Game to examine years of deer, elk, and pronghorn migration across the state of Idaho.

Risky behaviour: Species and sex differences in contact during the breeding season may explain variation in Chronic Wasting Disease prevalence.

Kelsey Saboraki and Susan Lingle

Chronic Wasting Disease (CWD), a contagious and fatal disease that threatens populations of ungulates, is more common in mule deer than in white-tailed deer and in males of both species. The reasons for these differences in prevalence are unknown. We tested the hypothesis that species and sex differences in behaviour during the breeding season underlie species and sex differences in CWD prevalence in mule and white-tailed deer. We observed behavioural interactions between deer during the breeding season on an open grassland site, the McIntyre Ranch, in southern Alberta to assess whether species and sex differences in direct physical contact (deer to deer) and indirect contact (deer to environment to deer) correspond to the higher prevalence of CWD in mule deer and in males. We found that males exhibit sex-specific behaviours, such as marking vegetation and flehmen, that have the potential to elevate their risk of prion transmission relative to females. During courtship interactions, contact was more common in mule deer than in white-tailed deer, which could explain species differences in prevalence. As females are in estrous for only 1-2 days while a successful male engages in high-risk courtship throughout the rut, these results show that males of both species should have a higher cumulative potential for prion transmission throughout the breeding season. By collecting empirical data on the fine-scale behaviour of sympatric mule deer and white-tailed deer during the breeding season, we identified mechanisms that could be responsible for the higher prevalence of CWD in mule deer and in males.

Biosketch: Kelsey Saboraki is a graduate student at the University of Winnipeg, pursuing a Master of Science in Bioscience, Technology and Public Policy. Kelsey is investigating whether variation in social behaviour can explain differences in the prevalence of CWD between mule deer and white-tailed deer, and between males and females.

How do boreal predators coexist on a working landscape? Exploring spatiotemporal co-occurrences of large and medium bodied carnivores in northern Alberta

Erin Tattersall and Cole Burton

Interspecific interactions are an integral aspect to ecosystem function, and maintaining them is critical to protecting biological communities in an increasingly anthropocentric world. In northern Alberta, industrial landscape change creates a novel playing field on which these interactions take place. As boreal mammal species adapt to new landscape patterns, a key question for ecologists is how species are able to coexist with one another, and what interspecific interactions govern their use of the working landscape. Using camera traps deployed southwest of Fort McMurray, we surveyed boreal mammals to determine whether interspecific interactions affected occurrences of black bears (*Ursus americanus*), coyotes (*Canis latrans*), and lynx (*Lynx canadensis*) within a seismic line network. We hypothesized that top-down influences from apex predators – wolves (*Canis lupus*) – would produce spatiotemporal relationships between occurrences of interacting species on linear features. Black bears showed positive associations with wolves at fine (daily) spatiotemporal levels, coyotes at coarse (weekly) spatiotemporal levels, and lynx exhibited spatial overlap with both wolves and their prey. Further, all three species responded individually to level of anthropogenic disturbance, but interspecific interactions were not affected. The positive association between wolves, black bears, and coyotes suggest a facilitative interaction in which wolves provide scavenging subsidies for the two non-apex predators and spatial overlap between wolves and lynx point to benefits of co-occurrence for these two species as well. These

results highlight important considerations of the impact of single-species management decisions, as well as re-inforce the value of apex predators to healthy ecosystems.
Biosketch: I am a M.Sc. student in the WildCo lab at UBC Vancouver. My work involves using camera traps to explore large mammal community dynamics on the working landscape in northern Alberta, examining interspecific interactions and understanding how mammals respond to seismic line restoration.

Should we keep flying to count deer? Reliability of indirect measures for white-tailed deer populations
Mariana Nagy-Reis, William Jensen, and Mark Boyce
Ungulate populations in North America are typically assessed with aerial surveys, an exceptionally expensive method that requires specific flight and snow conditions. Because flight conditions vary, we obtain inconsistent population indices and population estimates. To deal with this, many wildlife agencies collect other sources of data such as harvest statistics, citizen science, and collision reports. Here, we assessed the use and reliability of seven alternative indices (harvest density, hunter success, hunter observation rate adjusted by snow conditions, fawn:doe ratio in harvest, fawn:doe ratio observed by hunters, average days hunting, and number of deer-vehicle collisions) to infer white-tailed deer abundance and density. We used data collected from 2010 to 2017 in 31 hunting units in North Dakota and investigated correlations between winter aerial survey data and alternative indices. We then assessed the potential of each index in predicting white-tailed deer density using linear mixed models (LMM) to account for variability among hunting units. Deer counts from aerial surveys did not correlate with any alternative index, but deer density was positively correlated with harvest density and average days hunting. Although these correlations were statistically significant ($P<0.001$), the strength of the correlations was relatively low ($rs <0.4$). In addition, based on model fit of LMM, all alternative indices poorly predict white-tailed deer density ($R^2 <0.2$), suggesting that these might not be reliable for setting harvest regulations.
Biosketch: I am interested in mammal ecology, behavior, conservation, and management. My goal is to answer real-world questions and deliver wildlife research that is tailored to guide animal conservation plans and science-based management.

Integration of remote camera data among projects for better management of mammals in Alberta
Jim Schieck
During the past 5 years, remote (trail) cameras have become a common method to survey mammals. When an animal passes in front of the camera, its body heat and movement trigger a picture. Remote cameras work well in a wide variety of environments, and only need to be visited once per year to change batteries and SD cards. Remote cameras collect high-quality information for approximately 25 large and mid-sized mammals in Alberta, with a further 20+ species detected to a lesser degree. Although individual camera studies often are focused on localized areas, by combining information among studies much of Alberta is being presently being sampled. It is not a trivial task, however, to combine information among studies. For the information to be useful: i) data must be collected using standardized protocols so that detection rates are comparable, ii) images and metadata for each study must be documented so that information can be used appropriately, and iii) information must be sharable so that it can be accessed by a variety of analyses teams. In addition, costs of data entry and species tagging must be low or organizations will use their own platforms. Alberta researchers have started to explore ways to integrate camera data, but a number of non-connected systems continue to

be used. Resolving the outstanding issues is required for integration to move forward. Now is the time to act to preserve the camera data that are being collected!
Biosketch: Jim received his BSc and MSc from University of Western Ontario, PhD from University of Alberta, post Doc from Simon Fraser University, and is an adjunct professor at the University of Alberta. Jim's research interests include avian ecology, population dynamics, community ecology, forest ecology, and conservation biology.

Large-scale monitoring strategies using passive acoustic sensor technology
Alexander MacPhail and Erin Bayne
Increasingly, ecologists are using passive acoustic recording technologies to monitor vocalizing species. The Bioacoustic Unit is a collaboration between the University of Alberta and the Alberta Biodiversity Monitoring Institute. Our research group develops tools, protocols and recommendations for monitoring programs across the country for citizen scientists, industrial partners and all levels of government. We have found that large-scale species monitoring programs can be designed around these technologies that limit human intervention while collecting large amounts of data. However, the scale at which data collection, storage and analysis takes place can grow exponentially and requires novel approaches for these "big data". Integrating traditional monitoring techniques (e.g. point counts) is also vital to understand the ongoing changes in the natural world. Machine-learning and neural networks for multi-species recognition are also in development in tandem with single-species recognizers to expand our knowledge of species occupancy and habitat use. We have been able to develop strategies to monitor rare and elusive species, species-at-risk and the biophonic community. WildTrax is our newest online tool for storing, managing, processing, and sharing biological data collected using sensor technology. It serves as a centralized location and database to host, manage, and analyze large quantities of digital data collected via environmental data sensors; currently it supports remote cameras and acoustic recorders. We will be presenting our current work and strategies on how best to manage large-scale environmental sensor data, applications for species monitoring and management and future goals to keep with the newest technologies and techniques.
Biosketch: Alex MacPhail is the Research Coordinator for the Bioacoustic Unit. He will be presenting on large-scale monitoring strategies, data integration and sharing of environmental sensor data (acoustic recording units and remote camerasacross Alberta and at the national scale.

SESSION 6B

SPEED TALKS – SESSION 2

Evaluation of citizen science to measure bobcat (Lynx rufus) trends in an urban environment
Sarah Julin, Brad Taylor, and Vanessa Carney
This study aims to determine changes in bobcat trends within the City of Calgary, and this will be completed by assessing citizen science data. The data for this project was collected through the City of Calgary Parks 311 reporting system. This is a citizen reporting method where citizens call to report wildlife or other issues in their neighbourhoods. A total of 2078 calls reporting sightings of bobcat/lynx were obtained. In order to validate these calls as they were from the public, a survey was sent out to determine if the public can correctly identify wildlife. The survey consisted of 9 questions; 5 of these

questions asked the public to identify bobcat, 1 question asked to identify cougar, 1 question asked to identify marmot, and 2 questions asked the respondents their level of wildlife related training and their closest urban centre. Each wildlife identification question contained four pictures and respondents were asked to decipher between each photo to identify the animal in question. Through a brief analysis of the results, it was found that 76% of the public were able to correctly identify wildlife. This information will be used to develop a correction factor that will be applied to the 2078 calls to give an estimate of the percent of these calls that were correct in their identification. A further analysis of the results is yet to be completed.

Biosketch: I am in my final semester of the Bachelor of Applied Science in Ecosystem Management at Lethbridge College. My early interest in the outdoors and wildlife turned me towards this program, and I hope to become a wildlife biologist in the future!

Wildlife corridors and connectivity

Simon Ham, Jesse Whittington, Robin Baron, Dan Rafla, and Bill Hunt

Wildlife corridors are an important conservation tool for maintaining landscape connectivity where narrow bands of habitat are fragmented by rugged topography, water bodies and human developments. In the late 1990's Banff National Park improved connectivity for wildlife around the Town of Banff by relocating facilities and by reducing human use in wildlife corridors. Our objectives were to monitor wildlife use of corridors in the Bow Valley and to identify additional restoration actions to improve connectivity and reduce human wildlife conflict. We assessed wildlife use of corridors in the Bow Valley using snow tracking surveys, backtracking, predation sites, human-use data, and GPS collar locations of wolves and grizzly bears. Snow transect data from 1993 to 2018 show corridor use varied considerably over time. Corridors improved connectivity, yet overall carnivores used corridors less than reference transects away from town. Key predictors of corridor use were snow depth, slope, adjacent human use and the amount of high quality habitat. Wildlife movement close to high human use areas can lead to human wildlife conflict incidents. We recommend restoration actions to reduce attractiveness of habitat adjacent to residential areas, clear wildlife travel routes within wildlife corridors, reconfigure hiking trails to improve both visitor experience and habitat connectivity, and further reduce human use within wildlife corridors. Wildlife corridor restoration has been a successful tool for improving connectivity and reducing human wildlife conflict in Banff National Park.

Biosketch: As a Resource Management Officer in Banff National park I have been involved in monitoring wildlife in the Bow Valley for two decades. I currently coordinate the wildlife corridor monitoring in Banff during the winter and work with Human Wildlife Conflict during the summer.

