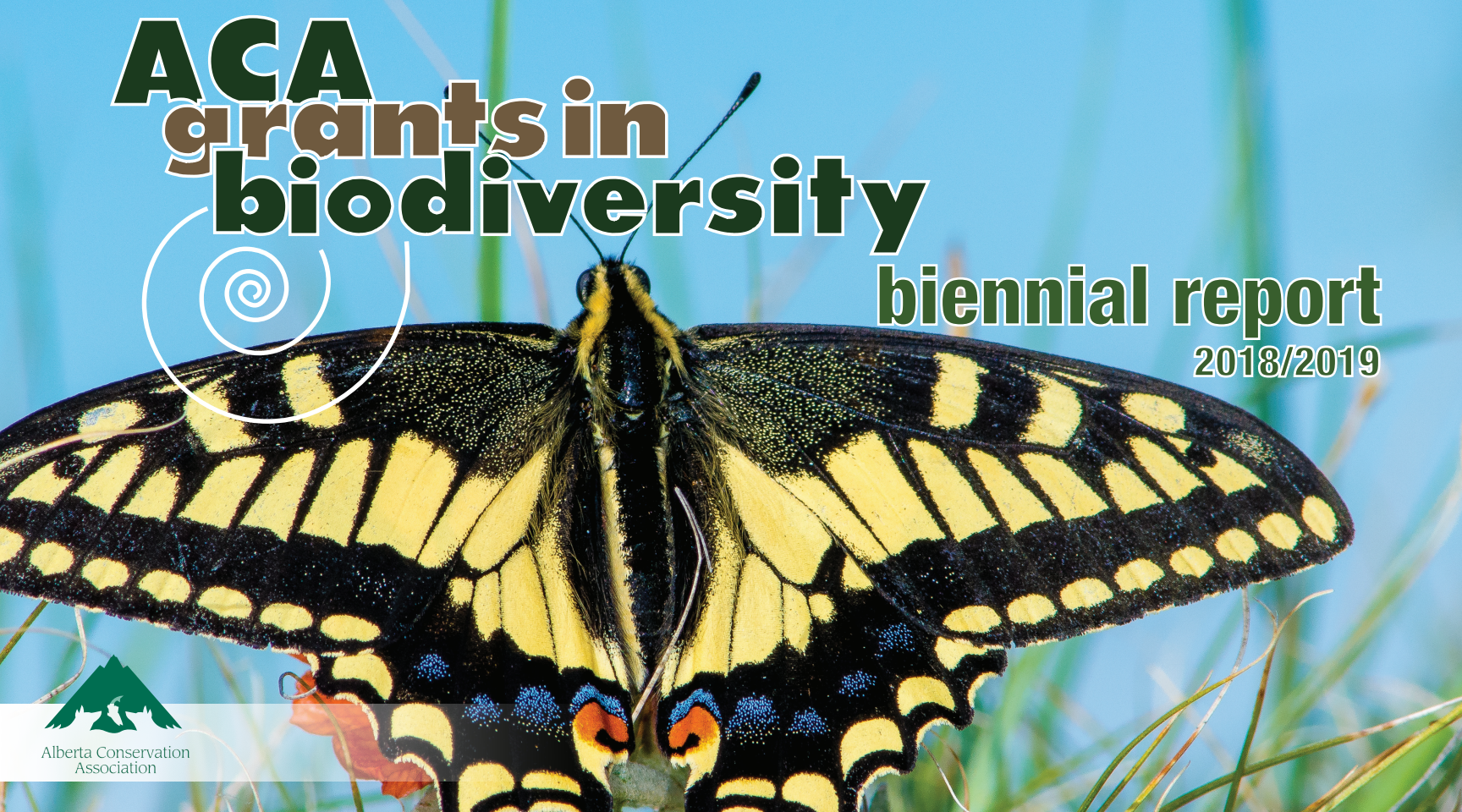
ACA grants in biodiversity

biennial report

2018/2019



Alberta Conservation Association

2019 Director's Message – ACA Biennial Report for Biodiversity Grants

Dear Alberta Conservationists,

Another two years have passed and it is time for another edition of the Biennial Report of the Biodiversity Grant Program! This publication is our way of sharing some of the excellent research being supported by the Alberta Conservation Association. And through the support of the outdoorswomen and men of Alberta, this program continues to be an important initiative that I'm proud to be involved with.

This publication reports on new and interesting research: how fish abundance and diversity can be assessed by environmental DNA; what the behavior of root systems in reclaimed soils can tell us about carbon sequestration; how elk predation interacts with their migration patterns; what isotope analysis can tell us about prey specialization in cougars; and how seismic lines can be refuges for butterfly populations in times of wildfire. And those are only a few of the interesting topics in the pages ahead.

There are multiple people and groups that make this program possible. On behalf of the Alberta Conservation Association, I would like to thank Syncrude for their ongoing financial commitment to this program; the numerous scientific reviewers and adjudicators who are integral to the functioning and professionalism of this program; and I'd like to give specific thanks to outgoing adjudicators Dr. Jana Vamosi (University of Calgary) and Dr. Glen Hvenegaard (University of Alberta). Finally, I would like to thank Tracy Stewart for many hours of work administering this program and creating this biennial report.

I encourage you to take the time to read these pages and learn more about the land and wildlife around us. We are proud of the work of these graduate students and hope this report will inform and inspire you.

Respectfully,

Dr. John K. Pattison-Williams
Director, ACA Grants in Biodiversity

John K. Pattison
ACA Director

Tracy Stewart
ACA Adminstrator

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Photo Acknowledgements

Unless otherwise noted, photos are credited to the grant recipient.

Cover photo: Zachary G. MacDonald

Caption: An adult Old World swallowtail butterfly, *Papilio machaon dodi*, taking in some rays on a sunny south-facing bank of the Red Deer River, Alberta.

Final Reports

Effects of Host Community Structure on Parasite Transmission

Sangwook Ahn
University of Lethbridge, M.Sc.
Dr. Cameron Goater, Supervisor

Ecologists have proposed that host community structure can mediate rates of parasite transmission. An extension of this idea is that rates of transmission decline within diverse host communities via a dilution effect. But there is limited support for dilution because few systems are amenable to manipulation of both host diversity and rates of exposure. I tested for a dilution effect by exposing fathead minnows to cercariae of the trematode *Ornithodiplostomum ptychocheilus* in outdoor mesocosms and in indoor aquaria. A field study of parasite species in fathead minnows was also performed in southern Alberta to correlate any environmental variables that might predict parasite risk. My experiment used containers with minnows alone or with 1-3 other species of fish. Parasites were added to containers and minnows were assessed for parasite intensity 10 days later. My experiments revealed that fathead minnows sympatric with emerald shiners were at a significantly lower risk of parasite infection in both mesocosm and aquaria experiments. Sympatry with brook sticklebacks and longnose dace had no effect on intensity in minnows and the mean parasite intensities were similar to those in minnow-only containers. These results indicate that the decrease in parasite transmission is independent of host diversity, but strongly affected by host identity. Furthermore, my field study indicates a high variation in the intensity and diversity of parasites between sites. A key finding of my field study was determining the presence of a novel, highly pathogenic, myxozoan parasite of fathead minnows that was present in every field site sampled.

Sangwook (aka Micky) exposing fish to parasites in his outdoor mesocosm experiments. Outdoor mesocosms were converted to experimental ponds emulating natural ponds as much as possible using local sources for substrate, algae, and plankton.

Salinity and Nutrients Affect Blue-Green Algae Growth in Shallow Prairie Lakes

Susan M. Anderson
University of Calgary, M.Sc.
Dr. Lee Jackson, Supervisor

Toxic blue-green algae growth is expected to increase in lakes globally. Blue-green algae limits the use of recreational lakes, such as Pine Lake and Pigeon Lake, due to the toxins it produces. It affects drinking water, such as when 500,000 people in Ohio had no potable water for a few days because of blue-green algae in Lake Erie. It also affects wildlife habitat for aquatic plants, aquatic insects, migratory waterfowl, reptiles and amphibians. Blue-green algae grows because of increased nutrients from human activities, such as runoff from agriculture fertilizer and effluent from waste water treatment plants, but the growth might also be affected by lakes getting saltier as the climate gets hotter and drier. To learn how increasing salinity affects blue-green algae growth, I measured nutrients, salinity, blue-green algae and toxins in 25 shallow lakes. I found that increasing salinity can limit blue-green algae growth, and that certain nutrient ratios can lead to more toxins. A few lakes were outliers, of course, but that's part of the puzzle of ecology. Overall, understanding patterns of blue-green algae growth and toxin production in lakes will help predict when a lake might be toxic and when it might not be. Figuring this out may help to target management strategies to lessen toxic blue-green algae growth, which will allow people to fully enjoy lakes, and help to conserve shallow lake habitat that is critical for biodiversity in the Canadian prairies.

Susan takes a sample from a blue-green algae bloom in a lake east of Strathmore, AB.

How do Black-capped Chickadees Respond to Different Types of Information About Predators?

Josue D. Arteaga-Torres
University of Alberta, M.Sc.
Dr. Kimberley J. Mathot, Supervisor

Animals exhibit anti-predator behaviours and may adjust the magnitude of anti-predator behaviour depending on the amount of information they have about current predation danger. In my experiment, I analyzed the anti-predator responses in the feeding behaviour of black-capped chickadees. My aim was to contrast the level of response depending on the source of the information about a nearby predator by using visual cues (a taxidermic mount of a merlin, a predator of small birds including chickadees) and acoustic cues (playbacks of chickadee mobbing calls made in response to a merlin mount) and a combination of both. I also examined the effect of temperature on the anti-predator responses. I carried out an experiment during winter 2018-2019 at the University of Alberta Botanic Gardens near Devon, Alberta. We gave each chickadee a unique identification marker to track the number of visits of each individual to each of the 8 feeders located through the field site. Data analysis is currently underway, but my hypothesis is that more information leads to stronger responses. In the context of these experiments, I predict that more information about their predators—for example, the combination of both acoustic and visual information—will increase the level of response. Additionally, I hypothesize that chickadees trade off food reward against safety from predators, and predict the lower the temperature in winter, the weaker the antipredator response of chickadees to cues of predation regardless of the information source (visual, acoustic, both).

