



**DEPARTMENT OF BIOLOGY
UNIVERSITY OF SASKATCHEWAN
PROGRAM AND BOOK OF ABSTRACTS**



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Welcome to Biology 990 Symposium, our showcase for the research of our M.Sc and Ph.D. students.

The 2020 Biology Graduate Symposium is being held remotely for the first time due to the COVID-19 global pandemic and public health orders. In this time of uncertainty, we hope the entire Department of Biology family is safe and well. I want to acknowledge all of the hard work done by our graduate students in bringing the 2019-20 regular term to a close and to congratulate everyone for excellent submissions for our virtual symposium.

Students were asked to prepare and record an oral presentation or a virtual poster presentation to be shared with each other and with faculty. In any other year, we would wrap up our symposium with a light supper and social evening. We look forward to a time in the future when we can come together and celebrate with each other, and when we acknowledge the outstanding work of our students, friends, and colleagues. Until then, we will stay physically separated but socially connected as we weather this together. Enjoy the presentations and thank you for all that you do.

Chris Todd
Coordinator
Biology 990 Symposium

POSTER PRESENTATIONS

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BIOL 990 POSTER PRESENTATION ABSTRACTS

#1. AKAASH BANSAL & JEFF HUDSON. The effect of cyanobacteria on pelagic phosphorus cycling in lakes Department of Biology, University of Saskatchewan, Saskatoon SK.

Cyanobacterial research has largely focused on the causal factors promoting blooms and the associated health impacts. The impact of cyanobacteria on ecosystem function has received less attention. However, there is evidence that these algae have significant effects on other planktonic organisms by numerous avenues (e.g., allelopathy, inedibility, food quality and toxicity) and these effects may be of a magnitude to affect ecosystem processes (e.g., pelagic nutrient cycling). We tested this hypothesis with a diverse set of lakes (i.e., from Saskatchewan to Ontario, including Lake Erie and Lake of the Woods) that represented a gradient in cyanobacterial biomass. We predicted that phosphorus cycling would be less efficient in lakes that had a large proportion of algal biomass in cyanobacteria. Contrary to our predictions, the turnover rate of phosphorous within plankton did not decrease with an increase in cyanobacterial biomass. Size fraction data of plankton will be incorporated to further identify phosphorous cycling dynamics and the impact of cyanobacterial biomass on the pelagic phosphorous cycle.

#2. DALE BARKS & DR. PHILIP MCLOUGHLIN. Ecological Invasion by Boreal-Dwelling White-Tailed Deer and the Risk of Chronic Wasting Disease Transmission to Woodland Caribou Populations. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Chronic Wasting Disease (CWD) is a fatal neurodegenerative prion disease affecting several cervid species. Its rapid global spread has caused heightened concerns regarding its potential impact on cervid populations and human well-being, yet relatively little is known about CWD's ecological effects. Of great concern is the potential for CWD to infect threatened woodland caribou (*Rangifer tarandus caribou*) populations via transmission from boreal-dwelling white-tailed deer (*Odocoileus virginianus*). Although no known cases of CWD exist in North American caribou, the 2016 discovery of infected reindeer in Norway highlights the potential threat to Canadian caribou. As white-tailed deer propagate within the resource-rich boreal-fringe zone of Saskatchewan and move into regions frequented by woodland caribou, they pose a significant risk of infection. Throughout 2020, I will examine the risk of interspecific CWD infection by capturing and GPS-collaring fifty (n=50) white-tailed deer in CWD-infected regions of the Saskatchewan boreal-fringe zone. I will then monitor and compare habitat selection of white-tailed deer with that of woodland caribou to determine the extent of spatial overlap between the two species. Sampling at time of capture will allow me to determine the age groups most affected by CWD and will provide valuable insight for development of future management strategies.

#3. ANA M. DIAZ¹, CHRYSTY A. MORRISEY¹, KEITH A. HOBSON^{1,2}. Assessing landscape effects on pre- and post-fledging condition and survival in two species of sympatric-breeding aerial insectivores. ¹ Dept. of Biology, University of Saskatchewan, Saskatoon; ² Environment and Climate Change Canada, Science and Technology Branch, 11 Innovation Boulevard, Saskatoon, SK.