Crossing structures reduce wildlife mortality in the Bow Valley

Eleonore Lebeuf-Taylor and Hannah Edwards

Wildlife in the Bow Valley is under increasing pressure from intensifying human activity in the area. In particular, vehicle traffic is on the rise on the Trans-Canada Highway through the Bow Valley east of Banff National Park -- in an important wildlife corridor -- threatening the integrity of wild populations due to both habitat fragmentation and collision-related wildlife mortality. Since 1999, a total of eight highway crossing structures and fencing have been installed as mitigation measures. In order to evaluate their effectiveness, we present evidence from over 10,000 wildlife events captured by wildlife cameras placed at the crossing structures since 2008. Our multi-species analysis shows that, after a period of habituation, these structures effectively reduce the number of wildlife-vehicle collisions along this

section of highway. Moreover, we show that carnivore and ungulate use of the crossing structures varies temporally, with intensifying use around dawn and dusk, as well as during the summer months; we also demonstrate that human foot and vehicle traffic negatively impacts wildlife use. Collectively, these results suggest that crossing structures and fencing are an important mitigation measure that reduce the impact of roads on wildlife populations in the Bow Valley.

Biosketch: Eleonore Lebeuf-Taylor is interning with the Kananaskis Ecology team in Canmore. When she isn't looking at how animals navigate the challenges of life in the Bow Valley, she can be found going up a mountain by ski or rock shoe.

Environmental Student Video Project - Why do Wildlife Matter?

Emily Thoroski

I am completing my Honours Thesis in my final year as an undergraduate student at the University of Manitoba. For my thesis, I am investigating why wildlife matter by gathering the perspectives of wildlife professionals, professors, and students. I am creating an environmental video of my findings to help build a resource that can be used as an educational tool and as a source of environmental inspiration. I was able to travel to the 25th Annual Conference of The Wildlife Society in Cleveland, Ohio in 2018. I interviewed 16 wildlife professionals from across North America, as well as a few students who attended the conference. For my speed talk, I will be discussing the results of my research and work towards engaging the audience in the quick presentation, where I will touch on the most important aspects. I hope to create inspiration and awareness to members as to why wildlife matter, and why we as students, professionals, and as The Wildlife Society need to work towards conserving wildlife species. And most importantly why we need to stress the importance of getting the public and the majority of the human population aware and educated on our research, and to build passion for the future of wildlife conservation. Why Should we Care? Why do Wildlife Matter?

Biosketch: I am an undergraduate student in the Clayton H. Riddell Faculty of Environment, Earth and Resources at the University of Manitoba. I have been a proud member of The Wildlife Society since 2016, and am looking very forward to the Conference in Canmore in March of 2019!

Seeking refuge: Avian community composition in boreal relicts as contemporary analog for future boreal hill systems

Cesar Estevo, Diana Stralberg, and Erin Bayne

Boreal forests are projected to retreat and shift northward due to climate change, thus decreasing habitat availability for several boreal songbirds. Areas relatively buffered and decoupled from regional climate conditions may provide refugia for wildlife and serve as meaningful conservation units. The relict character of Cypress Hills, an isolated montane forest within a grassland matrix in southern Alberta, Canada may provide insight about current and future refugia potential in boreal hills. Our objective was to evaluate characteristics of future boreal refugia potential by comparing similarities in bird communities among boreal relicts and hills. We used autonomous recording devices (N=166) to record songbirds in four hills distributed along a latitudinal gradient (from south to north: Cypress Hills, Marten Hills, Buffalo Head Hills, and Watt Mountain). We identified songbirds in 3-min point counts at dawn (N= 622 point counts) and generated a compositional dissimilarity matrix using the Jaccard index. We then performed both a permutational multivariate analysis of variance and an analysis of similarities to verify

whether communities differ by site. Overall, communities of the three northmost sites were more similar to each other (>70% similarity) than to Cypress Hills (<45% similarity). Both analyses indicated that site assemblages differed significantly (permutation: pseudo-F = 20.91; analysis of similarity: R = 0.69, $p<0.05$). These results suggest that community composition differs substantially between boreal relicts and hills and indicate how future boreal refugia might look like. The presence of common species might also suggest that future refugia may contain only a subset of boreal species.
Biosketch: Wildlife biologist specialized on climate change, species distribution and conservation strategies.

Nest site surveys and distribution of Black Swifts in Jasper National Park
Julien St-Amand and Brenda Shepherd
Black Swifts are high-altitude aerial insectivores known to nest almost exclusively near waterfalls. Like many other aerial insectivore bird species, Black Swift numbers have declined by > 50% from 1970 to 2018 and the species was designated Endangered by the COSEWIC in Canada. Nesting site identification is challenging because the birds spend the day foraging at an average altitude > 3 km above sea level and nests are concealed in steep canyons with limited access. In Canada, approximately 20 nesting sites have been confirmed, including seven in the Rocky Mountain National Parks. Nesting site identification is key to managing recreational activities that may affect breeding Black Swifts in canyons and waterfalls. In 2017-2018, we inventoried waterfalls and conducted daytime visits to assess nesting site suitability based on habitat requirements. To determine Black Swift occupancy at waterfalls, we conducted standardized surveys at dawn and dusk to detect adults as they left or returned to the nest. We inventoried 97 waterfalls in Jasper National Park, identified 24 suitable nesting sites during daytime visits and confirmed three new nesting sites during surveys. We used our results to improve the management of recreational activities and better protect Black Swifts in Jasper National Park.
Biosketch: Julien currently works as a Resource Management Officer in Jasper National Park. He has been working on avian Species at Risk since 2012 with Parks Canada and Environment Canada, focus species included: Williamson's Sapsucker, Black Swift, Lewis' Woodpecker, Yellow-breasted Chat, Barn Swallow and Bank Swallow.

A reclamation and wildlife success story in Alberta's Rocky Mountains
Beth McCallum
Over the past four decades there has been a rapid evolution of reclamation procedures and methods applied to lands disturbed by resource extraction. Reclamation speeds the return of ecosystem function, while minimizing the environmental degradation that might otherwise occur. Reclamation of lands disturbed by open pit coal mining in west-central Alberta has produced a diverse wildlife community including at-risk species like the grizzly bear and some of the world's largest bighorn sheep. This case study features reclamation procedures and design elements implemented at the Luscar and Gregg River mines located 50 km south of Hinton. Truck and shovel mining techniques and reclamation in this foothill environment have maintained connectivity and produced productive habitat voluntarily colonized by local alpine and subalpine wildlife species. The presence of an intact large carnivore component has implications for mine closure planning.

Biosketch: Beth MacCallum has worked in Alberta's east slope since graduating from the University of Calgary's Faculty of Environmental Design in 1991. She has experience in wildlife inventory, impact assessment, and reclamation to wildlife habitat. She is a specialist in bighorn sheep and Harlequin Duck biology.

POSTERS

Listed alphabetically by lead author's surname

Common nighthawk monitoring in Jasper National Park

Serge Aucoin and Brenda Shepherd

The common nighthawk was listed Threatened in Canada on account of an estimated decline of half of its population since 1968, and reassessed in 2018 to a status of Special Concern. Annual population indices estimated between 1970 and 2015 across the Northern Rockies (Bird Conservation Region 10) indicate a relatively stable trend in population abundance for the Region, and only past anecdotal information indicates nesting occurs in Jasper National Park. We deployed acoustic recorders to examine common nighthawk activity patterns (territorial calling) in the Park to help determine if breeding occurs today. From 2016 to 2018, over 9800 hours of audio recordings were collected across suitable nesting habitat (open to semi-open areas near freshwater) and analyzed using a detection algorithm (species recognizer). Results indicated that the common nighthawk remains a small but consistent component of the bird community across Jasper National Park but that nesting is likely a rare occurrence (no breeding activity was found). Although many of the lower elevation areas in the Park provide suitable breeding habitat, common nighthawks identified in Jasper National Park are more likely to be transient species, preferring to breed outside mountain areas. Future studies should focus on understanding how ecological factors (elevation, low insect abundance) are related to low population abundance in the region.

Biosketch: Resource Conservation Officer, Jasper National Park Field Unit.

Predator control in an oil and gas landscape: Grey wolf (Canis lupus) habitat selection pre- and post-cull

Katie Baillie-David, Jason Fisher, and John Volpe

Predator control is a common wildlife management strategy to stabilize vulnerable prey populations. Past research has focused on the effects of predator control on the abundance and distribution of either prey or competing predator populations. However, fewer studies have measured the impact of predator control on the distribution of the focal predator. The objective of this research is to determine whether a prescribed culling of grey wolves *(Canis lupus*) alters their habitat selection in an oil and gas landscape. Using camera trap data, I will test whether grey wolf occupancy as it relates to natural and anthropogenic landscape features differs as a result of lethal removal. The camera trap array is located in a 3000 km2 area of boreal forest, 150 km southeast of Fort McMurray, Alberta. Prescribed wolf culling has taken place in this area for approximately two years. I will utilize two multi-year camera trap datasets: a "pre-cull" dataset, collected from October 2011 to October 2014, and a "post-cull" dataset, which has been collecting continuously since October 2017. Across the province of Alberta, the use of predator control to conserve threatened woodland caribou (*Rangifer tarandus caribou*) has increased since 2017, despite conflicting evidence of its effectiveness. Understanding how these population

reductions affect the target predator species will allow for more informed predator control schemes. Future research will examine the habitat selection response among competitors and prey following the wolf culling.

Biosketch: Katie Baillie-David is currently a Master of Science student in the School of Environmental Studies at the University of Victoria. She completed her Bachelor of Science in Biology at the University of Ottawa in 2017. Katie is an avid wildlife photographer and lover of memes.

Comparing interspecific differences in ungulate habitat use in response to coal mine reclamation

Meghan Beale, Beth MacCallum, and Mark Boyce

Extracting coal through surface mining can drastically alter natural habitats and is associated with substantial changes to vegetative and topographic structure. Reclamation aims to mitigate effects of mining on environment and wildlife by revitalizing ecosystem functioning and returning landscape to useable habitat. Our study site in west-central Alberta boasts reclaimed mines inhabited by sympatric ungulate populations and thus provides a site to compare interspecific differences in response to mining and reclamation. We used direct ground counts employing a fixed survey route to obtain count data for bighorn sheep, elk, and mule deer between 2004-2017. We modelled habitat selection by fitting exponential resource selection functions using logistic regression and employing a used vs. available design. Our results demonstrate that ungulates selected landscape features to increase forage quality and decrease predation risk. Sheep strongly selected for high walls whereas elk and deer strongly selected for reclaimed grasslands. Sheep and elk selected for haul roads, which might be attributed to seeking human refuge. Deer avoided haul roads and selected disturbed areas, which was opposite to elk. Predicted relative habitat selection was highly correlated between sheep and deer, indicating high habitat overlap. Predicted relative habitat selection was less correlated for deer and elk, supporting that these species have different habitat requirements. Understanding interspecific differences in response to external environment are crucial for industrially modified landscapes, where humans wholly influence landscape design. Findings from our study become increasingly relevant as end land-use strategies for reclaimed mines in our study area are devised and eventually implemented.

Biosketch: Meghan Beale was born in Ontario and moved to Alberta to complete her Masters of Science at the University of Alberta in ecology. Meghan is passionate about nature, wildlife, and adventure in the mountains. During her free time, Meghan can be found rock-climbing, alpine touring, hiking, and paddling.