To the left: Black-capped chickadee with bands takes a sunflower seed out of the feeder. To the right: Josue works at the feeders checking the amount of seed left for the chickadees.

Evaluating Trade-Offs: The Effects of Forage, Biting Flies and Footing on Wood Bison Habitat Use

Robert J Belanger
University of Alberta, M.Sc.
Dr. Scott Nielsen, Supervisor
Dr. Mark Edwards, Supervisor

Studies of bison habitat use are often related to forage distribution, quantity, and quality, and rarely examine other relationships and factors that affect distribution and habitat use. I examined trade-offs between summer forage availability for bison with that of biting fly harassment, and soil firmness which affects locomotion and thus energy budgets and carnivore predation-risk. Trade-offs were assessed for 4 habitat types at 9 replicate sites used by bison in the Ronald Lake area of northeast Alberta, Canada in the summer of 2016. I hypothesized that bison use of areas composed of large quantities of forage would be reduced due to greater biting fly abundance and softer footing in these areas caused by increased soil moisture. I used structural equation models to quantify summer and winter bison habitat-use in relation to these factors. I found that graminoid availability was not related to summer habitat use. Summer habitat-use was related negatively to sites with greater biting fly abundance and positively to sites with firmer footing, suggesting that bison observe trade-offs between maximizing forage intake, harassment from biting flies, and soft terrain which can affect locomotion. In contrast, in winter when ground is frozen and biting flies absent, habitat use was related positively to graminoid biomass. In addition to forage quantity, this study provides a more comprehensive understanding of the factors that contribute to bison foraging decisions and habitat use and can help guide strategies for the conservation and management of wood bison populations.

Rob measuring soil penetration depth with a custom soil penetrometer in a marsh meadow where he set three horsefly traps.

Competitive Size-asymmetries in a Native Grassland: What Resources Drive It and What are Its Consequences?

Charlotte Brown
University of Alberta, Ph.D.
Dr. James F. Cahill, Jr., Supervisor

Competition among plant species is an important factor influencing species coexistence and diversity within grassland communities. Plant body size is a well-recognized trait influencing a plant's ability to compete with its neighbours, where larger plants have a competitive advantage over smaller plants. This size-asymmetry of competitive interactions is not well studied in plant communities but has been suggested to reduce species diversity and alter community composition, indicating it may be important to the conservation of native plant communities. Through a large rooftop and field experiment, I tested 1) whether soil properties can alter the degree of size-asymmetric competition and 2) how the degree of size-asymmetric competition influences plant community diversity and structure. Soil nutrient heterogeneity, where soil nutrients are patchily distributed, and soil fertility altered the degree of size-asymmetric competition. The effects of these soil properties, however, varied by species, suggesting species differ in their vulnerability to size-asymmetric competition. The degree of size-asymmetric competition had little to no effect on the number of species found in a community. However, from my field experiment, I used community composition data to test whether size-asymmetric competition can have more nuanced impacts on community structure through altering the relative abundance of species present. These results suggest that belowground resources can drive size-asymmetric competition and that there is an interaction between aboveground and belowground plant responses that alters competitive outcomes. This knowledge provides insight into some mechanisms of community assembly which can help better inform decisions on the conservation of native plant communities.

Assistant Kelsie taking overhead photographs of individual experimental pots used to determine the effects of soil resources on competitive size-asymmetries.

Anuran Calling Responses to Varied Light Conditions using Improved Acoustic Data Processing Techniques

Jillian Cameron
University of Alberta, M.Sc.
Dr. Erin Bayne, Supervisor
Dr. Cindy Paszkowski, Supervisor

Effective monitoring of anuran amphibians is becoming increasingly important as anurans are experiencing high rates of population declines and extinctions worldwide. With advancements in bioacoustic technologies, anurans can be effectively surveyed using autonomous recording units to record breeding vocalizations. However, this produces large volumes of recordings that must be processed to identify which species are present, and current processing methods are time-intensive. My research assessed a new method to efficiently process large amounts of recordings by visually scanning spectrograms. This method allows more surveys to be conducted, which produces more precise estimates of anuran occupancy, compared to the more time-intensive approaches that cannot process as many recordings. I applied this method to determine how the calling behaviour of anurans is affected by natural and artificial light. If light is a factor that alters behaviour, monitoring can be improved to account for these changes in calling to achieve better detection of anuran species. I found that there was no difference in calling behaviour between new moon and full moon phases for the Boreal Chorus Frog and Wood Frog in northern Alberta. However, in urban areas, in the presence of anthropogenic light pollution, the frogs both exhibited reduced calling behaviour. These results suggest that variation in light has little effect on calling behaviour and therefore, the differences observed in urban frog calling patterns could be attributed to other anthropogenic factors. This research can help improve monitoring practices for anurans and inform further research on how urbanization is affecting anurans.

Autonomous recording units were used to record anuran breeding vocalizations. They record on a preprogrammed schedule. Species present at a site can be identified by their calls on the recordings.

Characterizing Alberta Species of Silverspot Butterflies to Support Ecological Assessments

Erin O. Campbell
University of Alberta, Ph.D.
Dr. Felix Sperling, Supervisor

Understanding how species form is essential for effective conservation and management initiatives, yet species boundaries between closely related organisms are often difficult to characterize due to complex evolutionary processes. In Alberta and much of western North America, silverspot fritillary butterflies exhibit high levels of variation in wing colour and patterning, as well as high degrees of range overlap between species. Historically, this has made morphological species identification of fritillaries a daunting task, yet accurate identification and delimitation is essential for this group as several species are in decline due to habitat loss and climate change. New genomic tools are poised to aid in the characterization of species boundaries by revealing the molecular processes inherent in speciation, but until now have yet to be applied to silverspot butterflies. Using this approach, I conducted province-wide sampling of the 11 species present in Alberta and sequenced short pieces of DNA across the entire genome. I then reconstructed evolutionary relationships using genomic data and compared them to our current understanding of species in this group. My results indicate that different genetic markers depict variable, incongruent species relationships, and that wing colour and pattern are not always good predictors of genetic species. Hybridization and close evolutionary relationships have likely produced this discordance, which has important implications for the proper management of at-risk populations. My results underscore the importance of using multiple lines of evidence when delimiting species.

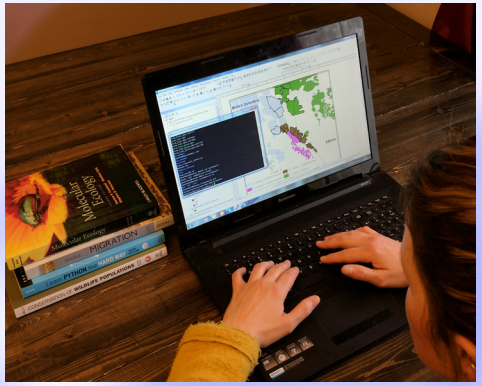
Collecting fritillary butterflies near Waterton National Park, Alberta.

Caribou Genomic Characteristics in Alberta for Management and Conservation Practices

Maria Cavedon
University of Calgary, Ph.D.
Dr. Marco Musiani, Supervisor

I am analyzing both ecological and genetic characteristics of caribou individuals belonging to different Albertan herds to determine the genetic basis of ecological (e.g. differences in habitat selection), behavioral (e.g. sedentary vs sedentary animals) and morphological differences between them. Preliminary results indicate a signature of selection on alleles associated with environmental variables along a North-South gradient. I also found a signature of balancing selection, which could be related to the maintenance of the phenotypic polymorphisms known within these populations. For example, caribou are known to display partial migration, a behavioral dimorphism occurring within a population where a fraction of the population seasonally migrates (i.e. selecting for resources available in seasonal ranges), while other individuals are sedentary throughout the year. The occurrence of balancing selection on partial migratory populations might indicate the action of frequency dependent selection, which has been also found to have a major role in maintaining behavioral polymorphisms in other species. Overall, results indicated differentiation between caribou populations across genes undergoing balancing selection and along an environmental gradient. This information could be used to provide a better delineation of caribou Designatable Units, which have been recently identified by the Committee on the Status of Endangered Wildlife Species in Canada and for which delineation is necessary to implement effective management and conservation plans.

Maria working on data analyses.



Forest in Freefall: 50-Years of Change in the Boreal Forest

Joseph Cooper
University of Alberta, Ph.D.
Dr. Justine Karst, Supervisor
Dr. Suzanne Simard, Supervisor

Given the longevity of trees, spatial patterns are often our only insight on density-dependent processes such as competition and facilitation in forests. Because tree recruitment and mortality events are generally infrequent, long-time scales are needed to confirm trends in forests. I concluded a 50-year forest survey of forest health and spatial patterns at the George LaRoi Forest Plot (GLR) in Alberta. The GLR was originally established in 1967 by Dr. George LaRoi and a complete census of the forest was conducted in 1967, 1977, 1988, and 1997. I completed the 2017 census of the forest and analyzed the 50-years of data for changes in forest health and the distribution of trees within the plot. Over the last 30 years the forest biomass, growth, and seedling recruitment have decreased along with a dramatic rise in mortality. The forest lost 70% of trees due to natural procceses and a combination of disturbance events. The forest experienced periods of intense drought in combination with a prolonged outbreak of forest tent caterpillar, *Malacosoma disstria*, and bark beetles. Cumulatively the results from my study reveal a stressed forest that is departing from natural patterns of forest development due to climate and insect-related stress. The continued interactions of drought and insects may shift other forests in Alberta into similar vegetation types.