Aerial insectivores have experienced steep population declines in the last few decades across North America which coincides with transformations to extensive agriculture and monocultures. Landscape composition and availability of nutritious insect prey can directly affect diet of chicks, which can have negative effects on nestling growth, condition and post-fledging survival. Using intrinsic (stable isotope) markers and extrinsic tracking technology (e.g. Motus Wildlife tracking) on two species of aerial insectivores in the Prairie Pothole Region (PPR), Barn Swallows (*Hirundo rustica*) and Tree Swallows (*Tachycineta bicolor*), I will test the following hypotheses: 1) Landscape homogeneity associated with high proportion of row crops and reduction in wetland presence, negatively affects nestling condition, growth rate and fledging success in both species; 2) Birds in better condition pre-fledging will have higher survival during the early post-fledging period; 3) Tree Swallows will rely more on aquatic emergent insects than Barn swallows; 4) increased use of aquatic emergent insect will positively influence nestling growth rate and post-fledging survival; and 5) Fledglings in better condition will initiate dispersal earlier from the natal site. This study will contribute to the understanding of habitat needs of aerial insectivores during breeding season and how agricultural stressors can affect important demographic rates of two species of conservation concern.

#4. PRASHANI D. W. ARACHCHILAGE¹, DOUGLAS P. CHIVERS¹, MAUD C. O. FERRARI² Effects Of Neonicotinoid Exposure On Antipredator Behaviour of Larvae *Enallagma sp* (Odonata: Zygoptera). 1 Department of Biology, University of Saskatchewan, Saskatoon, Canada; 2 Department of Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon, Canada.

Neonicotinoids are widely used, water-soluble neurotoxic insecticides. The effect of this class of insecticide on non-target aquatic environments has become a major environmental concern since this insecticide equally affects both pests and non-target insects. Along with lethal effects, in aquatic

environments these insecticides could cause visual and chemoreception damage or irritation. This can lead to behavioural alteration in aquatic organisms by disrupting the sensory systems used for detecting predator, thereby affecting anti-predator behaviours. In this experiment, we will investigate the effects of water contaminated with an environmentally realistic concentration (0.1µg/l) of imidacloprid on the anti-predator behaviour of *Enallagma sp* larvae. The number of feeding bites performed after injecting the conspecific damage-released alarm cue solution and predator kairomones mixed with digestion-released cue solution will be observed and recorded after 24hr, day5, and day10 of exposure to imidacloprid. No significant decrease in feeding frequency is expected in neonicotinoid exposed damselfly larvae before and after injecting the predator stimulus. A reduced feeding frequency in damselfly larvae is expected after injecting predatory stimulus in the control treatment (without exposed to neonicotinoid). Hence, damselfly larvae are expected to reduce their anti predator behaviour under the neonicotinoid exposure.

#5. AHMAD GHOBEISHAVI; MAUD C.O. FERRARI; DOUGLAS .P. CHIVERS. Effects of sound exposure on learning and neurotransmitters levels in Zebrafish (*Danio rerio*). Department of Biology, University of Saskatchewan, Saskatoon, SK.

As a result of human population growth and mechanization over the past few centuries, the planet has been increasingly exposed to human-made (anthropogenic) stressors. One of these stressors is anthropogenic noise, and according to the World Health Organization, environmental noise exposure represents an increasing polluting agent of global concern. Anthropogenic noise can affect different aspects of fish biology like physiology, behaviour, and learning. To evaluate the effects of noise on fish learning, we will expose 9-month old adult zebrafish to three white noise sound treatments with different intensities (80, 100, and 120 dB). Each sound treatment will be played back in two patterns; regular and irregular, for 15 minutes. Following exposure, fish will be trained in a plus maze to associate between a color cue and social reward, and then their learning will be assessed in a trial. Furthermore, to elucidate the possible molecular mechanisms underlying the neuro-behavioural effects of different noise treatments, two primary neurotransmitters that are involved in learning, GABA and Glutamate, will be measured in the brain. This study will help to have a better perspective of how anthropogenic noise can affect learning process in fish and what are the effects on a molecular scale in the brain.

#6. MERCY E. HARRIS¹, KEITH A. HOBSON² & CHRISTY A. MORRISSEY^{1,3}. Factors affecting the neonicotinoid exposure of aerial insectivores in Saskatchewan's agroecosystems. ¹ Department of Biology, University of Saskatchewan, Saskatoon, SK; ² Department of Biology, University of Western Ontario, London, ON; ³ School of Environment and Sustainability, University of Saskatchewan, Saskatoon, SK.

Aerial insectivore populations have declined significantly across Canada, but the drivers of these losses are unclear. Despite the potential for environmental contamination to contribute to declines, the exposure of aerial insectivores to agrochemicals remains largely unstudied. A particularly relevant knowledge gap is the extent to which aerial insectivores are exposed to neonicotinoids, which are the most widely used insecticides worldwide. This project will quantify the exposure of two declining aerial insectivores, Barn and Tree Swallows, to neonicotinoids in Saskatchewan, and examine whether differences in foraging location, diet, or agricultural intensity affect insecticide exposure. I hypothesize that neonicotinoid concentrations will differ between species and landscape intensities as a result of foraging, diet, and land use differences. To test this, I will measure blood neonicotinoid concentrations in adults and nestlings in habitats of different intensities. I will study foraging habitat by affixing adults with GPS tags, and will evaluate diet through DNA barcoding of fecal samples. These data will then be modeled to identify factors influencing insecticide exposure. This will be one of the first studies of neonicotinoid exposure in

aerial insectivores and will increase our understanding of insecticide fate, thereby improving our ability to predict risks for declining aerial insectivore species.