Fragmentation of polar bear habitat in Hudson Bay

Brooke Biddlecombe

Habitat fragmentation is the separation of continuous habitat into smaller, more isolated patches, and often occurs in conjunction with habitat loss. Habitat fragmentation is most commonly studied in landscapes, but Arctic sea ice also experiences fragmentation, although exploration of the extent and effects are limited. Arctic marine ecosystems are characterized by seasonal or constant sea ice cover, and changes in sea ice area, thickness, or duration of cover have the potential to threaten the survival of one or many of the organisms that inhabit these ecosystems. Negative changes in sea ice caused by climate change may decrease polar bear habitat quality and hamper the fundamental processes of their survival. I focused my analyses on the western Hudson Bay polar bear subpopulation and their sea ice habitat during the spring sea ice break up period from 2013-2018. Most fragmentation analyses are conducted using patch-based metrics, which are restrictive for sea ice, as sea ice does not show clear

delineated patches, but rather, shows more gradual changes between sea ice concentrations. Thus, I used spatial autocorrelation on a small-scale, equivalent to the distance an individual bear can travel in one day, to assess sea ice fragmentation to retain as much detail as possible, and reduce error caused by ineffectively delineating patch types. I will present preliminary results using the variation in spatial autocorrelation throughout the break up period to visualize both temporal and spatial patterns of sea ice fragmentation at a scale that is relevant to individual polar bears.
Biosketch: Brooke is a Master's student at the University of Alberta, supervised by Dr. Andrew Derocher. She is driven to learn more about how changes in sea ice extent affect Arctic marine ecosystems. Alongside her studies, Brooke is also the President of University of Alberta Chapter of the Wildlife Society.

Monitoring ecosystem dynamics in the Beaufort Sea using stable isotopes in polar bears (Ursus maritimus)
Nicole Boucher, Andrew Derocher, and Evan Richardson
Longitudinal studies on the diets of apex predators can be used to understand the effects of environmental changes within an ecosystem and to monitor shifts in community dynamics. Using nitrogen and carbon stable isotopes in polar bear (*Ursus maritimus*) guard hairs, we examined their diet in the Beaufort Sea from 2003 to 2011. We investigated how stable isotope values were related to population demographics, sea ice dynamics, climate indices, and an index of ringed seal (*Pusa hispida*) reproductive productivity (ovulation rate). Bayesian stable isotope models were implemented to determine annual variation in diet proportions and niche widths. The main component of the polar bear diet was ringed seal with contributions from bowhead whale (*Balaena mysticetus*), beluga (*Delphinapterus leucas*) and bearded seal (*Erignathus barbatus*) that varied by age, sex, reproductive status, and year. Sea ice dynamics, summer Arctic Oscillation, and air temperature were related to polar bear diet, suggesting that polar bears forage adaptively in response to environmental changes, and availability and accessibility of prey. Polar bear diet proportions and niche widths fluctuated with ringed seal productivity, highlighting the biological link between these species and the potential role polar bears can play in monitoring changes in Arctic marine ecosystems.
Biosketch: Nicole Boucher is currently a PhD student studying moose calf survival in interior British Columbia. She completed her M.Sc. in 2018 at the University of Alberta, with research conducted on spatial and temporal variation of stable isotopes in polar bears and ringed seals in the Beaufort Sea.

Evaluating the risks and impacts of rapidly expanding invasive wild pigs across the Canadian landscape
Ryan Brook
Wild pigs (*Sus scrofa*) are a free-ranging invasive species that are comprised of hybrids of Eurasian Wild Boar and domestic pigs that escaped or were released from meat and penned shoot farms across Canada and have rapidly expanded their range to > 750,000 km^2. They are one of the most prolific and destructive large mammals on earth. Here I outline my research program aimed at characterizing: (1) the genetic status of wild pigs in Canada, (2) crop damage patterns and trends, (3) spatial overlap of wild pigs and livestock at multiple scales, (4) disease status of wild pigs and specific risks to livestock, (5) impacts on native ecosystems and species at risk, (6) distribution, density and spread, (7) social perspectives, and (8) current management strategies. Methods include GPS satellite collaring, trail camera networks, citizen science trail camera images from hunters, telephone surveys, interviews, bounty data, stakeholder mapping workshops, and necropsies of harvested animals. Results show that

wild pigs are expanding rapidly, especially in Alberta, Saskatchewan, and Manitoba. Rural Canadians have highly variable awareness of the presence of wild pigs in their province, with respondent awareness increasing with increased wild pig distribution. Management efforts are limited, largely uncoordinated, and few provinces have formalized strategies and none have monitoring programs. Few conservation organizations are engaged in monitoring or control efforts. Given the overall lack of action, rapid and widespread expansion of wild pig populations in Canada is expected to continue and the window for potential eradication is closing rapidly.

Biosketch: Dr. Ryan Brook is an associate professor at the University of Saskatchewan. His interdisciplinary research team is focused on the wildlife-livestock interface, working with aboriginal people, linking traditional and local knowledge with science, youth engagement in field research, and he has side hustles in the arctic and the jungle.

Ecological and behavioural mechanisms underlying reproductive isolation in mule deer and white-tailed deer

Rebecca Carter

Hybridization between two genetically distinct species can be beneficial as it introduces genetic variation to the population allowing the potential to adapt to changing conditions. However, hybrids may have lowered survival and lead to the potential extinction of the parental species. White-tailed and mule deer are closely-related species that are similar in their life histories. Hybrids have been reported across the species' zone of overlap, however the exact mechanisms that facilitate or prevent this interbreeding are not well understood. My objectives are to identify ecological conditions and behavioural mechanisms that prevent or facilitate the reproductive isolation of mule deer and white-tailed deer. To test whether behavioural barriers influence heterospecific courtship, I conducted focal observations on individuals in same- and mixed-species groups to record social and courtship interactions within and between species. I will use video recordings to analyze the specific form of courtship and the outcome of courtship interactions. To test for ecological barriers, I recorded the position, size, and composition (species, sex, and male size) of all deer groups within approximately 1km of the focal group, to analyze where on the landscape mixed species groups occur and what habitat variables may facilitate this. My project will fill a critical gap in the knowledge about what role ecological and behavioural mechanisms play in the interbreeding between two sympatric species, and will inform will act as a guide for management plans aimed at protecting the kind of habitat that fosters genetically distinct populations of white-tailed and mule deer.

Biosketch: I'm currently doing my MSc at the University of Winnipeg, studying potential ecological and behavioural mechanisms that may facilitate or prevent hybridization between mule deer and white-tailed deer in southern Alberta. I am love researching animal behaviour and hope to contribute to the conservation of species and their habitats.

"Pine-ing" for cover: Caribou & grizzly bear response to mountain pine beetle in west-central Alberta

Siobhan Darlington, Laura Finnegan, Gord Stenhouse, and Terry Larsen

Mountain Pine Beetle (MPB) infestations have become a pervasive management problem in Alberta, following expansion from neighbouring British Columbia (BC) in 2006. Areas of primary concern include the eastern slopes of the Rocky Mountains where mature lodgepole pine (*Pinus contorta*) stands are abundant and susceptible to MPB attack. Large-scale infestations can affect a multitude of forest values including habitat for provincially threatened caribou (*Rangifer tarandus*) and grizzly bear (*Ursus arctos*).

Previous research in BC suggests caribou use grey-attack stands more than clear-cut and salvage-logged stands, whereas ongoing research on grizzly bears suggests increased food supply in MPB affected stands. However, there have been no quantitative assessments of how caribou and grizzly bear respond to MPB infestations over time in Alberta, and current habitat models do not consider these species' responses to MPB-killed forest. To address these knowledge gaps, we are developing population-level Resource Selection Functions at multiple spatial and temporal scales. To do this, we are using long-term caribou (20 years) and grizzly bear (13 years) telemetry data along with GIS data for forest composition (i.e. amount of pine forest), levels of MPB mortality, as well as anthropogenic disturbances (well sites, cut blocks, roads, seismic lines). We hypothesize that caribou will avoid MPB affected areas because of a probable decrease in lichens, whereas grizzly bears' use of pine would increase due to an increased food supply. These models will be used to evaluate species response to pine and MPB-killed pine, and develop an interactive web-based planning tool for forest practitioners.
Biosketch: I am originally from Halifax Nova Scotia and recently completed my Master's Degree researching white-tailed deer habitat selection and movement in Northeastern Alberta with the University of Victoria. I now work as a research assistant with fRI's Caribou Program out of Hinton, Alberta.

Beavers (Castor canadensis) as bioindicators of trace element contamination in northern Alberta
Melissa Dergousoff, Beatriz Bicalho, Iain Grant-Weaver, Glynnis Hood, and William Shotyk
The increasing rate of industrial expansion in the Athabasca Bituminous Sands region of northern Alberta has raised concerns regarding trace element contamination of country foods, including local wildlife species. As trace elements are naturally occurring, the challenge is to determine the degree to which commonly trapped species like beavers are exposed to inorganic contamination from anthropogenic sources (Ag, As, Be, Cd, Pb, Sb, Tl). Our team worked with local trappers and industry professionals to collect tissue samples from industrially impacted (mining and bitumen upgrading facilities) and non-impacted sites across northern Alberta. We used inductively coupled plasma quadrupole mass spectrometry (ICP-QMS) to conduct comparative analyses of trace elements in the liver, kidney, and muscle tissue of beaver, using the metal-free, ultraclean SWAMP lab facility. Our goal is to determine whether beavers can serve as bioindicators of trace element contamination from anthropogenic activities like surface mining and bitumen upgrading. Ultimately, our research enables us to explore the potential impacts of anthropogenic activity on wildlife in northern Alberta, and provide a methodology for future research to continue with other culturally important species such as moose, muskrat, and otter from industrially impacted and control locations.
Biosketch: Melissa is a Master's student at the University of Alberta studying Wildlife Ecology and Management.

Analysis of mule deer (Odocoileus hemionus hemionus) contact rates in a CWD endemic area
Maria Dobbin, Evelyn Merrill, Eilidh Smith, Peter Smolko and Johanna Thalmann
Chronic wasting disease (CWD) is a fatal disease of cervids that was detected in Alberta in 2005 and has been spreading eastward in the province ever since. CWD is transmitted by prions through direct contact with infected individuals and via contaminated environment. We quantify seasonal contact rates of male and female mule deer in Eastern Alberta using GPS-proximity collars and direct observations as inputs into models of CWD transmission and spread. We contrast relative contact rates during winter using seasonal overlap in range use (volume of intersection), 2-hr GPS locations, and contacts based on

proximity collars to determine the effect of spatial and temporal scales on estimates of contact rates. We then compare factors influencing contact metrics at these scales to predict the relative probability of the contact at a spatial location during monthly time periods. We use data from 35 deer in winter when deer are most concentrated and contact rates are highest. Initial results indicate contract rates of female deer are greater relative to males, occur primarily in agricultural areas and are most frequent just after nightfall. Overall contacts are highest during crepuscular periods although there is greater variability in males. These data will be useful in relating relative contact rates to prevalence of CWD and can inform management harvest strategies that target individuals most likely to transmit the disease.
Biosketch: Maria Dobbin recently graduated from Memorial University of Newfoundland and am currently completing my master's thesis in Dr. Evelyn Merrill's lab at the University of Alberta.