Joseph records the tree diameter and species identity (*Betula papyrifera*, Paper Birch) while field-tech Dana measures the tree.

Rangeland Health Relationships with Plant Diversity in Alberta's Grasslands

Craig DeMaere
University of Alberta, M.Sc.
Dr. Cameron Carlyle, Supervisor
Dr. Edward Bork, Supervisor

The majority of Alberta's native grasslands have been converted to cropland, thus, management of remaining grasslands is important to maintain natural functions that provide ecological benefits such as biological diversity. The dominant land use on existing grasslands is cattle grazing, which can have positive or negative effects on plant diversity. The rangeland health assessment tool developed in Alberta is designed to measure grasslands' ability to perform ecological functions such as maintaining community integrity, structure, hydrological function, nutrient cycling, and soil stability, and is assumed to relate to plant diversity. In this study, overall range health scores did not relate to diversity measures, however some components of the scoring system did predict plant diversity. Increases in vegetation structure, hydrological function, nutrient cycling, and soil stability had positive relationships with some diversity measures. The overall score did strongly predict the abundance of introduced plant species – healthy rangelands had very few introduced species. Although these species did not affect diversity, they significantly affected the functional integrity of the community.

Plant species sampling in a pasture utilized for the grasslands range health and biodiversity project.

Detection and Mitigation of Rare Vascular Plants in the Oil Sands Area

Jacqueline M. Dennett
University of Alberta, Ph.D.
Dr. Scott Nielsen, Supervisor

Conserving rare species is important for maintaining biodiversity, especially in regions undergoing rapid land use change such as the Oil Sands Area. Successful conservation depends not only on effective mitigation techniques for plants in proximity to development, but also on reliably locating such populations during pre-disturbance assessment surveys. My research focused on plant detection using volunteer trials with pre-planted decoy plants and mitigative translocation of two rare peatland species, pitcher-plant (*Sarracenia purpurea*) and few-seeded sedge (*Carex oligosperma*). I found that plant density was the greatest determinant of success in targeted surveys, where detection of low-abundance species in large plots was exceptionally poor. Experts and observers with less experience were equally successful in detecting a small number of target species. Repeat surveys can potentially compensate for low detection probability on a per site basis and should thus be used where possible. Mitigative translocation appeared to be a viable conservation action for the two peatland species considered. Survival of both species after three years was high and initial differences in growth between transplants and controls of few-seeded sedge diminished over time. This research is helpful for improving guidelines and best practices for rare plant surveys and mitigation actions within the Oil Sands Area.

An experimental survey plot used in detection trials. Decoy plants were planted in the plots prior to survey by volunteer observers.

Fire and Whitebark Pine Recovery Strategies: Drivers of Post-Fire Natural Regeneration

Luiz Drummond
University of Alberta, M.Sc.
Dr. Mike Flannigan, Supervisor
Dr. Vernon Peters, Supervisor

Whitebark pine is an endangered tree species in Canada. Prescribed burns have been employed as a recovery strategy to create open habitats free of competition for regeneration to occur. However, key questions exist about the success of prescribed burns for restoration of whitebark pine and what role fire plays in whitebark pine communities at its northern geographical limits. This research was aimed to better understand how factors at different scales influence whitebark pine post-fire natural regeneration establishment. I visited four prescribed burns and five wildfires ranging from 5 – 18 years age, and distributed across mountain parks in western Alberta. I found that whitebark pine post-fire seedling density was driven by the existence of favorable conditions at smaller scales, such as lower levels of soil organic matter and intermediate levels of shrub cover. Post-fire conditions remained suitable for establishment up to 18 years on wildfire, but appeared to decline after 10 years on prescribed burns. Although nearby seed sources were not always required, they were important drivers of both whitebark pine regeneration abundance and occurrence, with mean densities averaging 148.8 seedlings/ha, and 93% occupancy at the stand level. Fires allow whitebark pine to escape competition from other tree species in the longer term, but forest community types and the protection of proximal seed sources should be considered in future fire management actions. These results will guide future fire management and restoration efforts to effectively conserve the species.

Field assistants Brendan, Karambir and Nathan collecting data on environmental conditions and white-bark pine regeneration.

The Role of Predator Induced Stress in the Reproductive Decline of a Mountain Goat Population

Frédéric Dulude-de Broin
Université Laval, M.Sc.
Dr. Steeve Côté, Supervisor

Giulia weighing a mountain goat with a remotely controlled electronic platform scale baited with salt.

The rocky mountain goat (*Oreamnos americanus*) population of Caw Ridge was once the largest in Alberta. Over the past decade, the population experienced a drastic decline in abundance and fell by more than 80%, potentially because of higher predation pressure by grizzly bears, cougars and wolves. Unexpectedly, the proportion of reproductive females, which used to fluctuate around 50%, also dropped recently and now varies around 20%. The objective of my project was to assess if the stress induced by high predation pressure could impair the fertility of females in this mountain goat population. I measured the concentration of hormones associated to physiological stress in faeces and hair of marked mountain goats and linked these measurements to the annual predator-occurrence at Caw ridge and to the reproductive success of adult females. My results suggest that predator-induced stress contributed to the decline in reproduction at Caw Ridge. Small populations of alpine ungulates may be especially vulnerable to these indirect effects of predation because they are confined in mountain habitats which could limit their ability to move away when predation risk increases.

Ducks and Development: Nest Success in the Western Boreal Forest

Matthew E. Dyson
University of Waterloo, Ph.D.
Dr. Brad Fedy, Supervisor

Research on how industrial development affects wildlife in Alberta's boreal forest has focused primarily on large mammals. However, there is a large research gap pertaining to the knowledge of breeding ecology of boreal ducks, which is concerning because the boreal is a critical breeding area in North America. Therefore, I investigated where ducks nest in the boreal, identified predators of real and artificial nests, and estimated how industrial development affects predator occupancy. To do this, I searched for and monitored duck nests, established artificial nest transects, surveyed predator communities with camera traps. I located 167 duck nests between 2016 and 2018 and deployed 380 artificial nests. Apparent nest success was 31% for real nests and 55% for artificial nests. Documented nest predators of duck nests included common ravens, red-tailed hawks, black bears, Canada lynx, coyotes, and ermine. I am currently developing resource selection functions to evaluate important habitat features at multiple scales and their relationship with nest success. I am also building hierarchical occupancy models for nest predators to understand how industrial development affects occupancy. I will use the data from this research to make predictions about waterfowl nest success relative to landscape change to inform conservation policy. My research will contribute new theoretical knowledge to boreal forest ecology and waterfowl ecology, while simultaneously testing and informing key waterfowl management assumptions currently in practice.

Matt holding a hen mallard marked with a VHF transmitter prior to release on the edge of a boreal wetland.

Determinants of Elevational Range Limits in the Annual Plant, Yellow Rattle

David J. Ensing
Queen's University, Ph.D.
Dr. Christopher Eckert, Supervisor

Nearly all species have range limits, indicating a limit to adaptation by natural selection at the range margin. This poses a fundamental problem for evolutionary ecology and despite a long history of inquiry and a more recent resurgence of interest, the mechanisms constraining adaptation at range margins remain unclear. Using an elevational season length gradient in the Kananaskis valley, I tested how the timing of reproduction (phenology) contributes to elevational range limits in yellow rattle. Reproductive phenology could limit species ranges when shorter growing seasons (e.g. at high elevation) select for increasingly early reproduction, which requires reproducing at a smaller size, with fewer resources for reproduction. This pattern leads to a trade-off between the timing of reproduction and fitness that, when the season is too short, means fitness declines below self-replacement and a species range is limited. Combining three years of regular visits to natural populations and two years of reciprocal transplant experiments with population genomics studies, I found no size / time trade-off in yellow rattle. Moreover, I found limited evidence of selection on phenology, with only weak selection for earlier reproduction in some years, a pattern independent of season length. However, despite limited genomic diversity and no pattern of genomic variation on the elevational gradient, transplant experiments suggest local adaptation to season length. The presence of local adaptation despite weak evidence of selection on phenology, suggests other traits and environmental characteristics enforce yellow rattle's upper elevational range limit.

Dave planting his reciprocal transplant seeds in Autumn 2015, along the Kananaskis River.

Do Elk Delay Their Return to Areas Recently Visited by Predators?

Mitchell J. Flowers
University of Alberta, M.Sc.
Dr. Evelyn Merrill, Supervisor

Previous research on predation risk typically focuses on short-term or immediate responses after a predator encounter or compares prey space-use to risky areas across large spatial scales, often using kill-sites. However, a prey animal's perception of risk – and the precautionary behaviours that follow – can be initiated long before a predator is directly encountered. Ungulates, in particular, are known to increase vigilance and reduce residency time when detecting fresh predator sign such as urine, scat, and even hair. Using data from a network of remote cameras, I evaluated whether elk visitation rates at camera sites shifted with the presence of wolves, cougars, and grizzlies in summer and winter at the Ya Ha Tinda, which is located adjacent to Banff National Park along the eastern slopes of the Rockies. After controlling for seasonal variation in elk movements, I predicted that depending on group size and/or site characteristics (e.g. proximity to human activity or protective forest cover), elk visitation rates would decrease when predators were present between elk visits. I found that wolf presence consistently reduced visitation rates in both summer and winter, as did the presence of grizzlies and cougars in summer. Sites surrounded by predominantly open habitat had higher visitation rates in winter, whereas sites located farther from the main road corridor, even if surrounded by grasslands, had a lower rate of being revisited in both seasons. This close association with the road was likely due to the elk's use of the ranch facilities as a predation refuge. By modeling the smaller-scale dynamics of elk space-use, this novel and non-invasive approach helps explain how prey can avoid predator encounters altogether to cope with frequent changes in predation risk.