#7. ATEFEH NAJAFI & JAMES D. BENSON. A mathematical framework for developing freezing protocols for the cryopreservation of ovarian tissue. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Over 100,000 Canadian women were diagnosed with cancer in 2019, and approximately 13.4 percent were under the age of 49. Recent success in treatment has lengthened lives for patients with cancer. However, these lifesaving measures are associated with ovarian failure and infertility. To address this need, the only available option for such patients is to cryopreserve ovarian tissue. While researchers have successfully cryopreserved ovarian tissue, progress in this field has been slow. Moreover, incomplete understanding of the molecular mechanisms underlying the cell injury makes the development of optimal cryoprotocols challenging.

One approach to address this damage is the use of mathematical modeling, where damage models can be combined with chemical and physical models to predict possible tissue responses to cryopreservation protocols.

Therefore, to provide a critical ovarian tissue cryopreservation optimization framework, the objectives of this research are to model CPA diffusion into ovarian tissue and associated osmotically and chemically CPA induced damage, to determine and mathematically model the effect of CPA exposure, cryopreservation on epigenetic alterations, and to identify the relationship between epigenetic alteration and cryo-induced oxidative and DNA damage. The outcome of this research will be a rationally optimized cryopreservation process producing an experimentally validated facile tissue cryopreservation protocol.

#8. DOMINIC J OLVER¹, PABLO HERES², ESTEFANIA PAREDES², JAMES D BENSON¹. **Time Dependent Osmotic Damage in Sea Urchin Oocytes,** ¹Department of Biology, University of Saskatchewan, Saskatoon, SK; ²Department of Ecology and Marine Biology & Marine Biological Resources Functional Preservation Service at ECIMAT marine Station, University of Vigo, Vigo, Spain

Classically, mechanical damage due to swelling or shrinking have been thought to have a constant “osmotic tolerance limit”: after a fixed amount of volume change the cells die. Here we show that this is not the case for sea urchin (*Paracentrotus lividus*) oocytes, but instead demonstrate that osmotic damage is time dependent. We exposed urchin oocytes ($n \geq 100$ per treatment with 3 replicates) to seawater (~1000 mOsm/kg) either supplemented with 500, 1000, and 1500 mOsm of NaCl or Sucrose or diluted (with DI water) to 800, 700, 600, or 500 mOsm/kg. The exposure duration periods were for 2, 6, 15, 30, 50, 75, and 90 minutes. After exposure, oocytes were returned to seawater holding media, in vitro fertilization was performed, and development to the 4-arm-pluteus stage was assessed at 48 h.

Development data were fit to a novel mathematical model of population cell death that is proportional to the integration of volumetric deviance throughout time. This model works well ($R^2 \sim 0.90$) to describe osmotic related damage across multiple concentrations and solution types and will hopefully result in more accurate and better optimized protocols for loading and unloading of CPAs.

#9. MAHESH RACHAMALLA & SOM NIYOGI. Reproductive, behavioural and developmental effects of chronic dietary arsenic exposure in adult zebrafish (*Danio rerio*). Department of Biology, University of Saskatchewan, Saskatoon, SK.

Arsenic (As) is a priority aquatic pollutant because of its ubiquitous nature and high toxicity to marine organisms, including fish. Literature suggests that dietborne As has severe chronic toxicity than waterborne, and its underlying mechanisms are unexplored. Objective of present study to investigate the reproductive and developmental effects of chronic dietary exposure to As in adult zebrafish (*Danio rerio*). For this study, adult fish will be exposed to environmentally relevant concentrations of dietary As (control, 30, 60 and 100 µg/g dry weight) for 60 days. Following exposure, over two weeks period several reproductive endpoints (fecundity, egg size, hatching success, spawning frequency) will be assessed. Morphological deformities and survival rates will be assessed in produced larva. Group of As-exposed fish will be examined for cognitive performance using a latent learning paradigm in a complex maze. Subsequently, As accumulation will be measured in brain, liver, and gonad from As-exposed fish along with mRNA expression of several marker genes for antioxidant, neurological, and reproductive functions will be assessed. Besides, eggs will be measured for As levels for potential of As maternal transfer. After reproductive and developmental effects are characterized, study will be expanded to investigate transgenerational impact of As through epigenetic mechanisms.

#10. ITA A. E. RIVERA-HERNÁNDEZ¹ & MAUD C. O. FERRARI². Do fish embryos learn about danger from their siblings? Embryonic communication of danger. Department of Biology, University of Saskatchewan, Saskatoon, SK; Biomedical Sciences, WCVU, University of Saskatchewan, Saskatoon, SK.