Grizzly bear habitat selection adjacent to recreational trails
Sarah Elmeligi, Owen Nevin, Gordon Stenhouse, David Gummer, Joseph M. Northrup
Human recreation can impact grizzly bears indirectly by changing habitat selection and movement patterns. We examined how the level of human use on recreational trails impacted grizzly bear habitat selection in Banff, Yoho, and Kootenay National Parks. We used GPS collar data from 2012 to 2015 from 27 different grizzly bears. Using data from remote cameras, we estimated human use on all trails in the parks. The human use model was subsequently used as a covariate in a step selection function (SSF) to define grizzly bear habitat selection likelihood based on movement patterns through various habitat characteristics, including human use on trails. The SSF revealed that grizzly bears consistently selected for higher quality habitats, irrespective of human use levels. The SSF results indicated a high degree of individual variation in grizzly bear habitat selection in relation to trails; most bears selected areas closer to low human use trails but only some bears selected areas farther from high use trails. Grizzly bears showed increased movement during the day, and most bears crossed trails more often than expected during the day. Grizzly bears in the study area were willing to access high quality habitat near human use features and during times when people were active, showing a degree of tolerance for humans. The data suggests bears in the study area may be using trails as movement pathways to access high quality habitat. Management recommendations to improve connectivity therefore include ensuring spatial and temporal human use levels of trails accommodate grizzly bear movements.
Biosketch: As an interdisciplinary scientist, Sarah Elmeligi's Masters and PhD research focused on the relationship between recreationists and grizzly bear habitat use in Northern BC and Alberta's Rocky Mountains. Her career has centred on improving human-bear coexistence, reducing conflict, improving grizzly bear habitat security, and defining applicable management solutions.

Evaluating population parameters of ungulates using trail cameras
Jennifer Foca and Mark Boyce
Population measurements are needed to inform science-based wildlife management plans. Trail cameras offer a low cost, non-invasive, safer alternative to methods such as aerial surveys or methods that require capturing animals. This study will be conducted in Elk Island National Park (EINP), an enclosed park with closed populations of five species of ungulates (elk, mule deer, white-tailed deer, moose, and bison) that have been monitored using aerial surveys. This presents a unique opportunity to evaluate the efficacy of camera trap methods. Due to the fenced perimeter, wildlife movement is restricted, and predation is limited. Active ungulate population management is necessary to protect the ecological integrity of the park. Previous management strategies such as translocation can no longer be

used for cervids due to the risk of spreading chronic wasting disease. As park management explores alternatives to control ungulate populations, more robust population data are needed. South of EINP is Cooking Lake-Blackfoot Provincial Recreation Area. Blackfoot is an enclosed natural area with similar habitats as in EINP. Blackfoot is managed very differently, allowing livestock grazing, limited industrial activity, and Aboriginal and licenced hunting. These adjacent areas provide an excellent opportunity to compare ungulate density and demographic data. Trail cameras have great potential for collecting robust demographic data and may be an option to replace park aerial surveys in the future. We will evaluate alternative models for camera data analysis of unmarked individuals, with the intent of establishing a protocol for obtaining yearly ungulate abundance estimates and demographic data using trail cameras.

Biosketch: Jennifer Foca is a graduate student (MSc) in the Boyce lab at the University of Alberta. Her interests include population ecology, spatial ecology, non-invasive monitoring techniques, and the development of accessible tools to support science-based wildlife management.

Canada warbler response to vegetation structure on regenerating seismic lines

Jocelyn Gregoire and Erin Bayne

Seismic lines have an extensive footprint in northeastern Alberta through habitat removal, degradation and fragmentation. Predominantly left to natural regeneration, there is an abundance of legacy features that are still in the early stages of succession. This state has been perpetuated by their frequent use as human and animal corridors. Seismic line restoration has since become a priority for academic researchers, conservation groups and industry, however, their attention has focused largely within caribou habitat. Upland deciduous and mixed-wood forests in the boreal are an important source of breeding habitat for many species of migratory songbirds. This includes species at risk, such as the Canada Warbler. My research applies acoustic localization to understand how Canada Warbler movement is influenced by vegetation structure on regenerating seismic lines. This technique uses a grid of GPS time-synchronized recorders to precisely locate singing males without human interference. Results indicate that a threshold level of vegetation structure is required for their presence along the edge and movement across the line. This can be characterized by tall shrub encroachment and the presence/absence of specific shrub species. Additional research is being done on alternative field methods that can be conducted with a higher efficiency and result in greater sample sizes. While accurate data is crucial to conservation, proactive research requires efficient data collection to produce timely management strategies.

Biosketch: Jocelyn is a MSc student at the University of Alberta in Dr. Erin Bayne's lab. Her research aims to inform the reclamation of linear features in Alberta's boreal forest and ensure the persistence of a species at risk, the Canada Warbler.

Plains bison reintroduction to Banff National Park

Caroline Hedin

In summer 2018, Parks Canada released 31 wild plains bison into the backcountry of Banff National Park after translocating the animals from Elk Island National Park in 2017 and holding them in a soft-release pasture for 1.5 years. This is part of a 5-year pilot project to explore the feasibility of long-term bison restoration. Following an in-depth evaluation at the conclusion of the pilot project, Parks Canada will decide to maintain the project, expand the vision, or if necessary, withdraw from the initiative.

Biosketch: Caroline Hedin is the Public Outreach Education Officer for the reintroduction project who has promoted bison conservation with Parks Canada for over 7 years.

Spatial separation during the caribou rut as a mechanism of reproductive isolation
Liam Horne, Marco Musiani, Maria Cavedon, and Jessica Theoret
Barren-ground caribou (*Rangifer tarandus groenlandicus*) carryout an annual latitudinal migration from south of the Taiga to the Arctic coast. Comparatively, mountain caribou, an 'ecotype' of woodland caribou (*R. t. caribou*), have partial migratory populations (PMPs) in which some individuals perform altitudinal migrations, while other individuals from the same herd have sedentary behaviour year-round. For the mountain caribou PMPs, it is especially unclear how distinct migratory behaviours are maintained within a single population, despite the increased potential for gene flow of migratory animals. The purpose of our study was to determine if isolation during the rut could be a mechanism maintaining differences between subspecies and within PMPs of caribou. We created 95% kernel densities during rutting season (as defined by the literature), and subsequently reduced the kernels to centroids, for mountain and barren-ground caribou from four different regions in western and northern Canada. Distances of the centroids to the Taiga treeline were determined for the barren-ground caribou; the preliminary results showed a strong potential for rutting north of the treeline to be a mechanism of reproductive isolation from woodland caribou. The elevations of the centroids were determined for the mountain caribou; preliminary results indicated that there is bimodality in the intra-population elevations at which caribou rut. These preliminary results highlight the importance of the caribou rut as the sole time for genetic sorting. Accordingly, spatial separation of the caribou during the rut is very relevant, especially with regards to potentially maintaining genetic differentiation between sedentary and migratory individuals within PMPs.
Biosketch: I am a recent graduate from the University of Calgary. This study of spatial separation in caribou is an extension of my honours research project. I am now working with the University of Alberta on Chronic Wasting Disease in mule deer in Eastern Alberta.

Influence of woody cover distribution on the contact zones of chronic wasting disease
Dasha Ivanova, Jingjing Xu, Peter Smolko, Mark Lewis, and Evelyn Merrill
Chronic Wasting Disease (CWD) is a fatal, untreatable, and difficult-to-detect prion disease that affects cervid populations in North America, including Alberta. One of the challenges to the monitor and management of CWD spread comes from its long latent period (1~2 years), during which infected deer can shed prions, and the prions can persist in the environment for a long time. Therefore, deer can develop CWD either directly from an infected deer, or indirectly from the environment (e.g., prion contaminated soil, plants), which raises the importance of studying the movement of deer and identifying the home ranges. Our study focuses on the influence of woody cover distribution on deer home range size, which can determine the potential CWD contact zone. Three steps are taken to achieve this goal. First, we analyze the GPS location data collected from 2006 to 2010 for 30 mule deer captured and collared in southeastern Alberta (deer location is recorded every two hours, for up to one year for each deer), and obtain the home range radius for each deer using Mean Squared Displacement. Second, we use the average of the radius to determine the neighborhood area for every cell in geographic information system (GIS) to generate the woody cover rate for each cell, so we have a woody cover distribution. Third, we classify deer by the woody cover rate at the centroid of their GPS

locations, and compare the home range size of deer with high woody cover and those with lower woody cover.
Biosketch: I am a student at the University of Alberta completing a BSc in Mathematics. Currently I am doing undergraduate research in the Merrill Lab where my interests in mathematical biology and conservation ecology can be applied.

Home range, habitat selection and nesting density of urban merlins (Falco columbarius) in Winnipeg, Manitoba
Justine Josephson-Laidlaw and Richard Baydack
North American urban landscapes are thought to provide an environment conducive to enhanced productivity and distribution in Merlins (*Falco columbarius*), as observed across North America. In the city of Winnipeg, research on the Merlin is unavailable, even though local rehabilitation centres and other efforts have recorded a significant Merlin presence. My ongoing study involves banding Merlins, monitoring nest site success, recording nest site locations and characteristics, and radio tracking the home range of individuals across the landscape. This research will record nest density in Winnipeg, document habitat selection during the breeding season, and examine how urban landscape characteristics may influence the transmission of West Nile virus on raptors.
Biosketch: The primary focus of my Master's of Environment research has focused on urban raptors and habitat-use. Between November 2017 and March 2019, I have been fortunate enough to sit on the CSTWS Executive as Student Representative and TWS Manitoba Chapter Executive as President-Elect.

Goat Gatorade: How do mineral licks define mountain goat home ranges?
Laura Kroesen, David Hik, and Seth Cherry
All North American ungulate species deliberately ingest soil from mineral licks to obtain nutrients they cannot acquire from regular forage. Mineral licks have a critical impact on fecundity, population dynamics and survival of ungulates, yet, little is known about how mineral resources define home range and affect movement patterns of individuals within a population. I will evaluate mineral licks as critical 'resource hotspots' for mountain goats (*Oreamnos americanus*), an alpine ungulate that displays extreme travel behaviour and high site fidelity to a limited number of licks. My research aims to answer these questions: Do mineral licks constrain or extend mountain goat home range? What specific minerals do mountain goats seek out at these licks and do their preferences change seasonally? My research will capitalize on the high fidelity of mountain goats to licks by using individual based tracking to measure mountain goat movements within their core home range. All research will be conducted in collaboration with Parks Canada in Banff and Yoho National Parks, in the Rocky Mountains. Mineral licks are a special habitat feature that is critical to maintaining the health of ungulate populations. Incorporating mineral licks into landscape-level management planning is necessary, but first, it is essential to know how and why ungulate species use them.
Biosketch: Laura is currently a Masters student at Simon Fraser University. She lives and breaths mountains from skiing, climbing, hiking and of course: mountain ecology.

The influence of linear development on elk (Cervus canadensis) populations in the Foothills region of Southern Alberta
Jayme Ladouceur

Elk (*Cervus canadensis*) have commonly resided in the Southern Alberta Foothills region for many years, maintaining a healthy population prior to the area becoming dominated by agricultural land use and residential properties. Southwest to the city of Calgary is a point of interest regarding the relationship between linear development and elk population densities. The rate of increased linear development poses undetermined influences towards local elk population densities and wildlife management in Wildlife Management Units (WMU) 212, 310 and 312 located in the foothills. WMU 212, 310 and 312 are being observed to identify elk population density, amount of linear development, associated conflicts and the wildlife management strategies implemented in the study area. This will be analyzed by measuring the population densities from aerial ungulate surveys, linear development, and land use changes with the use of Geographical Information Systems (GIS), aerial imagery and research. A majority of elk winter in this area on the western borders of WMU 212; this location consists of tree cover, farmland, rangeland, acreages and subdivision development (Ranger and Rasmussen, 2013). Local landowner reports have indicated that elk began occupying the south-west region of Wildlife Management Unit (WMU) 212 in the 1960s and gained concern (Webb and Anderson, 2009). The objective of this study is to determine the effects of linear development on the elk population in the Foothills region of Southern Alberta and potentially aid in discovering the type of influence on elk populations caused by humans.
Biosketch: I'm an Ecosystem Management student at Lethbridge College, studying wildlife management. I've always been an active outdoor enthusiast, spending time hiking and hunting in Alberta. I've been fortunate enough to be raised in rural Alberta and am passionate about agriculture and conservation.