A GPS-collared elk notices the quiet click of the camera while the rest of the herd forages among a burned portion of the grasslands.

Wildlife Responses to Variable Retention Harvesting

Caroline Mary Adrianne Franklin
University of Alberta, Ph.D.
Dr. Ellen Macdonald, Supervisor
Dr. Scott Nielsen, Supervisor

Variable retention harvesting, whereby live mature trees are retained in harvested forests, is used as an alternative to clearcutting to mitigate undesirable effects of forest harvesting on biodiversity. I investigated the influence of different retention harvest levels (0%, 10%, 20%, 50%, 75%, 100% retention) on habitat use by wildlife 15-18 years post-harvest using a combination of midden counts, scat surveys, and camera trapping. I also measured forest structural attributes, including canopy cover, basal area, horizontal cover, log cover, and understory cover, to document habitat differences post-harvest. Habitat use of six species (black bear, coyote, fisher, red squirrel, wolverine, woodland caribou) increased with increased levels of retention. Woodland caribou, a species of conservation concern, was only detected in stands harvested to at least 20% retention. Habitat use of two species (grouse, snowshoe hare) declined with increasing retention level, while habitat use of five species (American marten, Canada lynx, deer, gray wolf, moose) did not significantly vary by retention level. Higher levels of retention were associated with greater canopy cover, basal area, and dead-wood abundance, which likely enhanced habitats for late-seral species. Lower levels of retention were characterized by greater understory and horizontal cover, which likely benefitted early-seral species. These findings demonstrated the value of retention harvesting for conservation of vertebrates in boreal forest, while highlighting the challenge of managing forests for multiple species with different habitat preferences.

A woodland caribou captured by a motion-triggered camera in north-western Alberta.

Canada Warbler Response to Linear Feature Regeneration

Jocelyn M. Gregoire
University of Alberta, M.Sc.
Dr. Erin Bayne, Supervisor

Linear features are a challenge to environmental managers because of their unnatural design and extensive footprint within Alberta's boreal forest. This has implications for species at risk due to habitat removal, degradation and fragmentation. The Canada Warbler is a threatened songbird that lives in upland deciduous forests with dense shrubby vegetation. This suggests a tolerance for regenerating disturbances which develop a similar understory structure. My thesis examines Canada Warbler response to linear features at different stages of regeneration to (a) identify if and how they use the area around the disturbance and (b) determine how the level of regeneration influences this behaviour. Grids of audio recorders (ARUs) were deployed within an individual's territory to triangulate their location over a period of days. Canada Warblers were detected closer to the disturbance on linear features with high densities of beaked hazelnut and tall shrub encroachment. The significant effort required to conduct such field work raised questions on the value of rapid data collection for proactive research on species at risk. Research is ongoing into developing an efficient field method that uses signal strength to determine the relative location of songbirds. Understanding edge use by Canada Warblers will help to identify critical habitat for this species within the industrialized zone. This may also inform reclamation standards for the energy sector by helping to define when a linear feature is considered recovered from an ecological perspective.

Jocelyn carrying ARUs to a site to set up an acoustic localization grid.

Using Environmental DNA to Assess Diversity and Abundance of Alberta Fishes

Jori Harrison
University of Calgary, Ph.D.
Dr. Sean Rogers, Supervisor

Understanding aquatic species diversity is vital to ecological research, policy development, and conservation planning. Environmental DNA testing is a rapidly expanding tool to assess both aquatic species diversity and abundance. In this technique, genetic material shed from living organisms is isolated from the water, and DNA tests are used to infer the species that are present. However, there are multiple biological, hydrological, and biochemical factors that can influence eDNA detection; and there are many uncertainties in the reliability of such tests. In addition, it was unknown if such a technique would work in Alberta's winter conditions, as low temperatures may lead to less fish movement and less tissue shedding. To test these factors, I used an experimental setup using 12 320m replicated research streams. I caged three different fish species (*Oncorhynchus mykiss, Oncorhynchus clarki-lewisi*, and *Salvelinus fontinalis*) in each of these streams, and collected water samples at the start, middle, and end of each stream for three days. I isolated DNA from these samples and sequenced three regions of the mitochondria. I found that all species were detected along the entire length of the stream even in very cold temperatures, but that there were significant amounts of variation in the amount of DNA recovered that was unrelated to the number or size of fish caged within the streams. Using eDNA to determine the number of fish present should be viewed with some caution, and additional studies are needed to determine the environmental and biological causes of the variation in eDNA amounts.

Field assistant, Adam, collecting water samples next to the fish cages.

Maternal Stress Physiology, Not Anthropogenic Disturbance, Influences Nestling Stress Physiology

Alexandra L. Heathcote
University of Manitoba, M.N.R.M.
Dr. Nicola Koper, Supervisor

In recent decades oil and gas development and associated infrastructure have increased in central North America, fragmenting grassland ecosystems and introducing anthropogenic noise to the soundscape. The non-lethal effects of these disturbances on the landscape may impact grassland songbird nestlings during a critical period of development when energetic demands are high. To determine how anthropogenic disturbance and chronic noise impacts the development of chestnut-collared longspur (*Calcarius ornatus*) nestlings, I isolated noise from the associated infrastructure by broadcasting generator-powered screwpump recordings on the short- and mixed- grass prairies of southeastern Alberta using solar-powered playback units. I then took blood samples from mothers and their nestlings close to and far from noisy playback units and active screwpumps to quantify corticosterone, a hormone used to measure an individual's ability to respond to and cope with stressful environments. Increased corticosterone during development may lead to reduced growth rates and changes to adult behavior and physiology, potentially impacting long-term survival. Surprisingly, my results indicate that maternal corticosterone has a stronger effect on nestling corticosterone than anthropogenic disturbance. Stressed mothers may provide more unpredictable care to their nestlings potentially increasing the energetic demands on individuals, resulting in increased corticosterone levels. Identifying the underlying mechanisms leading to the decline of grassland songbirds will aid land managers in the difficult task of mediating human impact during vulnerable stages of their life history.

Chestnut-collared longspur nestlings begging for food. Photo by Chris Ng.

Resilience of Mountain Pond Communities to Extreme Thermal Regime Shifts

Mitchell A. Johnsen
University of Alberta, M.Sc.
Dr. Rolf Vinebrooke, Supervisor

Recent climate warming rates have been shown to increase with elevation, hypothetically affecting cold-adapted alpine communities more adversely than montane communities at lower elevations. I tested this hypothesis by conducting a replicated experiment involving a reciprocal transplant of regionally-sourced alpine and montane pond communities across two elevational sites (1390 m versus 2345 m asl). At each site, half of the mesocosms had plankton and sediment (containing egg-banks) collected from alpine ponds introduced, while the other mesocosms were similarly seeded with a regional species pool and sediment collected from montane ponds in 2016. After overwintering, the mesocosms were sampled for temperature and plankton during the ice-free periods of 2017 and 2018. The mesocosms at the montane site were an average of 8.0°C warmer than those at the alpine site. Total community biomass was predominantly affected by the elevation where the mesocosms were located. Elevation effects revealed that the temperature difference affected the timing of species within the assembled communities, but not their total biomass. Analysis of species traits revealed that warming selected for smaller body size and asexual reproduction as a warmer environment stimulated several small herbivores while suppressing larger, sexual omnivores. Nevertheless, the overall mean trait identities of either transferred pond community was not substantially affected. This highlights ponds as potential sources of functional resiliency for lake ecosystems against increasingly extreme climate change.

Alpine site mesocosms in Banff National Park.

Function-Specific Habitat Use of Common Nighthawks in the Boreal Forest

Elly C. Knight
University of Alberta, Ph.D.
Dr. Erin Bayne, Supervisor

Consideration of habitat function can be important for understanding the habitat attributes of mobile species that use separate areas for different functions (e.g., foraging, nesting). Understanding a particular function-specific habitat can also be important for management if that habitat contributes disproportionately to fitness or survival. However, functional significance is often ignored during habitat modelling because the behavioural context required is usually inferred from movement patterns in tracking data, which can be difficult to obtain. I propose that the type and rate of avian acoustic signals could also be used to infer functional significance. I conducted observations of individual Common Nighthawks (*Chordeiles minor*) to link their acoustic signals to the function of the habitat they were using. I found the rate and type of acoustic signal could be used to differentiate between some habitat functions. I then used these acoustic proxies to build two habitat models for northeastern Alberta: one that did not consider habitat function and one for nesting habitat. I found that the models identified different habitat attributes. I also showed that the model that did not consider habitat function predicted much of the study area as moderate suitability, while the nesting habitat model clearly differentiated between areas of high and low suitability. My results suggest that function-specific models may be important for conservation management of the Common Nighthawk, which is listed as *Threatened* under the federal Species at Risk Act. The bioacoustic methods developed during my research will also facilitate habitat modelling for other bird species.

Matt and Elly affix a VHF transmitter to the tail of a Common Nighthawk (*Chordeiles minor*) for individual identification.

Iridescent Coloration of Tree Swallows as an Early Indicator of Metal Pollution

Natalia Lifshitz
University of Alberta, Ph.D.
Dr. Colleen Cassady St. Clair, Supervisor

Ornamental coloration in birds has been identified as a powerful, non-invasive tool for identifying exposure to metal pollution. Despite this potential, few studies have examined the effects of metals on iridescent coloration or assessed related impacts on bird reproduction. Iridescent coloration is likely to be sensitive to metal pollution because it is already known to affect melanin production and this form of coloration is produced when light is refracted through layers of keratin, air and melanin inside feathers. In this study, I measured plumage coloration of adult tree swallows (*Tachycineta bicolor*) nesting on a gradient of urbanization and compared colour metrics to bird health (measured with oxidative stress) and reproductive success (measured by brood mass). Plumage blueness declined, while feather brightness increased with increasing exposure to copper and zinc. Both patterns would be expected from a decline in melanin production or availability. Unexpectedly, increasing exposure to these metals correlated with increased apparent health (lower oxidative stress) in female swallows, but not males. Metal exposure caused a decline in brood mass only for early-laying birds. Finally, brighter males had lighter chicks. More information about the complex relationships between ornamental color, including iridescence, and fitness metrics will be needed to use feather colour as a proactive, non-invasive and effective diagnostic tool for detecting subtle effects of pollution on birds. To support that goal, I am developing a method for standardizing digital photographs from remote cameras to document, without capture, changing colouration of wild birds among sites and over time.