The ability to obtain information from the environment, assess predation risk, and mediate physiological and behavioural responses to this risk, increase individual's survival. There is increasing evidence that a way of obtaining information about the environment is through vibrations. Also, it has been proposed that embryos can use vibrations produced by the heartbeats of their siblings, to synchronize important events in life, like hatching. We want to test if fathead minnow embryos (*Pimephales promelas*) can obtain information about the environmental risk from their siblings and use this information to adjust their antipredator response. For our first experiment, we hypothesize that the changes in heart rate in embryos exposed to alarm cues are going to be detected by siblings in the same clutch and elicit a similar change in their heart rate. For our second experiment, we hypothesize that individuals from the same clutch are going to have a similar neophobic response to novel odour during the larval stage, either if they were directly exposed to alarm cues during their embryonic stage or their siblings were directly exposed to alarm cues.

ORAL PRESENTATIONS

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BIOL 990 ORAL PRESENTATION ABSTRACTS

#11. MARYAM O. AJIBOYE¹, DOUG P. CHIVERS¹ & MAUD C. O. FERRARI². The Effectiveness of Larval Cases in Protecting Caddisfly Larvae (Trichoptera: Phryganeidae) Against Predatory Crayfish: Case Construction Material Preferences. ¹Department of Biology, University of Saskatchewan, Saskatoon, Canada; ²Department of Biomedical Sciences, University of Saskatchewan, Saskatoon, Canada.

Defense against predation is essential for the survival of prey. The portable case constructed by caddisfly larva using various materials present in the environment is agreed to have evolved as a defense against predators. We examined larvae preferences for different case construction materials, and we also investigated which material provided more protection when the larvae are exposed to predatory crayfish. Larvae were divided into three groups, and each group was provided with either leaves, plastics, or the combination of both materials for case construction, after which they were exposed to crayfish to determine which case offers more protection against predation. We found that larvae will construct new cases using the materials provided, and these materials do not affect the proportion of larvae that constructed new cases in each group. However, larvae provided with both materials prefer to construct their cases using leaves. We also found that larval survival when exposed to a predator is not dependent on the case construction material, and whether a larva has a case or not, rather it is dependent on whether the crayfish has previous experience with larvae. This result shows that larva cases are less efficient in protecting larvae when they encounter experienced predators.

#12. MOHAMMAD AMINI & JAMES D. BENSON. Rapid cooling-high pressure cryopreservation. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Cryopreservation of cells and tissues is an essential part of modern medical science, including bio-banking. Conventional methods for cryopreservation often result in significantly reduced cell and tissue viability. These methods rely on high concentrations of cryoprotective agents (CPAs) to mitigate deleterious ice crystal formation. However, high CPA concentrations are toxic. In order to reduce the concentration of CPA, and to achieve a non-damaging and non-crystalline, *vitreous*, state, a possible approach is the use of ultrarapid freezing. When a biological sample comes in direct contact with a cryogen, a film of vapor forms around the biological sample, creating an insulating layer around the biological sample. A method to avoid this is solid surface cooling, where a sample contacts a cooled surface with high thermal conductivity. Another approach to reduce the CPA concentration is to apply hydrostatic pressure because the glass transition temperature increases and the melting point decreases with increasing hydrostatic pressure, reducing the temperature difference between the melting point temperature and the glass transition temperature. Here I present the theory, design, implementation, and initial data for an apparatus with instantaneous two-side solid surface cooling and arbitrarily high pressures with the aim to reduce CPA concentration while entirely avoiding ice crystallization.

#13. IQRA AZAM & JAMES D. BENSON. Silymarin Mediated Osmotic Responses and Damage in Cultured Hepatocytes. Department of Biology, University of Saskatchewan, Saskatoon, SK

Osmotic tolerance limits are considered a critical determinant of cell survival after cryopreservation. Here we tested the hypotheses that hepatocytes behave as ideal osmometers, and that osmotic damage during cryopreservation can be reduced by silymarin, a flavanoid derived from *Silybum marianum*. In our first experiment, cell volume and osmotic permeability parameters were measured for adherent HepG2 cells resulting in a linear Boyle-van 't Hoff plot. In the next experiment, hepatocytes were exposed to a series of anisotonic solutions and the effect of this treatment was measured by assessing trypan blue exclusion and metabolic activity. Adherent HepG2 cells preincubated with silymarin, when exposed to extreme hypotonic conditions (DI water) for 10 min, showed a 77% increase in viability with silymarin (10^{-5} M) and 27% increase with silymarin (10^{-4} M) as compared to untreated control. Similarly in hypertonic conditions (2000 mOsm), a 20% and 50% increase in metabolic activity was observed with silymarin 10^{-5} M and 10^{-4} M respectively. Additionally, in suspended cells resistance to osmotic damage and significant increase (11%) in membrane integrity was observed. Our study concludes that the addition of silymarin leads to elevated osmotic resistance and a potential increase in the cryosurvival of HepG2 cells.