Gaining insights into Alberta's building roosting bats using citizen science
Erin Low and Cory Olson
The Alberta Community Bat Program (ACBP) was initiated in 2015 by WCS Canada, in collaboration with Alberta Environment and Parks and participants of the Alberta Bat Action Team. The program promotes bat conservation and stewardship in communities throughout Alberta by engaging the public using a combination of outreach, education, and citizen science projects. Since the summer of 2016, the ACBP has been collecting reports submitted by the public on the locations of known bat roosts. Participants were asked to submit an online report detailing the location, physical characteristics and history of the roost. A sample of guano collected from below the roost was also requested for genetic analysis to determine which bat species is occupying the structure. This is a relatively inexpensive, yet reliable way of determining accurate species identification, while involving the public. These data are being used to develop a long-term database that will contribute to population monitoring, conservation, and provide further insights into habitat use by a range of Alberta bat species. The database of reported roosts has been growing annually. Over 44 roosts were reported in 2018, bringing the total number of reports to over 150. Since 2017, the ACBP has been a partner with the Neighbourhood Bat Watch Research Network. This has given participants the opportunity to input bat observations and provide regular updates on their roost counts. We will present the first three years of preliminary results from the citizen science project and discuss future directions and priorities for monitoring building roosting bats.
Biosketch: Erin Low is the Edmonton Regional Coordinator for the Alberta Community Bat Program. She has been involved in bat research and outreach throughout Alberta as well as in other provinces and internationally. She is pursuing her Master of Science degree with Dr. Robert Barclay at the University of Calgary.

A temporal comparison of delta 13C and delta 15N signatures in muscle and fin tissues in boreal freshwater fishes: Non-lethal sampling methods for stable isotope analysis

Taylor Lund, Mark Poesch, and Karling Roberts

Stable isotope analysis (SIA) is a powerful tool that can be applied to many aspects of ecology, allowing researchers to study food webs such as invasive species impacts, trophic position, and shifts in diet due to disturbance. SIA can be applied to aquatic research to capture long-term diet characteristics of fish. Extracting dorsal muscle is the most common method to use; however, is not always possible to lethally harvest fish to obtain this tissue especially due to small population size or at-risk status of species. The use of fin tissue has been adopted as an alternative method. The ability to use fin clips as surrogates for muscle has been studied recently in temperate fishes such as salmonids. These studies have demonstrated strong relationships between isotope signatures. My study will test the same relationship with three freshwater fishes of the Boreal region of Northeastern Alberta: Northern Pike, Lake Whitefish, and Yellow Perch. Although not of conservation concern, these fish species are sport fish in the province. The first specific objective of my study is to compare δ13C and δ15N signatures of caudal fin compared to pectoral fin in relation to dorsal muscle. The second objective is to develop a temporal comparison of these isotopic signatures in muscle and fin tissues during spring, fall, and winter seasons. The latter will examine if the relationship holds between seasons, since seasonal changes can impact isotope turnover rates due to factors such as changes in water temperature and diet.

Biosketch: Fourth-year undergraduate student in the BSc. Environmental and Conservation Science program majoring in Conservation Biology at the University of Alberta. I have a great passion for the outdoors with a love of fishing, camping, and hiking. My greatest interests lie in the ecology of large mammals especially ungulates.

Raptor behaviour at the Alberta Grain Terminal in Edmonton, Alberta: An Update

Marissa Lynds and John Acorn

The 95 year old Alberta Grain Terminal, in Edmonton, Alberta, is frequented by several raptor species, hunting rock pigeons (*Columba livia*). This phenomenon was reviewed shortly after it was first noticed (Decker and Lange, 2001, Can. Field Nat. 115: 395-401), and since then numerous additional insights have emerged. For example, pigeons do not appear to be feeding extensively on spilled grain, and the terminal may instead serve as an artificial cliff, with abundant roosting sites, which attains surface temperatures c. 10oC warmer than ambient on sunny days. The presence of other raptors varies each year idiosyncratically (species include merlin (*Falco columbarius*), peregrine (*F. peregrinus*), northern goshawk (*Accipiter gentilis*), Cooper's hawk (*A. cooperii*), rough-legged hawk (*Buteo lagopus*), and bald eagle (*Haliaeetus leucocephalus*)) as well as ravens (*Corvus corax*). Agonistic, territorial, and kleptoparasitic interactions among these raptors have frequently been observed. Hunting success and strategies by gyrfalcons (*F. rusticolus*) and prairie falcons (*F. mexicanus*) are similar but not identical to those observed by Decker and Lange. Between 1996 and 2018, observations of 134 hunting attempts indicated success rates of 21.0% and 11.1% respectively (compared to earlier rates of 10.6% and 26.0%). The most successful prairie falcon strategy was a repeated swirling attack on flying pigeon flocks, resulting in 57.1% of successful kills. Gyrfalcons used two main strategies: the swirling attack, and a downward dive from the top of the building, resulting in 23.1% and 30.8% of kills respectively.

Biosketch: I am a fourth year undergraduate student in the Environmental Conservation Sciences program at the University of Alberta, majoring in Conservation Biology. I am a Director of UACTWS and

am interested in the change between the relationship and behaviours of individual raptors at the Alberta Grain Terminal since the 2000's.

Resilience of bighorn sheep in Banff National Park: Linking health to the long-term sustainability of an ecologically, culturally, and economically important alpine ungulate in Alberta.
Bryan Macbeth, Jesse Whittington, Karsten Heuer, and Bill Hunt
The health status of bighorn sheep is a key driver of population dynamics with direct implications for the resilience and long-term sustainability of this ecologically, culturally, and economically important species. An ongoing Bighorn Sheep Health Assessment and Monitoring Program was initiated in Banff National Park (BNP) in 2015 in response to sporadic reports of individual sheep in poor body condition and with evidence of poor hair coats, extensive skin lesions, or chronic diarrhea in three front country herd ranges. To date, we have evaluated biological samples from n=55 live-captured sheep and n=5 sheep carcasses for exposure to, or infection with, selected bacterial, viral, and parasitic diseases along with indices of health related to chronic physiological stress and nutrition. *Mycoplasma ovipneumoniae, Psoroptes* sp. mites, and Johne's disease have not been identified and there is little evidence of exposure to selected ungulate respiratory viruses. However, most sheep in BNP are infected with diverse and heavy parasite burdens and all adults tested have been exposed to a unique ovine herpesvirus that may be related to skin lesions observed in some individuals. Trace nutrient abnormalities, variation in stress levels, and other important bacterial or viral pathogens [e.g. *Bibersteinia trehalosi*, *Mycoplasma bovis*, *Parapoxvirus* (orf)] along with anecdotal evidence of suboptimal lamb:ewe ratios and declining abundance in some herds have also been recorded. The establishment of an interjurisdictional program to assess and monitor landscape level factors affecting the health status and performance of bighorn sheep in BNP and on adjacent provincial lands in Alberta is recommended.
Biosketch: Dr. Bryan Macbeth is a wildlife ecologist and veterinarian in Banff National Park whose research interests are focused on understanding the cumulative effects of anthropogenic and environmental conditions on wildlife health and mechanisms through which these factors may lead to diminished population performance in sensitive species and species at risk.

The movement ecology of infection risk for California bighorn sheep (Ovis canadensis california) in the South Okanagan, British Columbia
Sultana Majid and Adam Ford
Parasites influence animal behavior, population dynamics, and ecosystem processes. Parasite transmission is tied to the host animal's movement, which is influenced by changes in the landscape. In the Okanagan Valley of British Columbia, California bighorn sheep (*Ovis canadensis california*) populations have declined by 60% following an infestation of *Psoroptis ovis* mites in 2011. The mites are transmitted through individuals and the environment, leading to debilitating skin diseases. *P.ovis* infection is currently contained to a subpopulation of sheep on the west side of the valley due to landscape barriers (i.e., highways, towns, and lakes), but the transmission risk to the east subpopulation is a significant concern for these premier big game species. We will be conducting two analyses: habitat connectivity and landscape change scenario simulation. Using GPS tracking data of 75 sheep from 2015 – 2019 (45 infected in the west; 30 uninfected in the east), we will compare habitat selection and identify areas of contact risk between infected and uninfected subpopulations. We will use these habitat selection data to populate an agent-based model simulating the spread of mite infection under different

landscape change scenarios, including increased connectivity (i.e., the creation of a wildlife overpass) and new point sources of infection (i.e., domestic sheep operations). Understanding the link between connectivity and disease exposure will help wildlife managers design effective mitigation measures that will be critical for conserving sheep populations in the future.
Biosketch: Sultana is a MSc student committed to wildlife conservation with a keen interest in predator-prey interactions, spatial ecology and population dynamics. She has a BSc in Ecology from the University of Calgary and is currently studying the spatial interaction between mites and bighorn.

Bull elk ecology in a partially migratory population
Hans Martin, Jacalyn Normandeau, Evelyn Merrill, and Mark Hebblewhite
Migration is a behavioral strategy used to maximize fitness in environments where resources and predation vary spatially and temporally on the landscape. In partially migratory populations, the decision to migrate can be fixed or depend on intrinsic factors such as sex, age, and reproductive status or extrinsic factors such as forage quality, predation, and weather conditions. Differences in predation risk, nutritional requirements, and reproductive demands between male and female elk are hypothesized to result in differences in resource selection and thus differences in migratory strategy. We captured and collared 59 bull elk and 38 female elk in 2018-2019 to determine differences in male and female migration and habitat selection in the Ya Ha Tinda elk population. A higher proportion of males than females migrated which has the potential to reduce intraspecific competition and suggests that males select for higher quality forage than females. Additionally, migratory strategy may affect the trophy quality of bulls by increasing their access to high-quality forage and their harvest vulnerability. Hunter harvest was the leading cause of bull mortality within our study with 26 percent of collared bulls being harvested and age-at-harvest varying with migratory strategy. This research will provide valuable information to managers setting harvest quotas and seasons for partially migratory elk populations.
Biosketch: Hans Martin started his PhD in the Hebblewhite lab in the fall of 2017 and is studying the effects of facultative switching between migrant and resident strategies in the partially migratory elk population in the Ya Ha Tinda located to the east of Banff National Park.