Tree swallow perched on water-quality warning sign at one of Natalia's urban sites.

Spatial Predation Risk for Elk in a Multi-Predator Community

Kara M. MacAulay
University of Alberta, M.Sc.
Dr. Evelyn Merrill, Supervisor

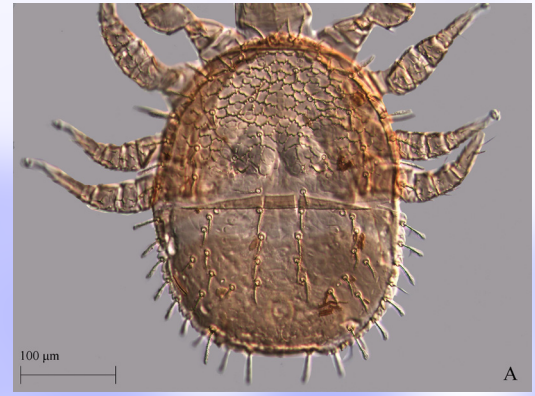
Previous approaches quantifying predation risk have focused on predator space use or kill sites, approaches that can be costly and result in low sample sizes. I used a non-invasive alternative based on predator scat distribution and contents to spatially map predation risk for the partially migratory Ya Ha Tinda elk herd in Alberta, which has exhibited a shift in migration patterns. Scats were collected from bears, cougars, coyotes and wolves during the summers of 2013-2016 using detection dogs. I combined maps of scat-based resource selection functions and scat contents (n = 476) from macroscopic and DNA analyses to map predator-specific predation risk to the different migratory segments of the elk herd. Contents of cougar, wolf, and coyote scats had high overlap in multivariate space, whereas bears had reduced overlap due to more vegetation in scats. Elk more frequently occurred in wolf and bear scats found on resident elk ranges near Ya Ha Tinda, and elk presence in scats was associated with areas of high herbaceous forage biomass and open cover. Elk more frequently occurred in cougar scats on industrial forests east of Ya Ha Tinda where forest edge density is high. Based on combined expectations of predator distribution and scat contents, elk that migrate west into Banff National Park were exposed to lower predation risk relative to the resident and eastern segments. While the eastern migrants have higher calf survival, these data show the demographic benefits may eventually reverse due to higher risk by predators on this segment of the population.

Kara collecting predator scat in Banff National Park to be analyzed for prey contents.

Can Predator Mites Indicate Changes to Forested Areas in Alberta?

Matthew L. Meehan
University of Alberta, M.Sc.
Dr. Heather Proctor, Supervisor

Predatory mesostigmatid mites (Arachnida: Parasitiformes: Mesostigmata) are among the most diverse and abundant groups found in belowground communities. However, relatively little is known of their sensitivity to shifts in environmental conditions. The Albertan landscape is constantly changing due to natural (e.g. forest fires) and human-made (e.g. forest harvesting, mining, agriculture) disturbance events. Given their diversity and high food chain position, mesostigmatid mites are good candidates as indicators of disturbance in Albertan soils. Samples for my M.Sc. were collected by the Alberta Biodiversity Monitoring Institute, and extracted and stored in the Royal Alberta Museum. I examined the effectiveness of predator mesostigmatan assemblages as indicators of forest fire, forest harvest and linear disturbance (e.g., pipelines, powerlines, seismic lines). In total, I identified over 100 species/morphospecies of mites, from ~40 genera and 20 families. A pictorial database of these mites can be found at https://mesostigmataofalberta.wordpress.com (Meehan and Turnbull 2017). I found that mesostigmatid mites were indicators of all three-disturbance types at the species-, genus-, and family-level. Now that there is a pictorial database for soil Mesostigmata of the northern Alberta region, I recommend their use as indicators for these disturbance types, and potentially for other disturbances present in Alberta.



A dorsal shield for *Parazercon radiatus* (Zerconidae) from Meehan and Turnbull (2017). Note the ring-shaped pattern of setae on the lower dorsal shield, a notable feature to identify this species.

Identifying Roots of the Boreal Forest with Molecular Tools

Paul A. Metzler
University of Alberta, M.Sc.
Dr. Justine Karst, Supervisor

Identifying roots to species is challenging, yet a common problem in ecology. While identifying flowers and leaves is relatively straightforward, identifying roots to species can be difficult. Identification is especially challenging when roots are excised from aboveground stems and sampled in bulk, i.e., the usual method of sampling roots with a soil core. Because of logistical barriers to observing roots, many studies rely on aboveground plant parts, even though their belowground characteristics may be more illuminating. For instance, neglecting roots has resulted in underestimates of global carbon stocks, plant primary production, length of growing season, and plant diversity. I expanded on a molecular method to identify roots based on the lengths of key DNA regions. Fluorescent amplified-fragment length polymorphisms (FAFLPs) are accurate, inexpensive, and allow analysis of mixed-species samples without the time-intensive bioinformatics and high expense associated with high-throughput sequencing. I found that this method was accurate when considering a small species pool but distinguishing among the hundreds of species included in this study was more difficult. The ability to identify small fragments of roots will allow researchers to relate data from soil to data from plants at the species level. This has the potential to help us understand how roots contribute to global carbon stocks, how roots behave in reclaimed soils, and how plants interact with belowground symbionts.

Paul digging up a voucher specimen.

Ferruginous Hawk Response to Transmission Line Development in Southwestern Alberta

Nick W. Parayko
University of Alberta, M.Sc.
Dr. Erin Bayne, Supervisor
Dr. Troy Wellicome, Supervisor

Within their Canadian range, Ferruginous Hawks (FEHA; *Buteo regalis*) have experienced severe population declines and are currently listed as Endangered in Alberta and are federally Threatened. As grassland specialists, FEHA are primarily threatened by habitat loss and anthropogenic development. Energy infrastructure such as oil and gas wells, windfarms, and transmission lines are commonly encountered in native grasslands and, in the case of transmission lines, their indirect effects are relatively understudied. In Alberta, transmission lines are expected to increase by 4,000 km in the next two decades alone. Previous research is divided on the effects of transmission lines on FEHA, with some suggesting they be used as a passive conservation technique and others proposing the use of perch deterrents. My objective was to assess the influence of transmission lines on FEHA nest and reproductive success, fidelity, and the likelihood of nest blowout from different structures in southwestern Alberta. From 2013-2017, field surveys were performed to assess the number of suitable nesting sites in survey blocks and to determine the breeding success of FEHA through weekly nest monitoring. Preliminary results suggest that transmission lines may provide suitable nest-sites for FEHA nest success and reproduction, however, their vulnerability to extreme winds may influence ability for birds to re-use old nests – their preferred nesting strategy. This study is ongoing and my results will provide recommendations to industry and energy developers for Ferruginous Hawk mitigation strategies.

Three recently fledged Ferrugionus Hawks practice their flying skills atop a large nest in a transmission tower in southern Alberta.

Seismic Lines are Wildfire Refugia for Plants and Butterflies

Federico Riva
University of Alberta, Ph.D.
Dr. Scott Nielsen, Supervisor
Mr. John Acorn, Supervisor

The challenge of understanding how composite disturbances affect ecosystems is a central theme of modern ecology. Indeed, anthropogenic footprints and wildfire are increasing globally, including in Alberta, but how their effects combine remains poorly understood. I assessed how the disturbance legacy of seismic lines cleared for assessments of oil sands affected wildfire severity, and thus plants and butterflies, in boreal peatlands. I hypothesized that seismic lines could reduce fire severity, and thus support plants and butterflies in the presence of a severe wildfire (the "refugium hypothesis"). To test this hypothesis, one year after the Fort McMurray Horse River wildfire of 2016 I assessed changes in plant and butterfly assemblages across forests and cutlines, from unburned and severely-burned peatlands.

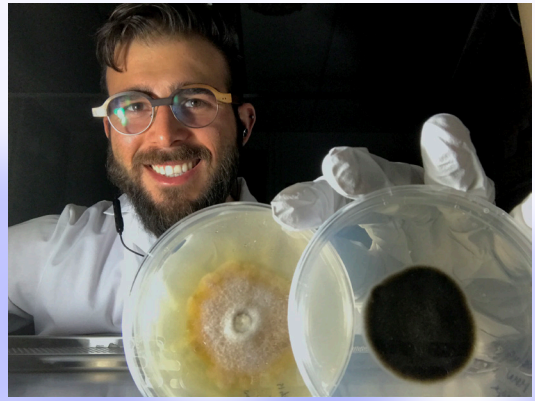
The amount of burned duff was 5-times higher in burned forests compared to burned cutlines. I found 107 plant and 46 butterfly taxa, with species richness of both plants and butterflies being approximately 1.5 times higher in lines than in forests, independently from wildfire. Both plant and butterfly species demonstrated various responses to disturbance. Seismic line refugia occurred for 20% of plant and 70% of butterfly species, which decreased with fire but where more common in seismic lines within burned forests. I showed how anthropogenic refugia occur in these peatlands, yet different patterns of responses confirm how complex are the effects occurring when different disturbances combine. Further studies should investigate the implications of these results on recovery trajectories of these forests' succession after wildfire.