#14. DYLAN E. BALOUN & JEFFREY E. LANE The influence of variation in resource availability on life-history trait correlations in North American red squirrels (*Tamiasciurus hudsonicus*). Department of Biology, University of Saskatchewan, Saskatoon, SK

Trade-offs between life-history traits occur when investment in one trait (e.g. litter size) reduces resources available for others (e.g., offspring growth rates). In North American red squirrels (*Tamiasciurus hudsonicus*) variation in traits is influenced by the availability of resources that fluctuates episodically every 4-7 years. Mothers transition between quality-quantity reproductive strategies where they invest more in a few offspring when resources are high (quality), while investing less in a larger number of offspring when resources are low (quantity). Litter size and offspring growth rate are both heritable and negatively correlated at a phenotypic level. However, whether they are genetically correlated and how variation in resource availability may influence such a correlation are unknown. I hypothesize genetic

correlations between and within traits (but across years) are dependent on resource availability. I will use long-term red squirrel life-history data from the Kluane Red Squirrel Project (Yukon Territory). I will model correlations between, and partition variation in, genetic components of life-history traits (i.e., growth rate, litter size) using general linear mixed ‘animal models’ incorporating yearly changes in resource availability. This study will be one of the first to test how genetic correlations between mammalian life-history traits change in response to naturally fluctuating resources.

#15. AARON J. BELL^{1,2}, DAVID A. WARDLE³, & IAIN D. PHILLIPS^{1,2,4}. Burning for biodiversity: testing the pyrodiversity-biodiversity hypothesis in a boreal island archipelago.

¹Department of Biology, University of Saskatchewan, #112 Science Place, Saskatoon, Saskatchewan, Canada, S7N 5E2; ²Troutreach Saskatchewan, Saskatchewan Wildlife Federation, #9 Lancaster Road, Moose Jaw, Saskatchewan, Canada, S7J 1M8; ³Asian School of the Environment, Nanyang Technological University, 50 Nanyang Avenue, Singapore, 639798, Singapore; ⁴Water Quality Services, Integrated Water Services, Water Security Agency of Saskatchewan, #101-108 Research Drive, Saskatoon, Saskatchewan, Canada, S7N 3R3.

Wildfires are diverse in their spatial extent, frequency, seasonality, and severity (conceptualized as ‘pyrodiversity’) and this variation helps shape a wide variety of habitats in fire-prone ecosystems like the boreal forest. More ‘pyrodiverse’ landscapes typically support more habitats which, in turn, accommodate a larger number of species. The notion that ‘pyrodiversity begets biodiversity’ suggests that wildfires should be managed in a way that conserves ecologically meaningful fire patterns; however, appropriate levels of pyrodiversity have not been identified. Furthermore, climate warming and large-scale fire suppression activities over the past century have reduced overall pyrodiversity. My thesis provides a rigorous test of the pyrodiversity-biodiversity hypothesis with a focus on saproxylic beetles; a hyperdiverse group of invertebrates that are important in the function of boreal ecosystems and the decomposition of decaying wood. Using a boreal lake island system, I will also consider the spatio-temporal patterns of fire in the context of other foundational principles in biogeography including isolation and landscape configuration. Understanding the relationship between pyrodiversity and biodiversity in a classic island experiment offers unique opportunities to test ecological theory while also providing timely recommendations pertinent to biodiversity conservation and fire management in Canada.

#16. NICHOLAS A. BELLIVEAU & J. HUGO COTA-SÁNCHEZ. A new type of herkogamy in the plains pricklypear cactus *Opuntia polyacantha*. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Herkogamy is a reproductive syndrome of plants with hermaphroditic flowers, wherein the female and male organs are physically separated. Usually, herkogamy is the defining trait of a polymorphism (i.e. a syndrome with two or more distinct floral “morphs”). Such polymorphisms are known in various plants, but only recorded for a few species of cacti. Here, we report and describe for the first time the morphological nature of herkogamy in flowers of *Opuntia polyacantha*, a cactus indigenous to the Canadian prairies. Using 142 flowers collected in Beaver Creek, SK, 23 distinct morphometric traits were quantified; these data were analyzed against three quantifications of herkogamy, using univariate and multivariate analyses. Unlike other herkogamous plants, *O. polyacantha* exhibits extremely variable floral attributes, which follow a continuous rather than multimodal distribution of herkogamy. Simple linear, polynomial and logarithmic regressions, and ANOVAs, indicated that no strong relationships exist between herkogamy and any one floral trait. One of three principal component analyses revealed an increased similarity between flowers as the separation of male and female reproductive organs increases.