Winter behaviour of a new migratory strategy: The Ya Ha Tinda elk herd
Darby McPhee, Madeline Trottier, Jacalyn Normandeau, and Evelyn Merrill
Partial migration is a common behaviour in ungulates and can lead to trade-offs between predator avoidance and foraging. The partially migratory Ya Ha Tinda (YHT) elk herd in Alberta is comprised of residents, western migrants, and an emerging eastern strategy that occupy allopatric summer ranges and a sympatric winter range. Previous studies show that residents exhibited more group cohesion and antipredator behavior than western migrants in winter, attributed to differential exposure to predators and humans during the summer. We predicted that eastern migrants will exhibit a greater amount of vigilance and intermediate group cohesion due to less predictable human disturbance on the summer range. Nearest neighbor data from GPS-collared female elk was used to compare spatial segregation and group cohesion of strategies during the winter. Through foraging observations, we documented feeding behavior, interference, and vigilance among focal individuals of each strategy relative to habitat, group dynamics, and predation risk to create models to explain the variation in vigilance. Preliminary results indicate that vigilance was significantly different only between residents and eastern migrants, with average percent vigilance times of 11.4±14.1%, 16.9±19.6%, 17.2 ±27.2% for residents, eastern migrants, and western migrants respectively. Additionally, position within the herd best explained

vigilance behaviour in our top model. This project furthers knowledge of a new eastern migration strategy in the partially migratory YHT elk herd.
Biosketch: I am completing my BSc with a specialization in Animal Biology at the University of Alberta. I am currently researching the behavior of a partially migratory herd of elk at Ya Ha Tinda, within the Merrill Lab. I one day hope to move into conservation and rehabilitation as a career.

Arthropods in the fall diets of Plains sharp-tailed grouse in Alberta
Sejer Meyhoff, Dan Johnson, and Scott Bazinet
This project is part of a two-year study examining the diet and utilization of arthropods by plains sharp-tailed grouse (*Tympanuchus phasianellus jamesi*) in Alberta. The goal is to use esophageal crop content analysis along with arthropod and vegetation surveys to inform the use of stable isotope analysis of feathers to determine dietary proportions of arthropods and vegetation during the summer months in Alberta. In this preliminary component of the project, 180 crops collected from hunter-harvested grouse during the 2017 and 2018 hunting seasons (October) were analysed, their contents identified, dried, and weighed to determine relative contribution of foods items. Results indicate that despite low relative availability of arthropods in the fall season, they still make up a notable proportion of sharp-tailed grouse diets. Dawson's grasshopper (*Melanoplus dawsoni*) was found to represent over 80% of all arthropods consumed by grouse in the fall. This species is present on fescue grasslands later into the season than most other grasshopper species and is potentially important for grouse and other grassland birds. These data will be used to inform a baseline of potential diet items to be used in stable isotope analysis to estimate the relative contribution of arthropods to the diets of grouse. The results will be combined with historical data from grasshopper monitoring, lek counts, climate data, and nutrient information on diet items to explore the food webs and ecological relationships between grouse and arthropods.
Biosketch: I am a graduate student at the University of Lethbridge working towards a masters in environmental science with a focus on avian food web studies using feather stable isotopes.

Shifts in East Kootenay elk migration patterns
Kelly Mulligan, Garth Mowat, Tara Szkorupa, Patrick Stent, and Evelyn Merrill
Elk (*Cervus elaphus*) in western North America commonly show migratory behaviour in montane ecosystems in response to low snow in valleys during the winter and green-up at high elevations in the summer. Intensification of anthropogenic land uses, return of large predators, and climate change can disrupt migration by fragmenting habitats, posing barriers to movement, and altering the relative habitat benefits of migration. In British Columbia's East Kootenay Trench, migratory behaviour of elk has declined from 95% in 1986-1993 to 63% in 2007-2009, but has not been assessed in recent years. East Kootenay elk migratory decline has resulted in increasing year-round residency on winter range, increasing crop depredation, reduced time spent in hunted areas, and increasing deterioration of range condition. Determining recent East Kootenay elk migratory trends will help inform wildlife management decisions to minimize human-wildlife conflicts within a changing environment. Here we use yearly telemetry data of cow elk from 1986-1993 (n=191), 2007-2009 (n=76), and more recent 2014-2018 (n=36), and classify movements using net squared displacement, post-hoc spatial rules, and visual confirmation in GIS to determine if East Kootenay elk migration has continued to decline. Preliminary analyses found elk migration decreased from 1986-2009, similar to previous findings, but has since recovered in 2018.

Biosketch: Kelly Mulligan received her B.Sc. at the University of Guelph in Molecular Biology & Genetics and is currently an Ecology M.Sc. student at the University of Alberta working with BC's Ministry of Forests, Lands, Natural Resource Operations and Rural Development on exploring East Kootenay elk spatial and temporal variation in movement in response to anthropogenic disturbance.

Living in the country: The importance of wildlife habitat patches in mixed-use landscapes

Jordan Nakonechny, Glynnis Hood, Glen Hvenegaard, and Anne McIntosh

Fragmented habitat in agricultural areas is common within many rural counties. Preservation of natural and protected areas by government or non-governmental organizations provide relief to wildlife in fragmented landscapes. We examine how natural areas and protected areas maintain wildlife biodiversity within a predominantly fragmented agricultural landscape. From May to August 2016 and 2017, trail cameras recorded wildlife use of two habitats (upland and wetland) within four land cover classes (agricultural, boreal, aspen parkland, and natural grassland) throughout Beaver County, Alberta. Beaver County (3,317.57 km^2) comprises a large geographic area dominated by agriculture. We developed biodiversity measures and identified age and sex of all animals when possible. Cameras captured images of 16 species of wildlife, and 3 species of domestic animals (cattle, dogs and horses). Of the total number of photos of animals in 2017, on average, the highest percentage of photos (22.9%) were at the natural grassland-wetland sites and the lowest percentage of images were at the agricultural-wetland sites (0.33%). The percentage of images at the other habitat types were: agricultural uplands (6.3%), aspen parkland uplands (22.6%), aspen parkland wetlands (6.6%), boreal uplands (11.2%), boreal wetlands (18.7%), and natural grassland uplands (11.3%). Images of white-tailed deer (n = 1,575, 47.1% of the images) were most numerous, followed by mule deer (n = 1,258, 37.6%), and then moose (n = 182, 5.4%). With increased urban sprawl and agricultural development land acquisition, land protection, and land stewardship for wildlife conservation is critical in increasingly fragmented landscapes.

Biosketch: Jordan graduated from Augustana in 2017 with a Bachelor of Science in Environmental Science. Jordan became a research assistant under Dr. Hood, Dr. Hvenegaard, and Dr. McIntosh. He then continued research under Dr. Hood before being hired on as an Environmental Scientist within Solstice Environmental Management.

Seasonal variation in parasite egg counts of seven parasites in male and female bighorn sheep, Ovis canadensis

Samridhi Rijal, Peter Neuhaus, Susan Kutz, and Kathreen Ruckstuhl

Factors such as temperature, precipitation and humidity affect how well parasites survive. Similarly, hosts also experience pressures exerted during different seasons due to changes in their behavior. These behavioral changes can affect the frequency and intensity of parasite prevalence in the population. For approximately two years (2016-2017), we have been going to the Sheep River Provincial Park to collect fecal samples from individually tagged male and female bighorn sheep. These fecal samples were processed using the modified Wisconsin double centrifugation technique to count the number of eggs per gram of feces (EPG) of seven different parasites that infect bighorn sheep. This study will examine if the sex of the host influences parasite EPG over the annual cycle. Thus, giving us a clearer picture of the parasite load within each sex and within the population.

Biosketch: I am a Master's student and a field biologist at University of Calgary. I enjoy long hikes chasing after bighorn sheep and getting drenched trying to protect my datasheet during data collection.

Exploring fish species richness and co-existence in boreal lakes with isotopic niches
Karling Roberts and Mark Poesch
Environmental offsetting is the practice of compensating for environmental damage with the restoration, enhancement, or creation of habitat. This practice is used increasingly around the world, and occurs in the Alberta oil sands to offset the damage or destruction of fish habitat. Improving our understanding of the outcomes of offsetting projects and how offsets can be managed to achieve specific goals and targets is important to developing them as a reliable conservation tool. Here we examine how fish trophic niche size, overlap, and distribution differ with fish species richness in natural and compensation lakes of the oil sands region. How trophic niches respond to variation in species richness can provide evidence about the mechanisms that determine fish species richness in boreal lakes. Specifically, I test whether resource diversity, niche partitioning, or life-history trade-offs are more important for enabling co-existence among boreal lake fishes and determining species richness. Findings from this study will help with the design and management of offsets that support a desired fish community.
Biosketch: I am a PhD Candidate at the University of Alberta studying the food web structure and fish trophic niches of boreal lakes in order to inform future fisheries offsettting projects. My general research interests include fish ecology and conservation. When I'm not at school I like hiking, reading, and diving.

Female mating tactics of white-tailed deer and mule deer
Cora Romanow and Susan Lingle
What role do females play in white-tailed deer and mule deer mating systems? Do they passively accept advances from desirable males? Are they coerced into breeding pairs? When we think of the rut, we typically imagine large antlered males battling for access to females. In this scenario, the largest and most impressive males should monopolize breeding success. But this is not the case: genetic testing has revealed that smaller males contribute substantially to breeding success in wild populations. Previous research has attempted to attribute this to different sized males utilizing alternative mating tactics. For example, smaller males may wait in the wings to mate with a receptive female while a larger male is distracted in a fight. However, the role that females play in this system has been largely ignored. The objective of my MSc research is to conduct behavioural observations on wild white-tailed deer and mule deer to investigate whether females play a more active role in courtship than the current dogma seems to suggest. Specifically, I am investigating whether female deer engage in mate sampling, solicit courtship advances from males, and compete for male attention. My research is the first to exclusively use behavioural observations to directly assess the roles that female white-tailed deer and mule deer play in courtship.
Biosketch: Cora Romanow is a graduate student at the University of Winnipeg, pursuing a Master of Science in Bioscience, Technology, and Public Policy. Cora is investigating female mating tactics of sympatric white-tailed deer and mule deer on the McIntyre Ranch in southern Alberta.

Using drones to detect songbird nests in the province of Alberta, Canada
Kent Russell, Nick Bartok, Nikki Heck, and Jared Studyvin
The use of drones for commercial and research applications has been expanding greatly in recent years. With the ability to use a variety of instruments (e.g., infra-red [IR] cameras) mounted on drones, their

use has been shown to benefit a variety of applications. Many companies hire staff or consultants to conduct pre-construction nest surveys, including wind developments, as a mitigation tool to prevent or minimize the destruction, damage or disturbance to nests that are protected under federal and provincial laws. Conducting nest surveys can be a contentious issue due to low detection probability, with some provinces in Canada, such as Saskatchewan, no longer permitting these surveys. In spring 2018, we are testing if an IR camera equipped drone can increase the ability to detect nests compared to standard human nest search methods by testing a suite of variables. Delta Waterfowl has shown that nests have differing heat signatures from the surrounding landscape and can be found using drones with mounted IR cameras; however, it is unclear of the efficiency of drones, particularly with ground nesting songbirds. We will estimate the efficiency of drones using IR cameras to detect nests in differing conditions, estimate the proportion of false positive detections by drones, and estimate the efficiency of human searches to detect nests. If successful, results from this study will identify optimal conditions for detecting nests using drones and be useful to better protect developers from breaking laws.
Biosketch: Kent is a Wildlife Biologist and Project Manager for WEST in their Calgary office.