A seismic line burned during the Fort McMurray Horse River wildfire of 2016. In these features, many plant and butterfly species were observed despite the severity of fire disturbance observed in the surrounding forests.

Can Root-Associated Fungi Prevent Carbon Shortage in Pines by Becoming a Source?

Jean C. Rodriguez-Ramos
University of Alberta, Ph.D.
Dr. Nadir Erbilgin, Supervisor
Dr. Justine Karst, Supervisor

Prolonged droughts are not novel disturbances in Alberta; some have lasted decades and reoccurred multiple times in the past. Water stress negatively impacts seedling performance, carbon fixation, and forest productivity. However, mycorrhizal fungi might play a crucial role in alleviating effects of low water potential in seedlings through symbiotic-mediated stress resistance. Specifically, ectomycorrhizal fungi could become a carbon source to its host in scenarios where water stress in plants leads to carbon shortage due to declines in photosynthetic rates. To test this, I germinated lodgepole pine seedlings aseptically and inoculated their roots with ectomycorrhizal fungus, *Rhizopogon rubescens*, grown in nutritional media containing 13C-labelled glucose. After inducing a water-stress in the system, I traced the labelled carbon in the needles to test whether the fungus provided carbon to the host. Additionally, I quantified the expression of plant chitinase genes to test whether a mechanism in which the plant access carbon from its root symbiont is by breaking down the fungal cell wall to release the simple sugars in it. Soon, I will be receiving the results from the isotopic quantification and these will be combined with the genetic results in order to analyze and draw conclusions from them. Finding labelled carbon in plant tissue would suggest that the nutrient dynamics between the host and its symbiont could change in drought scenarios where the photosynthetic rate of the host is not optimal. As soon as data is analyzed, I will be updating the results.



Jean getting ectomycorrhizal fungal cultures ready for lodgepole pine root inoculations. *Rhizopogon rubescens* (left) and *Cenococcum geophilum* (right).

Behavioural Transmission of Chronic Wasting Disease in Mule Deer and White-tailed Deer

Kelsey Saboraki
University of Winnipeg, M.Sc.
Dr. Susan Lingle, Supervisor

Chronic Wasting Disease (CWD), a transmissible, fatal prion disease, is becoming more common in populations of mule deer and white-tailed deer in Canada and the United States. In Alberta and Saskatchewan, CWD is more common in mule deer than in white-tailed deer and in males than in females of both species. To test whether species and sex differences in behaviour can explain differences in CWD transmission and prevalence, I observed 82 mule deer and white-tailed deer, including males and females of both species, at the McIntyre Ranch in southern Alberta during the 2016 breeding season. Mule deer had a higher probability of direct deer-deer contact than did white-tailed deer, due to the higher frequency and duration of contact between mule deer males and females during courtship interactions. Higher levels of direct contact between mule deer males and females during the breeding season has the potential to increase their risk of prion transmission compared to white-tailed deer. Contact was more frequent and longer in duration during late stage courtship (i.e., a male tending an estrous female) than during early-stage courtship (i.e., a simple investigation of a female). Whereas females engage in late-stage courtship during the 1-2 day estrous period, a male that is successful in tending females will continue to engage in high-risk courtship throughout the breeding season. As a result, males of both species should be at higher cumulative risk of prion transmission over the breeding season than conspecific females.

Mule deer males closely investigate females (top) while white-tailed males tend to investigate females at larger-distances (bottom).

Lincoln's Sparrow Song Variation as a Response to Chronic Industrial Noise

Natalie V. Sánchez
University of Alberta, Ph.D.
Dr. Erin M. Bayne, Supervisor

Human-caused noise creates a new environment for animals, especially for those that rely on acoustic communication to perform fundamental behaviors such as mate attraction and territorial defense. Songbirds are one of the groups that have been reported to be more sensitive to human-caused noise, but not all the species respond to noise to the same degree. My aim is to determine how a common songbird in Northern Alberta (Lincoln's Sparrow, *Melospiza lincolnii*) is adapting its song to deal with chronic industrial noise. In 2017, I deployed grids of 12 acoustic recording units to record Lincoln's Sparrow songs in breeding territories close and far from compressor stations, the recorders were active during June 2017. In 2018, I identified breeding territories of Lincoln's Sparrows close to compressor stations. I color-banded the males to confirm bird-unique identification and to record good-quality songs with a manual recorder. I also performed playbacks of the recorded songs close to compressor stations to determine which song features are best transmitted in noisy locations. The analysis of the songs is in the process of being completed. Based on preliminary results, Lincoln's Sparrows are adjusting their songs in quiet habitats with different forest structure. This finding supports the premise of song adaptation in noisy conditions. This study will contribute to understanding how the species are adapting to chronic noise and future management actions regarding where the noisy sites are located to have less impact on vocal species.

Natalie holding a color-banded Lincoln's Sparrow male.

Restoration of Degraded Off-Highway Vehicle Trail Crossings in Wet Areas

Raiany Dias de Andrade Silva
University of Alberta, M.Sc..
Dr. Anne C.S. McIntosh, Supervisor
Dr. S. Ellen Macdonald, Supervisor

Off-highway vehicle (OHV) use in natural areas can result in ecosystem changes. Wet areas have low resilience and long recovery times following disturbances. Numerous unmanaged OHV trails traverse wet areas within Blue Rapids Provincial Recreation Area (BRPRA), Alberta. This project focused on the revegetation of enhanced trails (previously disturbed trails treated with access control and/or recontouring) in BRPRA, including: an investigation of three approaches for establishment of balsam poplar (*Populus balsamifera*) using cuttings (stems cut from donor plants) to identify which would be the most effective for restoring native forest canopy vegetation; and exploring how plant communities differ on restored trails, adjacent edges, and undisturbed forests. My treatments were unrooted (from dormant cuttings; collected in the winter; planted in spring), rooted (from dormant cuttings; rooted in a greenhouse; planted in the fall), and direct plant (from greenwood; collected in the summer; immediately planted). I measured initial diameter at planting day and monitored survival and height growth for two growing seasons. In addition, I conducted vegetation surveys to compare the plant community composition on different trail positions. The "rooted" treatment resulted in better survival but did not result in better height growth in the second growing season than the other two treatments. Initial diameter positively influenced height growth in both growing seasons. I recommend potential use of all three treatments, but which one to use will depend on the specific needs of a restoration program. Restored OHV trails and their associated edges had different plant communities when compared to adjacent forested areas. Longer-term monitoring of the enhanced OHV trails can help inform their successional trajectories.

Enhanced crossing: a) in the year of enhancement activities, in June 2017; and b) one year after enhancement activities, in August 2018.

Trace Elements in Berries: Distinguishing Root Uptake from Aerial Deposition of Dusts

Samantha Josee Stachiw
University of Alberta, M.Sc.
Dr. William Shotyk, Supervisor

Bitumen mining and upgrading operations in the Athabasca Bituminous Sands Region (ABSR) may lead to increased concentrations of trace elements in the surrounding environment. Elevated concentrations of potentially toxic trace elements could pose a risk to local indigenous communities through the contamination of native berries that are an important part of their traditional diet. I collected berries from around Alberta including traditional berries grown in proximity to mining, and berries grown in remote locations. Using ICP-MS in the Ultra Clean SWAMP laboratory, I was able to calculate concentrations of 19 trace elements. I was able to compare the trace element concentrations in the ABRS berries to concentrations found in the remote berries. In contrast, concentrations of Cr, Li, Pb, U, V, and Y were 2-24 times greater in ABSR berries compared to those grown in remote locations. A further study, comparing trace elements ratios found associated with the berries to concentration ratios found in the earth's crust determined that Al, Co, Cr, Ga, Pb, U, V, and Y were all associated with dust deposition onto the surface of the berry, where elements such as Cd, Cu, Mn, Mo, Ni, Sr, and Zn are associated with absorption through the plant roots.

Clean and dusty berries collected from around Alberta.

Impacts of Mountain Pine Beetle on Understory Vegetation in Alberta

Julie A. Steinke
University of Alberta, M.Sc.
Dr. Ellen Macdonald, Supervisor
Dr. Vic Lieffers, Supervisor

Mountain pine beetle (MPB), a native bark beetle that kills mature lodgepole pine trees, is expanding from British Columbia eastwards into novel areas in west-central Alberta, where pine forests have important ecological differences as compared to those in this beetle's historical range. To understand the effects of MPB attack in Alberta at varying severities, I conducted an experiment in which MPB attack was simulated, and assessed responses of understory vegetation. Treatments included: high mortality, medium mortality, simulated salvage logging operation, and untreated control. Seven years post-treatment, soil nutrient and moisture availability did not differ among treatments; however, high mortality resulted in reduced canopy cover and increased light. This was accompanied by changes in understory vegetation that differed according to treatment; more severe treatments resulted in larger increases in vegetation richness and larger changes to community composition, which occurred along a gradient of severity. These increases in vegetation may have been a result of their ability to use up additional nutrient and moisture that became available due to mortality of canopy trees. Grasses and mosses were impacted the most heavily by these treatments; grasses responded positively while mosses responded negatively to increasing disturbance severity. My results indicate that the severity of attack may determine the magnitude of vegetation changes, and potentially the ensuing succession, of a stand. These results provide novel insights into the potential transformations in forest composition, structure, and diversity that could accompany MPB attack in this landscape, and can aid in future management decisions for these forests.

The canopy of a simulated mountain pine beetle killed stand.