These findings suggest that *O. polyacantha* has a novel, non-polymorphic form of herkogamy, characterized by extreme variability. Future analysis will attempt to link ploidy level with this variability.

#17. Paul N. Boyce & Philip D. McLoughlin. Do horses avoid predators? Temporal dimensions of site use in feral horses (*Equus ferus caballus*) in relation to predator presence. Biology Department, University of Saskatchewan.

Interactions between feral horses and their predators are poorly understood. Inference from native species is limited due to the unique biology inherent in both equids and feral species in general, and with feral horses established a prey in many predator-prey systems these interactions are likely to become increasingly important for native species conservation. Issues such as apparent competition in multi-prey systems, driven by asymmetries in prey species vulnerability are frequent mechanisms driving rare and at-risk species declines, and thus, assessing these interactions in feral horses is critical to mitigating the impacts of predation on native species. We assessed spatio-temporal interactions among feral horses and predators, and how this related to social and reproductive characteristics of horses (e.g., band size and presence of offspring), within a multi-prey, multi-predator system in the Rocky Mountain foothills of Alberta, Canada. Using visitation rates we assessed whether horses adjusted their use of sites relative to predator proximity in time and how this related to the availability of alternate prey species and availability of resources.

#18. BRYAN M. TYLER & MORRISSEY C. CHRISTY. Influence of Wetland Pesticide Pollution on Waterfowl Distribution, Abundance and Productivity in the Prairie Pothole Region. Department of Biology, University of Saskatchewan, Saskatoon, SK.

The Prairie Pothole Region (PPR) provides critical stop-over and nesting habitat for many migratory avian species, namely waterfowl. The majority of the region has been converted to cropland, in-turn, dramatically changing the landscape from its historic condition. Current conventional agricultural practices often rely heavily on insecticides, fungicides and herbicides to maintain crop health throughout the growing season. Recent studies have shown alarming levels of pesticide pollution in wetlands throughout the PPR. The levels are high enough to cause detrimental impacts on aquatic macroinvertebrate and macrophyte populations; in-which, many species of waterfowl rely strongly upon. Direct effects on waterfowl abundance and distribution such as water availability and habitat quality are well studied however, indirect effects of agrochemicals on waterfowl abundance, distribution and productivity, is lacking. To accomplish this, we will conduct studies on selected wetlands in the PPR portion of Saskatchewan to assess waterfowl brood abundance in relation to traditional measures of wetland condition (e.g. macrophytes and aquatic macroinvertebrates), along with testing the water for pesticides and nutrient levels.

#19. JULIE A. COLPITTS¹, PHILIP D. McLOUGHLIN¹ & JOCELYN POISSANT². Characterizing runs of homozygosity in Sable Island feral horses and domestic horse breeds ¹Department of Biology, University of Saskatchewan, Saskatoon, Canada; ²Department of Ecosystem and Public Health, Faculty of Veterinary Medicine, University of Calgary, Calgary, Canada

Inbreeding is a crucial target for assessing genetic health of small populations. Inbreeding results in runs of homozygosity (ROH). ROH abundance and length can provide useful information on the extent and age of inbreeding in a population. Comparing ROH metrics in feral vs domestic populations may reveal

the relative impact of natural processes occurring in small populations versus selective breeding on genetic diversity. ROH were calculated using ~40 000 SNPs for 205 Sable Island horses and 794 horses from 37 domestic breeds (n=7-40). Number, length and ROH-based inbreeding coefficients (F_{ROH}) were highly variable between individuals and breeds, with Sable Island horses and Clydesdales having the largest numbers of ROH and highest F_{ROH} , and Mongolian and Tuva horses exhibiting the fewest ROH and lowest F_{ROH} . Short runs, indicating historic inbreeding, were abundant in all populations, with some evidence for more recent inbreeding in Sable Island horses. Fifty-eight identical ROH were found in $\geq 2\%$ of individuals, with 26 found exclusively in Sable Island horses. Gene ontology (GO) enrichment analysis revealed several genes associated with cancers and viral infections in these regions. ROH characteristics followed known breed history, and GO results suggest negative consequences of inbreeding in Sable Island compared to domestic horses.