Unmanned aerial vehicles and machine learning for eagle carcass detection
Kent Russell and Michael Gerringer
We tested unmanned aerial systems (UAS or drones) and automated photo recognition systems as a method to efficiently find eagle carcasses on wind facilities. We examined whether images taken from a UAS could be reviewed by an automated photo recognition system to recognize eagle carcass surrogates (turkey decoys and large feather spots). We gathered images across five habitat types in southeast Wyoming (corn stubble, short grass, long grass, roads, and bare soil) and trained two photo recognition systems. On hold-out validation images, the better of these systems detected 93.3% of all decoys and 100.0% of all feather spots across the five habitat types tested with 8.3% false-positive rate. The system's detection rates were generally higher than those of field biologists completing traditional scan-style surveys (roughly 70% on roads and pads, and approaching 10% in heavy vegetation). Including transit time and battery swaps, we estimate that a single drone and two operators could survey 100 turbines from a height of 120m in less than 5 hours. We conclude that UASs followed by automated carcass detection appears to be a viable, reliable, safe, and efficient method of searching for eagle fatalities surrounding wind turbines. We emphasize the need for additional field testing and additional training of the photo recognition system to maintain high detection rates in diverse vegetation types.
Biosketch: Kent is a Wildlife Biologist and Project Manager for WEST in their Calgary Office.

Urban, rural, agricultural Canada goose nesting success
Geoffrey Sage and Shane Roersma
Ten nests were found in 3 different locations. An urban, rural, and agriculture study location was found. The nests were monitored over the incubation period to maintain an active status. Once hatched I used evidence of a successfully hatched egg to judge if a nest was successful or not. The purpose of this study is to see if urban nesting geese have a higher chance of success can they be relocated and nest successfully or what other forms of urban wildlife control can be done to keep numbers of Canada geese in control in an urban setting.
Biosketch: I am in my 4th and final year of my Bachelor of Applied Science degree at Lethbridge College, and I have a strong passion for the outdoors, and am an avid hunter and angler. My passion for conservation is why I have embarked on my current career path.

Calibrating Trafx trail counters with wildlife camera data: Learnings and case histories from the field.
Stefan Seifert, Mitch Brown, Sandra Code, and John Paczkowski
We endeavored to calibrate Trafx trail counters with wildlife cameras to improve data accuracy. 51 infrared trail counters and 113 wildlife cameras were deployed in 2018 to estimate human use trails throughout Kananaskis Country, Alberta. While wildlife cameras may produce more accurate and detailed human use data, associated data management and image classification are prohibitive. Selectively "pairing" wildlife cameras with trail counters allows us to validate counter data. Thirty of 51 counters were paired with cameras. Meaningful trail counter data are based on two factors: 1) consistent data collection and 2) accurate calibration of counter data to reduce error. Over 70% of trail counter data were highly correlated with camera data (R^2> 0.90). High correlation implies accurate data and significant time savings in data processing when assessing human use on trails. 17% of trail counters were not highly correlated (R^2< 0.80). These data were used to calculate calibration coefficients for specific trail counter data. Factors affecting counter/camera data correlation include inconsistent servicing, vandalism, poor initial setup (excessive trail width, orientation), seasonal environmental variations (temperature / humidity) and equipment failures. This calibration process has highlighted the sensitivity of trail counters and the need for regular accurate service records. Attention must be paid to setup conditions and periodic calibration to ensure capture of consistent results.
Biosketch: Stefan Seifert has been a volunteer with Alberta Parks in the Kananaskis Region for over a decade. Since retiring from a career as a Geologist, Stefan has been assisting the AEP ecology section with the challenge of improving trail counter and wildlife camera data collection and management.

Ten Years of Monitoring Illustrates a Cascade of Effects of White Pine Blister Rust and Focuses Whitebark Pine Restoration in the Canadian Rocky and Columbia Mountains
Brenda Shepherd, Brad Jones, Robert Sissons, Jed Cochrane, Jane Park, Cyndi M. Smith, Natalie Stafl
Whitebark pine is considered both a keystone and foundation species in upper subalpine mountain areas. Grizzly and black bears, and many bird and small mammal species rely whitebark seeds for food. Whitebark pine forests are declining due to infection by white pine blister rust and mountain pine beetle, combined with the effects of climate change and fire suppression. The Canadian Rocky and Columbia Mountains represent a large portion of the whitebark range; a vast area, exemplifying the need for knowledge about whitebark pine stands to target restoration. The aim of our work was to identify variables predicting live tree infection, seedling infection, canopy kill, mortality, and regeneration across this region, and present the results in spatially-explicit formats to assist land managers with restoration. Live tree and seedling infection by white pine blister rust increased over the last decade and cascading effects of the disease are intensifying, including canopy kill and mortality. We show that large diameter trees are more likely to be infected, and the highest infection rates are in southern and western areas. The conditions for seedling infection are more strongly influenced by fine-scale climatic conditions than for trees. Areas with low regeneration are: (1) the dry east slopes where live tree infection is low; and (2) where live tree infection rates are high, suggesting that canopy kill and mortality are influencing regeneration. Results highlight where to target restoration and coordinate across boundaries.
Biosketch: Brenda Shepherd is a Parks Canada biologist working in Jasper National Park. She focuses on long-term ecological monitoring and species at risk recovery.

Modelling lichen availability for woodland caribou forage in a fire-driven landscape
Joseph Silva, Stan Boutin, Scott Nielsen, and Christine Hague
Across most of Ontario's Boreal Shield, forest fires are the primary disturbance agent on woodland caribou ranges. Fires consume the forest floor and the ground lichens caribou rely upon as a major food source. Nutrition can act as an important limiting factor in ungulate populations, as it influences survival and reproductive success. Understanding the influence of nutrition on woodland caribou is challenging due to the vast home ranges they typically occupy. Landscape nutrition models, linking forage availability to landscape-level GIS and remote sensing data, can create spatially explicit predictions of nutritional resources over large areas. In this study, we set out to map lichen presence and abundance in a fire-driven landscape to investigate caribou habitat use in relation to lichen. We characterized post-fire lichen recovery in Woodland Caribou Provincial Park, a large wilderness area in northwestern Ontario. We conducted field sampling by estimating terrestrial lichen biomass at 109 sites stratified by burn age and forest type. Field data was used to model lichen presence and abundance using landscape covariates derived from remote sensing and GIS data. The top model was used to spatially predict lichen presence and abundance across the study area, producing a lichen map. We will use the lichen map and GPS collar locations from ~12 female caribou in the study area to investigate patterns in habitat use with respect to lichen availability.
Biosketch: I completed my undergraduate degree at Lakehead University in Thunder Bay, Ontario, where I studied forestry. My research interests include GIS, remote sensing, fire ecology and wildlife ecology.

Home-range characteristics of cougars at the northern range of their geographic distribution
Corey Smereka
An animal's home range is defined as the area used by the individual where it performs behavioural actions such as avoiding predation, competing against conspecifics, locating mates, raising offspring, and foraging. We assessed how sex differences influence home range size and overlap of cougars (*Puma concolor*) in west-central Alberta, Canada. We predicted that (1) male cougars will have a larger home range size compared to females as males are more competitive for mates and will use more area to increase their chances for reproductive success, and (2) more overlap will occur between female cougars than males as males express higher same-sex territoriality. Home range size was estimated for cougars (18 female, 5 male) that had an established home range based on asymptote analysis. Furthermore, adult cougars (34 female, 11 male) had their home range analyzed to determine minimum percent overlap with neighbouring individuals. The 95% Brownian bridge home range for male cougars (612 km^2) was significantly larger than for female cougars (207 km^2). Male-male overlap was higher (22.54%, n = 20) compared to female-female overlap (19.04%, n = 119), however results were not significant. Our results are consistent with previous home range studies on cougars, with males having a larger home range size. Although our home range overlap results were not significant, we found that both males and females had similar amounts of overlap. These results will provide valuable information on cougar space use to improve our understanding of home range characteristics for an expanding large carnivore population.
Biosketch: Second year MSc student at the U of A studying cougars in west-central, Alberta.

Modeling risk of the Chronic Wasting Disease in Alberta
Peter Smolko, Dana Seidel, and Evelyn Merrill

Chronic wasting disease (CWD) is 100% fatal prion disease of cervids that has been detected in wild deer, elk and moose in two Canadian provinces. Alberta has had a surveillance program for CWD since 1996. CWD positive deer was detected in adjacent Saskatchewan in 2000 and in Alberta in 2005. Based on data collected during Alberta's surveillance program, we assessed the risk of a harvested mule deer having CWD over a 15-year in eastern Alberta. We hypothesized that the probability of a hunter harvested deer being CWD positive was a function of time since the first detection of CWD in the region (2000), sex and age of the deer, characteristics of the area where the deer was harvested (agricultural areas, extent of woody cover, distance to river and streams, topography, road density or distance to human settlements) and proximity to other positive cases. We developed a risk model using surveillance data from 2000 to 2010 (n=94) to predict risk of CWD in deer harvested in 2011 - 2016. We then re-developed the risk model using data from 2000 to 2016 (n=591) and tested the predictions of this model using data from 2017 (n=328). In developing these models we assessed how importance of sex, age, site characteristics and distance to non-CWD cases changed over time in influencing predicted risk. We also compared the influence of these factors on risk of CWD in the area along the edge of the CWD management zone to that within the core area for CWD.
Biosketch: Postdoc at University of Alberta.

Modeling sensitivity of Alberta mule deer populations to landscape changes
Eleanor Stern, Peter Smolko, Brad Stelfox, and Evelyn Merrill
Chronic Wasting Disease (CWD) is an emerging prion disease that threatens cervid populations, and has become a concern in Alberta due to its highly infectious nature, lethality, and potential to cause population decline. Mule Deer (*Odocoileus hemionus*) carry the disease at significantly higher prevalence rates than other cervids in Alberta, making this species critical for management efforts to control the spread of CWD. Dispersal, movement, and distribution of deer across the landscape, all of which influence densities, contact rates, and disease transmission, are affected by landscape characteristics. We use ALCES Online (www.alces.ca), a spatially explicit landscape and population dynamics simulation model to analyze the effect of landscape parameters such as cover and rivers on simulated populations. The model is parameterized for mule deer in eastern Alberta based on movement, habitat selection, reproductive, and survival data from local telemetry studies, population size and composition from aerial surveys, age structure from teeth, and hunter harvest statistics. The model is calibrated predicting the population changes from 1995-2017, comparing the simulation with surveyed population data. We present the results of a population sensitivity analysis to major model landscape components (e.g., distance to cover, distance to rivers), and test the sensitivity of population vital rates in the context of the Alces model. These efforts will provide information to assist the use of ALCES software for wildlife management efforts, and landscape analyses that are integral to forming a proactive and effective strategy to managing CWD in Alberta.
Biosketch: I'm an undergraduate student finishing my BSc majoring in Conservation Biology at the University of Alberta. I'm studying in the Merrill lab, working with the Chronic Wasting Disease team. I've previously spent time researching seismic lines and effects of disturbance in boreal forests, and in geophysics.

Sequential mating tactics in bighorn sheep
Ryan Tate and Kathreen Ruckstuhl

We present a game theoretic mathematical model that examines factors that contribute to bighorn sheep using sequential mating tactics. Specifically, we studied the life-long mating strategy of males and why they do not specialize in one kind of mating tactic. We propose possible implications for hunting management.
Biosketch: I'm a theoretical biologist working on applying game theory to bighorn sheep mating tactics to look at how male bighorn sheep invest in the multiple mating tactics they use over the course of their life.