Fisheries Productivity in Northern Boreal Lakes: Implications for Offsetting

Michael W. Terry
University of Alberta, M.Sc.
Dr. Mark Poesch, Supervisor

Despite covering less than 1% of the Earth's surface, freshwater ecosystems support a disproportionally large number of species, including approximately 9.3% of all described animal species and roughly one third of all vertebrates. Unfortunately, these ecosystems are also experiencing rates of biodiversity decline that rival tropical rainforests and freshwater fish have exhibited the highest rates of extinction among all vertebrates in the 20th century. In an effort to counter this decline and balance biodiversity conservation alongside economic development, fisheries managers in the Alberta oil sands have turned to the construction of new lakes (i.e. compensation lakes) to offset any residual impact to an affected fishery. However, these systems are being implemented despite numerous conceptual and practical challenges, including how to accurately calculate the amount of offsetting required to achieve no net loss in fisheries productivity. This study demonstrates the role of active SONAR in developing criteria for evaluating and enhancing offsetting projects using data collected from six natural relatively pristine lakes in the Alberta oil sands. The results of my study will contribute to (1) establishing natural levels of fisheries productivity in the region, and (2) help evaluate behavioral and physiological responses of fish to their environment. Improving our understanding of the mechanisms driving fish productivity will help guide adaptive management strategies and ensure the long-term sustainability of freshwater resources in this region.

Michael, Mike and Jess electrofishing on Steepbank Lake.

Song Rate as an Indicator of Breeding Status in the Olive-sided Flycatcher

Emily Upham-Mills
University of Alberta, M.Sc.
Dr. Erin Bayne, Supervisor
Dr. Samuel Haché, Supervisor

Monitoring breeding activity of songbirds is challenging and time-consuming, but the resulting demographic data are important for bird conservation. Fortunately, a male's singing behaviour may help inform biologists of his breeding status because singing rate tends to correlate with breeding status. The objective of my study was to determine if variation in song rate can be used to predict the breeding status of the Olive-sided Flycatcher (*Contopus cooperi*), a threatened species in Canada. In 2016 and 2017, I monitored 36 flycatcher breeding territories in northeastern Alberta and the Northwest Territories. I recorded the males' song rates in person and using autonomous recording units (ARUs). I developed a predictive model to determine the probability of being single, paired, or feeding young based on a male's average singing rate. My results show that we can predict the correct breeding status with 70% success when using the in-person data. The ARU-collected data are more challenging to predict from, due to bird movement away from the recording unit. I will continue to work with the acoustic recording data to determine if finer temporal scale song rate data improve breeding status predictions.

Emily holding an adult Olive-sided Flycatcher at a breeding territory north of Fort McMurray, Alberta.

Size-based Task Partitioning in Ants

Mari A.West
University of California, Riverside, Ph.D.
Dr. Jessica Purcell, Supervisor

Task partitioning is important to the ecological success of social insects, as it allows for efficient behavioral coordination. Commonly, within-colony variation among workers in body shape (morphological castes) or age (temporal castes) enables workers to specialize in tasks. However, few studies focus on task partitioning in social insects that are variable in size, but not shape. I conducted a mark-recapture experiment on several *Formica* species, which possess continuous worker size variation but differ in the scale of within-colony variation. While focusing on three external tasks, I paint-marked 8,831 ant workers from 51 colonies and observed them over two days. Of 3,520 recaptured workers, 98.6% performed the same task, demonstrating that *Formica* displays high task fidelity. Head-width measurements reveal that worker size is strongly associated with task, particularly in colonies with high worker size variation. During a second experiment, I investigated whether worker size impacts task performance. I divided workers from 12 field-collected colonies into three 50-worker groups of the following treatments: only small, only large, and mixed-size workers. I measured the amount of nest material and sugar-water each group collected over eight-hour periods and video recorded their behavior. Preliminary analyses suggest that large workers, which are more costly to produce, perform better, even at tasks that small workers specialize on in nature, suggesting a potential trade-off. A better understanding of size-based task allocation, a seldom recognized, but potentially widespread strategy, will be important for predicting the resiliency of different social insects in the face of global change.

Mari's team painted ant workers' abdomens with a task-specific color to observe whether they were task consistent. This *Formica obscuriventris* worker is posing with a heart-shaped paint mark.

Using Stable Isotope Analysis to Infer Prey Specialization of Cougars

Samantha L. Widmeyer
University of Alberta, M. Sc.
Dr. Mark S. Boyce, Supervisor

Although typically regarded as a generalist species, individual cougars specialize on specific prey-types. Traditional methods for estimating cougar diets are laborious, time consuming, and often costly. To circumvent these drawbacks, my study used –13C and –15N stable isotope analysis (SIA), a form of chemical tracing, to estimate prey specialization for seven cougars. This method is based on the assumption that "you are what you eat"; carbon and nitrogen stable isotopes from prey tissues are incorporated into consumer tissues after prey have been digested. Based on this assumption, the stable isotope content of cougar hair was expected to reflect the isotopic content of their diet. With isotope data derived from analysis of cougar and prey hair, I used mixing models to tease apart the contribution of each prey-type to an individual cougar's diet. I then estimated the specialization of each cougar, defined as the prey-type contributing the greatest proportion of diet. I compared our SIA results to estimates derived from kill-site analysis. From my kill-site data, with respect to biomass consumed, I found two cougars specialized on bighorn and five specialized on deer. My SIA results complemented these findings; however, I was unable to separate the isotope values of some ecologically similar prey species, likely due to their high degree of niche overlap. My results suggest SIA can be used as a low-resolution proxy for estimating cougar prey specialization, particularly to determine if cougars are specializing on bighorn sheep or prey from the cervidae family.

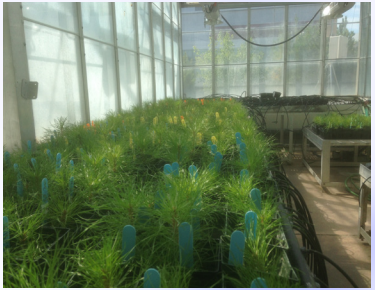
Samantha sampling whiskers from a female cougar. "Poppy" (F2) was captured on November 11 2017 and observed to specialize on bighorn sheep over the study period. Photo by Conor Mallory.

Progress Reports

Impact of Disturbance Altered Soil Fungal Communities on Pine Regeneration

Jackson Beck (M.Sc.)
University of Alberta
Supervisor: Nadir Erbilgin

I investigate how forest disturbances impact soil fungal communities and the cascading impacts of these disturbances on lodgepole pine carbon allocation and performance. This work may indicate which disturbed communities and fungal taxa improve lodgepole pine performance, helping to inform management of disturbed lodgepole pine stands.



Lodgepole pine seedlings growing in the greenhouse at the University of Alberta.

Feral Horse Ecology and Management in the Alberta Foothills

Paul Boyce (Ph.D.)
University of Saskatchewan
Supervisor: Philip Mcloughlin

Feral horse population growth may impact many native species on the Alberta landscape. The population in the Alberta foothills has not been studied since the late 1970s and there exists very little information regarding the population, which is critical to informing effective management strategies. This project will provide population demographic and species overlap information required to assess the impact of the population.

Paul collecting data from one of 130 camera traps.

Montane Alberta Bumble Bees and Landscape Changes

Danielle Clake (Ph.D.)
University of Calgary
Supervisor: Paul Galpern
Supervisor: Sean Rogers

My project is investigating the impact that landscape heterogeneity can have on populations of bumble bees, and the ability of these important pollinators to survive, disperse, and specialize in different habitat conditions. My research tests ecological and evolutionary predictions that will help enhance our understanding of how susceptible bee populations will be to existing and predicted climate and landscape changes, and under which conditions they would be more likely to persist.

A blue vane trap set up to sample bumble bees in the Alberta Rocky Mountains.

Phytoplankton Communities as Indicators of Water Quality in a Changing Climate

Jenna Cook (M.Sc.)
University of Alberta
Supervisor: Rolf Vinebrooke

Maintaining water quality of freshwater environments is important for ecosystem services and to sustain biological life. Because the effects of climate change are exaggerated at high elevations, by monitoring many mountain lakes with a large elevation span, determining the drivers of phytoplankton changes at high elevations can allow us to predict water quality changes at lower elevation sites.

Filtering apparatus used to concentrate phytoplankton cells from Honeymoon Lake.

Beavers as Biomonitors of Trace Element Contamination in Northern Alberta

Melissa Dergousoff (M.Sc.)
University of Alberta
Supervisor: William Shotyk
Supervisor: Glynnis Hood

Bitumen mining and upgrading activities in northern Alberta may be exposing commonly trapped species like beavers to inorganic contaminants. By determining whether beavers can serve as biomonitors of trace element contamination, we can assess the impact of industrial activity on wildlife and provide a methodology for future research on culturally and ecologically relevant species.

Learning about beaver habitat at Miquelon Lake Provincial Park, AB.

Climate Change Refugia Potential of Boreal Hills in Alberta

Cesar Estevo (M.Sc.)
University of Alberta
Supervisor: Erin Bayne

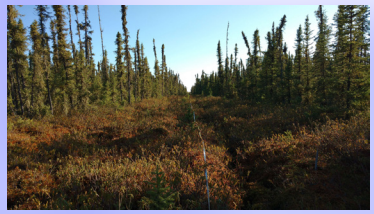
Identifying and protecting climate refugia, areas that could potentially buffer unfavorable environmental conditions, may enable species to persist and adjust to climate change in the future. This is important because the long-term effectiveness of wildlife conservation in the Canadian boreal region needs to incorporate the dynamic nature of climate change.

Dunvegan West Wildland Provincial Park, Northwest Alberta. Even though this consists of a Boreal forest, some grass-lands features are apparent, such as the hoodoos on the left.

Fire And Forest Recovery of Seismic Lines

Angelo T. Filicetti (Ph.D.)
University of Alberta
Supervisor: Scott E. Nielsen

Many seismic lines have failed to become reforested and, in effect, have increased predation on woodland caribou. It is vital to learn under which conditions seismic lines do and do not restore in order to save limited restoration dollars and guide woodland caribou recovery.