#20. JESS M. COSENTINO & CHRISTY A. MORRISSEY. Discriminating Non-Breeding Origin and Migration Chronology in a Long-Distance Migratory Shorebird Staging in the Canadian Prairies. Department of Biology, University of Saskatchewan, Saskatoon, SK

Approximately 40% of Canada's shorebirds have been lost in the past half century however the causes for these declines are not well understood. Nearly 90% of North American shorebird species rely on Canada as critical breeding or stopover habitat during migration and each spring an estimated 75,000 Sanderling stopover at Chaplin Lake, Saskatchewan on their way to Arctic breeding grounds. Transcontinental, long-distance migrants such as these are experiencing the steepest declines however little is known about where these birds overwinter or their use of the Midcontinental route. My objectives are to (i) identify wintering origin composition of the Chaplin Lake population and (ii) investigate corresponding northward migration strategies. Isotope ratios from 600+ feathers sampled from northward migrants caught in Saskatchewan have been assigned to 3 main general non-breeding biomes. These will be compared with isotope ratios of feathers recently obtained from known wintering areas across the Americas: Chile, Peru, southern Texas. Additionally, 70+ nanotagged individuals across these sites are currently being tracked on a continent-wide scale providing insight into individual migration behavioural strategies. The results of this study will aid in identifying potentially vulnerable populations and better characterizing the relationship between non-breeding origin, migration, and use of the Midcontinental flyway.

#21. CHRISTINA D. DESNOYERS¹, ANDRÉS LÓPEZ² & KIRSTY E. B. GURNEY³. Validations of an emerging DNA-based approach to dietary assessment. ¹Department of Biology, University of Saskatchewan, Saskatoon, SK; ²Department of Fisheries, University of Alaska, Fairbanks, AK; ³Environment and Climate Change Canada, Prairie and Northern Wildlife Research Centre, 115 Perimeter Road, Saskatoon, SK.

DNA-based fecal analysis is an emerging non-invasive approach for wildlife diet assessment. Although targeting genetic markers in feces can identify prey consumed, our understanding of the approach's potential to estimate quantity and proportion of consumed items is limited. My research goal is to evaluate a DNA-based approach to quantitatively characterize an avian diet and build knowledge on current molecular techniques. I am testing hypotheses about prey-based (body type) and predator-based (time since consumption) factors that influence quantification of invertebrate DNA in avian feces. I expect to measure less DNA from hard- than soft-bodied invertebrates, and that hard-bodied invertebrate DNA will have a shorter detection period. I also expect the proportion of prey DNA detected in feces will reflect proportion consumed. So far, I have isolated DNA from hen's feces and designed custom species-specific primers targeting the cytochrome c oxidase I gene. Next, I will test primer efficiency with isolated DNA

from feces. Finally, I will perform multiplex qPCR assays to quantify target DNA within fecal and invertebrate samples. By addressing unresolved questions about the use of fecal DNA in quantitative diet studies, my research will help validate a genomics approach to analyzing environmental samples and improve inference from diet studies.

#22. CHULANTHA P. DIYES¹, SHAUN J. DERGOUSOFF², NEIL B. CHILTON¹. Do engorged females and unfed larvae of *Dermacentor andersoni* and *Dermacentor variabilis* represent important colonizing individuals at the species' distribution limits. ¹Department of Biology, University of Saskatchewan, Saskatoon, SK; ²Lethbridge Research and Development Centre, Agriculture and Agri-Food Canada, Lethbridge, Alberta.

The geographic range of *D. andersoni* in Saskatchewan has remained relatively unchanged since the 1960s. However, the distributional range of *D. variabilis* is progressively expanding northward and westward. Why *D. variabilis* is more successful in range expansion is the question of interest. Unfed (questing) ticks of both species have limited dispersal ability, whereas feeding ticks can be dispersed over longer distances as a consequence of the movement of their hosts. The successful establishment of a new tick population depends on the number of offspring produced by engorged females (i.e., the major colonizing individuals) and the ability of their offspring (unfed larvae) to survive and find a host. It is likely that the temperatures and relative humidities in microhabitats at locations outside a species current distributional limit are less favourable for the survival of unfed larvae. In this study, we determined the reproductive potential of engorged *D. andersoni* and *D. variabilis* females. We also examined the effect of temperature, relative humidity and overwintering success of unfed larvae. Results indicated that high relative humidity and low temperature have a profound impact on larval survival of both species; and that *D. variabilis* larvae had greater survival under changing environmental conditions.

#23. SEBASTIAN A. ESPINOZA-ULLOA, NEIL CHILTON & JOSE A. ANDRES. Genomic consequences of island colonization in Galapagos mockingbirds. Department of Biology, University of Saskatchewan, Saskatoon, SK.

The effective population sizes (N_e) of species colonizing remote Islands are expected to be low due to bottleneck events and the isolation of the new environment. Also, N_e will be correlated to island size because of carrying capacity. In turn, these factors can influence the molecular evolution of these species. The ancestor of the Galapagos mockingbirds (*Mimus* spp.) arrived at the archipelago ~3 MYA, and gradually colonized many of the Galapagos islands. Our genomic study seeks to reveal the demographic history and its "genomic footprint" in current populations of mockingbirds in different islands of the archipelago. The results showed differences in initial N_e among island, and that each population has its own demographic history with events of demographic explosions and bottlenecks. A positive correlation was found for island size and genomic diversity (π) and heterozygosity. Runs of homozygosity analysis revealed recent bottlenecks in the populations that were near to extinction (Champion and Gardner), and in the most distant islands of the archipelago (Darwin and Wolf). We have demonstrated how the colonization events of each island have shaped the demographic history of mockingbird populations and how their genetic composition is related to the island size.