Assessing habitat enhancements to improve the restoration and development of northern boreal lakes
Sebastian Theis, Mark Poesch, Jesse Shirton, and Alicia Pruden-Beniuk
Offsetting has been used on a large scale in Canada to compensate for the loss of ecosystem productivity and overall biomass. Especially already implemented and further planned compensation lakes in the oil sands region have received an increased attention and popularity. However, evaluations of projects and regular monitoring programs beyond mandatory requirements are rarely conducted, making it difficult to determine if offsetting can truly compensate for lost habitat and ecosystem function. In terms of deployed and implemented methods, habitat enhancement has proven itself to be the most successful and often viable option to increase habitat quality and effectiveness in aquatic ecosystems. However, the major focus of habitat enhancement projects in the last decades has been largely centered on streams and rivers. Little attention has been set on lentic systems to evaluate potential positive effects of habitat enhancement for those ecosystems. To fill this gap of knowledge we are conducting habitat enhancement measures on northern boreal lakes by introducing Large Woody Debris and conducting capture and recapture studies. Results of our ongoing research allow us to gain invaluable insights in the potential; habitat enhancement could have for ongoing and future compensation lake projects in the northern boreal region of Alberta and which fish species it directly or indirectly benefits.
Biosketch: M.Sc. in Fishery Science and Aquaculture (Humboldt University of Berlin) B.Sc. in Geology and Paleontology (Ernst-Moritz-Arndt University Greifswald). Currently: PhD Conservation Biology at the University of Alberta with focus on habitat enhancement in northern boreal lakes.

Classifying caribou migratory behaviour to identify and preserve intraspecies biodiversity
Jessica Theoret, Maria Cavedon, and Marco Musiani,
Preserving intraspecies biodiversity, a fundamental conservation goal, strengthens species adaptability. Conservation biology literature suggests focusing on the concordance of ecological traits with genetic traits potentially of adaptive value, as extinction of locally adapted populations can concurrently result in the permanent loss of those adaptations. Caribou are declining, sometimes to extinction. As populations decline and are lost, gene to environment associations may therefor be at risk of extinction. Migratory or sedentary behaviours are considered adaptive relative to local ecological conditions of barren-ground and woodland caribou populations (respectively). These behaviours impact survival and may be influenced by genetic predispositions. My research contributes to addressing an important research question: is the presence of migratory behaviour associated to (a)genomic differences, (b)environmental factors, or (c)genomic differences when controlling for environmental factors? Through collaborations with officials from Alberta, British Columbia, Northwest Territories and Yukon, genetic and GPS telemetry data were obtained for 359 barren-ground and woodland caribou from 31 herds across western Canada. Utilizing a Net Squared Displacement (NSD) approach, individuals were

classified as migratory or non-migratory based on movement behaviours. Migratory behaviour was found to occur widely, also in woodland caribou populations. From these results, correlations of migratory behaviour with genomic traits and with environmental conditions will be evaluated. This research contributes to the growing field of ecological genomics and aids in defining its applicability for management strategies within species. Specifying migration behaviours within populations, the focus of my research, may itself result in more specialized conservation and management strategies and support preserving intraspecies biodiversity.

Biosketch: Jessica Theoret obtained a Bachelor of Science in Environmental Science with first class honours at the University of Calgary and is currently pursuing a Master of Environmental Design, also from UofC. Theoret is a passionate Albertan dedicated to informative science, conservation and environmental protection in the province she calls home.

Wildlife responses to a temporal closure

Jesse Whittington, Petah Low, and Bill Hunt

Increasing levels of human activity can degrade habitat quality, security, and connectivity for wildlife populations throughout the world. Area closures can improve habitat quality, but can negatively affect recreational and business opportunities. Temporal closures that limit human activity for a portion of the day have potential to increase habitat quality for wildlife while minimizing effects on people. We examined wildlife responses to a temporal closure in Banff National Park. Parks Canada closed a 17 km stretch of the Bow Valley Parkway for 12 hours at night to improve habitat quality and security for wildlife. We tested the effectiveness of the temporal closure using before-after control-impact study designs and three sources of data: remote cameras, road surveys, and grizzly bear (*Ursus arctos*) GPS data. All analyses found that wildlife detection rates doubled on the road during the closure while remaining unchanged in reference areas. Temporal closures may not be as effective as full closures. However, temporal closures are an important conservation tool that can increase habitat quality for wildlife while continuing to provide opportunities for people.

Biosketch: Jesse Whittington is a Wildlife Ecologist for Banff National Park and has studied wildlife ranging from harlequin ducks to grizzly bears in the Canadian Rockies for over 25 years. He is interested in understanding how interactions between predators, prey, and people affect wildlife movement and population trends.

Using stable isotopes to resolve prey composition in Puma concolor

***S*amantha Widmeyer** and Mark Boyce

Cougars (*Puma concolor*) are a generalist species composed of individuals that specialize to varying degrees on certain prey types. Specialization may be the result of prey availability and/or behavioural differences in prey selection between individual cougars. In systems where individual cougars select prey disproportionately to availability, small secondary prey populations risk extirpation when cougars subsidize their diets with abundant primary prey. The Government of Alberta manages cougar populations using an annual harvest based on quotas allocated to Wildlife Management Units. This generalist method may not remove specialist individuals that could threaten small or isolated prey populations. Current methods for determining the prey composition of individual cougars are costly and laborious, relying primarily on kill-site investigations of GPS collared cougars and/or scat analysis. Using stable isotope analysis, we hope to develop a non-invasive, cost effective method for estimating cougar diet composition. This method assumes that the contribution of assimilated C and N to consumer tissues

is proportional to the biomass of prey consumed. We are currently using cougar and prey stable isotope values to reconstruct the diets of 7 collared cougars using previously developed Baysian mixing models (MixSIAR). These data will be compared to diet composition estimates obtained by cataloguing prey type and relative biomass at the kill-sites of each collared cougar. With the completion of our study, we hope to provide the Government of Alberta with a tool that can be used to help redefine management practices in order to target specialist cougars that threaten small prey populations.
Biosketch: Samantha Widmeyer is in the third year of her MSc program at the University of Alberta. Samantha is a lover of nature and animal enthusiast with a passion for cats.

SESSION 7 SYMPOSIUM

30 Years of Women in Wildlife

Margo Pybus, Provincial Wildlife Disease Specialist, Alberta Fish and Wildlife

Margo Pybus spent the better part of a life-time learning from wildlife. She was schooled early in life among the fields, forests, and marshes of southern Ontario and later in the prairie, foothill, mountain, parkland, and boreal landscapes of Alberta and beyond. Margo received a B.Sc. in Fish and Wildlife Biology and M.Sc. in Wildlife Parasitology, both from the University of Guelph. She holds a PhD in Wildlife Parasitology from the University of Alberta and is an adjunct professor in the Department of Biological Sciences, UofA. Margo is a recipient of the Distinguished Service Award from the international Wildlife Disease Association and various professional awards for service and contributions to wildlife management and conservation. Margo is on staff with Alberta Fish and Wildlife as the first Provincial Wildlife Disease Specialist. She leads high profile provincial wildlife disease surveillance and management programs and advises on related policy, management, and research initiatives. Margo has an abiding interest in natural history and readily shares her knowledge and enthusiasm for all wild species and spaces. Within ACTWS, Margo is a former president, ongoing chapter mentor and historian, and grateful recipient of the Dedicated Service Award and William Rowan Award.

Melanie Dickie, Research Coordinator, Caribou Monitoring Unit, Alberta Biodiversity Monitoring Institute

Melanie Dickie is the Research Coordinator of the Alberta Biodiversity Monitoring Institute's Caribou Monitoring Unit. Melanie conducts research to support woodland caribou recovery in Western Canada, working closely with academics, industry, and government to facilitate applied research and provide scientific expertise to evaluate and monitor caribou recovery options. Current projects range from prioritizing areas for habitat restoration to evaluating the relative effect of habitat, climate and human land-use on mammal populations interacting with caribou. Melanie received her M.Sc. from the University of Alberta, under the supervision of Dr. Stan Boutin, where she examined how linear features from oil and gas exploration affected wolf movement behavior. She also has experience working with shorebird, wader, and seabird monitoring and census programs through the Canadian Wildlife Society and the National Wildlife Research Centre.

Sonja Leverkus, Ecosystem Scientist, Shifting Mosaics Consulting

Sonja Leverkus owns and operates two uniquely Canadian companies: Shifting Mosaics Consulting, an ecological consulting company where she is the Sr. Ecosystem Scientist, and Northern Fire WoRx Corp., a company dedicated to prescribed fire and wildland fire where she is the Sr. Fire Lead. Dr. Leverkus is an adjunct professor at the University of Alberta and is a TWS Leadership Institute Alumni (2014). Dr. Leverkus is the President-Elect for the Canadian Section of The Wildlife Society and she is looking forward to connecting with everyone in Canmore!

Wini Kessler, Retired Ecologist

Wini Kessler received her education at the University of California, Berkeley (BA, MS) and Texas A& M (PhD). A Certified Wildlife Biologist®, she is a fellow and past-president of The Wildlife Society. She held faculty positions at the University of Idaho, Utah State University, and University of Northern British Columbia where her innovative and integrated approach to natural resources education earned her the British Columbia Academic of the Year Award in 1997. Wini served 21 years with the U.S. Forest Service, retiring in 2010 as a regional director for the Alaska Region. She has been a professional member of the Boone & Crockett Club since 1993, most recently editing their 2018 textbook North American Wildlife Policy and Law. She serves on the boards of several NGOs chairs the board of directors of the Habitat Conservation Trust Foundation, which invests $7–8 million annually in conservation projects across British Columbia. She was the 2017 recipient of the Aldo Leopold Memorial Award.

Janet Ng, Cumulative Effects Specialist, Government of Saskatchewan

Janet Ng is the Cumulative Effects Specialist for the Government of Saskatchewan. As part of the Cumulative Impacts and Science Branch within the Ministry of Environment, Janet uses landscape simulations to model cumulative effects, such as changes to the human footprint, under varying land use development and climate change scenarios. Janet has expertise in ecological modeling, focusing on landscape ecology, habitat use, reproductive performance, and cumulative effects. Janet received her Bachelor of Science from the University of Alberta, Master of Science from the University of Regina, and her Doctorate in Philosophy from the University of Alberta. Her PhD work, under the supervision of Dr. Erin Bayne and Dr. Troy Wellicome, evaluated the cumulative effects of land use and climate change on Ferruginous Hawks habitat use and reproduction. Working with provincial and federal recovery teams, industry stakeholders, landowners, and environmental non-profits, Janet has used her research results to develop management tools that can be applied to conservation and recovery of Ferruginous Hawks in Canada. Janet has worked with a number of wildlife species in different sectors, including environmental non-profits and environmental consulting. Outside of work, Janet enjoys fly fishing and thinking about fly fishing.

Evelyn Merrill, Professor, University of Alberta

Evelyn Merrill (Evie) is a Professor in the Dept. of Biological Sciences at the Univ. of Alberta. She received her MSc from the Univ. of Idaho and her PhD from the Univ. of Washington. She has conducted research on Cervid foraging and habitat ecology for the past 40 years in a diversity of ecosystems across North America. She and her students' current research include a 18-year study of the trophic dynamics of a partially migratory elk population in the Rocky Mountains of Alberta, and spatial spread and population transmission of CWD in the prairies provinces of Canada. She is a Fellow of The Wildlife Society, served as President of The Canadian Section and the Alberta Chapter of The Wildlife Society, and is now the Canadian Section Representative to TWS. She served as Editor-in-Chief of the *Journal of Wildlife Management*. Evie has been awarded the Alumnae Award from the University of Idaho, the Dedicated Service and the William Rowan Distinguished Professional Award from the Alberta Chapter of TWS, and the Wildlife Researcher Award from the Rocky Mountain Elk Foundation. Her hobbies include traveling, gardening, horseback riding and entertaining her grandkids.