Typical seismic line that may stay unforested for over 50 years, possibly indefinitely.

Fungi Associated with Hair Lichens

Spencer Goyette
University of Alberta
Supervisor: Toby Spribille

As active participants in forest and montane ecosystems lichens such as Bryoria are indicators of ecosystem health, are central players in nutrient cycling, and are utilized as a food or shelter source for a variety of animals such as birds, small mammals, and Caribou. ***Athelia*** could be infecting ***Bryoria*** on a scale comparable to white-nose syndrome in bats or Chytridiomycosis in amphibians but has so far avoided any detection or documentation. The disappearance of *Bryoria* from forests would be devastating.

***Bryoria* covered in *Athelia*, note the "dreadlocked appearance".**

Grassland Plant Species and Functional Diversity Responses to Intensive Grazing

Jessica Grenke (Ph.D.)
University of Alberta
Supervisor: James Cahill Jr.
Supervisor: Mark Boyce

Though ungulate grazing is the most spatially extensive land-use on earth, the response of plant communities to managed grazing is not well understood. By comparing plant diversity and species assemblage between paired intensively and less-intensively managed ranches across Western-Canada, we are able to understand how land-management impacts plant communities in a way suitable for direct application to land-management and policy development.

Jessica measuring plant diversity and biomass at an aspen-parkland region ranch.

Intraspecific Variation in the Energetics of Reproduction in Columbian Ground Squirrels

Adriana L. Guerrero-Chacón (Ph.D.)
University of Saskatchewan
Supervisor: Jeffrey Lane

Understanding the energy allocation strategies of wild organisms is relevant for understanding both its fitness (how some are able to allocate more to survival and reproductive success) and population dynamics. Thus, the information obtained from this project will be crucial not only to predict how Columbian ground squirrels respond to anthropogenic shifts in energy availability, but also to anticipate the responses of associated species (predators), such as badgers, red-tailed and ferruginous hawks and goshawks.

Columbian ground squirrel using a pet feeder. Pet feeders were used to provide additional food resources to a sample of females, examining how the surplus food will influence their energy allocation strategies.

Influence of Forage Quantity and Quality on Bison Habitat Selection

Lee Hecker (Ph.D.)
University of Alberta
Supervisor: Scott Nielsen
Supervisor: Mark Edwards

My research is vital for the management of mega-herbivores on landscapes influenced by development. Understanding how differences in forage quantity and quality influence habitat selection of herbivores allows managers to identify and protect habitats crucial for survival.

Lee collecting fresh bison fecal samples for his analysis of diet composition.

How Do Small Owls Call in the Presence of Predators?

Jeremiah Kennedy (M.Sc.)
University of Alberta
Supervisor: Erin Bayne

Very little is known about the impacts of avian top predators on the daily behaviour of avian mesopredators. Until recently it has been nearly impossible to track changes in acoustic behaviour of small owls in response to detecting their predators. This made it difficult to fully understand the impacts of population changes or range expansions of predatory owls on avian communities. I am using Autonomous Recording Units (ARUs) to investigate in situ changes in vocal behaviour of small owls in response to large owl vocalizations within a nocturnal avian community. Understanding these behavioural changes will help us manage avian communities with invasive predators for which avoidance behaviour has not yet been evolved/learned.

February Autonomous Recording Unit in a mixed wood forest near Conklin Alberta.

Does Gene Flow Within a Badlands Butterfly Follow Eroding Riverbank Corridors?

Zachary G. MacDonald (Ph.D.)
University of Alberta
Supervisor: Felix Sperling

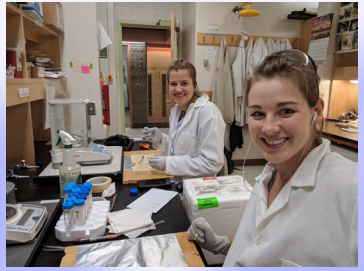
In southern Alberta, populations of the Old World swallowtail butterfly, *Papilio machaon dodi*, are restricted to eroding habitat along banks of major rivers where their larval host plant, *Artemisia dracunculus*, occurs. This unique landscape configuration presents an opportunity to infer how linear patterns of habitat connectivity relate to gene flow, population structure, and local adaptation in a charismatic butterfly species.

Larva of an Old World swallowtail butterfly, *Papilio machaon dodi*, perched on a stem of its food plant, *Artemisia dracunculus*.

Chemical Signature Changes of Lodgepole Pine Trees due to Elevation and Latitude

Melanie Mullin (M.Sc.)
University of Alberta
Supervisor: Nadir Erbilgin

My research findings will likely suggest geographic areas where lodgepole pines are most vulnerable to attack from mountain pine beetles. This information is relevant in current and future forest management practices, especially where insect outbreaks and climate change are concerned.



Melanie and lab technician Gail processing phloem tissue samples in the laboratory.

Home Range and Habitat Use of Cougars in West-central Alberta

Corey Smereka (M.Sc.)
University of Alberta
Supervisor: Andrew Derocher
Supervisor: Mark Edwards

Over the past few years human-cougar conflict in Alberta has increased. In an attempt to reduce this conflict, a new cougar adaptive management plan is being created for Alberta. Before management strategies can be implemented, knowledge of cougar space use and how increased harvest may affect space use must be understood.

Corey looking at an abandoned cougar nursery site.

Assessing Algal Communities and Nutrient Levels in Albertan Streams

Nikki van Klaveren (M.Sc.)
University of Alberta
Supervisor: Suzanne Tank

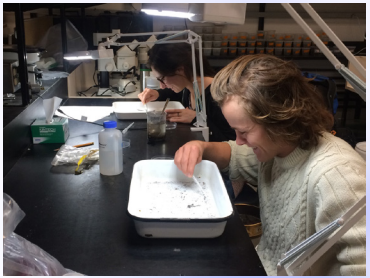
Streams provide important ecosystem services, such as nutrient cycling, which can be heavily impacted by nutrient pollution. Assessing the algal communities, nutrient uptake rates, and nutrient levels will provide a better understanding of current stream health and function, and potentially suggest nutrient limits specific to these systems.

Nikki taking a flow measurement in Kneehill Creek.

The Distribution and Habitat of *Tubifex tubifex*, Host of Whirling Disease, in Banff National Park

Colby Whelan (M.Sc.)
University of Calgary
Supervisor: Leland Jackson

Whirling disease is a new and dynamic threat to the populations of trout that Alberta is famous for. It has caused large scale reductions in rainbow and cutthroat trout in Montana and Colorado. The disease is actually caused by the microscope parasite *Myxobolus cerebralis*. *M.cerebralis* spores can be picked up on waders and fishing gear and transported to new waterbodies, so any waterbodies that contain *T. tubifex* may be at risk. I hope to determine if *M. cerebralis* can persist in the studied waterbodies, and to determine whether *T. tubifex* has any measurable habitat associations that could assist in future searches.



Research assistants Liam and Paige searching for *tubifex* worms sediment collected from the Spray River in Banff National Park.

Mandate

This grant program has been established to increase knowledge of flora and fauna in Alberta and to support Alberta-based research, consequently, all work proposed for funding must take place in Alberta. The location of a student's university is of no consequence but their research must be done here.

We support research by graduate students in Alberta, and grants are for up to a maximum of $20,000 distributed over a 2-year funding period. Awards are made in early April each year. Mean award amounts are close to $11,000.

Serious potential applicants should visit our web site (http://www.acabiodiversity.ca) where information is updated annually, and application forms may be downloaded.

Terms of Reference of this Program

The ACA Grants in Biodiversity have been established to:

- increase knowledge of Alberta's heritage of living resources, specifically the flora and fauna,
- support research by graduate students in Alberta, and
- promote the development of highly qualified, Alberta-based conservation biologists.

Who is Eligible to Apply?

The Grants Program is open to graduate students doing work in Alberta. Applicants must be associated with a university as a graduate student (see specific limits of eligibility on our website).

Mandate

Research Mandate

The Grants in Biodiversity program supports research in biodiversity, conservation biology, ecology, and related social science approaches that relate to flora, fauna and habitat in Alberta; all kinds of organisms are covered. Applications should focus on enhancing the understanding of Alberta's flora, fauna and habitat at any biological level, but research should be directly anchored in the real world. For example, an experimental laboratory study dealing with beetle chromosomes must have a direct linkage to that organism in nature. Impact-type studies, such as those involving human-induced environmental change and social science will be considered, but such manipulations must be process oriented and related to flora, fauna and habitat change. Applications will be adjudicated on the basis of: 1) research merit; 2) reasonable budget; and 3) ability of the applicant to conduct the proposed project.

Deadline: The deadline for receipt of applications is December 1 (or the last business day before December 1) each year.
Check http://www.acabiociversity.ca for deadlines, contacting the program staff and application information.

Reviewer Appreciation

Every application received for an ACA Grants in Biodiversity competition is sent to at least three volunteer reviewers. We appreciate the time, expertise, and effort of our reviewers for the last two years:

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The ACA Grants in Biodiversity invites proposals from graduate student from any approved research university, regardless of province or country, to apply for financial support to conduct research on basic biology or management of Alberta's flora, fauna or habitat. We support studies of conservation biology, biodiversity, ecology and management, all broadly defined. All taxa of living organisms are acceptable. Proposal strengths may emerge from their logic, clarity, usefulness, general interest, or discovery; however a high level of scientific merit is essential.

For more details on program, applications, deadlines and sponsors see:

Biodiversity Grants:
http://www.acabiodiversity.ca/

Alberta Conservation Association:
http://www.ab-conservation.com

Program goals are to:

- Increase knowledge of Alberta's living resources, notably flora and fauna.
- Enhance training of highly qualified graduate students working in conservation biology in Alberta.
- Support the ACA's mission to promote conservation of Alberta resources.