#24. KATHERINE FEDOROFF, MAUD C.O. FERRARI, MICHAEL S. POLLOCK & DOUGLAS P. CHIVERS. Sound Bites: Boat Noise Impacts Stress Level in Freshwater Fish. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Noise pollution is rapidly becoming more prevalent on a global scale, yet it is one of the least studied anthropocentric disturbances. Sound has low attenuation in water where it travels five times further than it does in air. Such effects, coupled with the wide spatial and temporal distribution of anthropocentric noise, makes noise pollution a major concern for aquatic species that may lack refuge from this modern-day stressor. In this field experiment yellow perch (*Perca flavescens*) were randomly assigned to a treatment of 20 minutes of exposure to either ambient noise only (control) or ambient noise plus boat noise at a specific distance (100, 250 500, or 1000 m) from a boat equipped with a 40 horse power engine. We will be recording pre and post dissolved oxygen levels in the tube that the fish is placed in, giving us an understanding of their metabolic rate during exposure. Our study showed that fish exposed to boat noise had increased metabolic rate compared to ambient even when the boat was a kilometer away. This study provides more information on the impacts of boat noise on fish in their natural environment, particularly with regard to freshwater lakes where data are very limited.

#25. RUTH J. GREUEL & PHILIP D. MCLOUGHLIN. Patterns of vegetation distribution on Sable Island, NS. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Vegetation community composition is dynamic in space and time, and controlled by numerous factors, including climate, biogeographic factors and soil fertility. Sable Island is a small sand island (approximately 47 km × 1 km) located approximately 275 km southeast of Halifax in the Atlantic Ocean. Vegetation is dominated by marram grass (*Ammophila breviligulata*), but also consists of areas of heathland and mixed grassland with forbs. The vegetation is subject to year-round intensive grazing by a population of feral horses (*Equus ferus caballus*; $n \approx 590$). Here, I will present estimated grazing intensities for the past 10 years based on herbivore population size and satellite-derived vegetated area. I will also present patterns of community composition in plants from a nutrient-enrichment perspective across the island. Further work is underway to determine areas of the island and seasons where vegetation community composition and growth of forage species may be most subsidized by inputs from marine mammals (e.g. grey seals; *Halichoerus grypus*). I also aim to determine the impacts subsidization may have on horse habitat selection and life history metrics.

#26. ADRIANA L. GUERRERO-CHACÓN & JEFFREY E. LANE. Energy allocation strategies during reproduction in Columbian ground squirrels. (*Urocitellus columbianus*). Department of Biology, University of Saskatchewan, Saskatoon, SK, S7N 5E2.

Understanding the patterns of energy allocation strategies among individuals within a species is crucial to test theoretical models of life history evolution. In particular, hibernating mammals such as Columbian ground squirrels (*Urocitellus columbianus*; hereafter, ground squirrels) have a temporally limited active season which presents challenges to obtain the energy necessary for reproduction, growth and overwinter survival. Females likely initiate reproduction with varying amounts of fat stores, which could influence their energy allocation strategies during reproduction. Our main objective was to evaluate how the amount of capital resources before reproduction (fat stores remaining after hibernation) and age, influence reproductive allocation strategies of female ground squirrels. To do so, we measured body composition (through quantitative-magnetic resonance) of females at hibernation emergence and their reproductive output (estimated as litter mass at weaning) at juvenile emergence in one population of ground squirrels

located in Sheep River Provincial Park, Alberta. Capital resources were highly variable between reproductive females (0.8-18.4% fat at emergence) and were positively associated to female reproductive output. Additionally, reproductive output seems to decrease in females older than 7 years.

#27. FARYAL HAMZA, JACK GRAY, JAMES D. BENSON. The effect of cryoprotectant equilibration and extracellular ice formation on the transmembrane potential of mouse oocytes, its effect on apoptotic gene expression, and cryopreservation solution design. Department of Biology, University of Saskatchewan, Saskatoon, SK.

There are two major physiological events during cryopreservation: equilibration to and from high concentrations of permeable cryoprotective agents, and the cooling to and warming from liquid nitrogen temperatures. In the former, I hypothesize that large and rapid osmotic changes induce changes in transmembrane potentials. In the latter, the classic two factor hypotheses of damage suggest that too-fast cooling cause harmful intracellular ice formation and too-slow cooling causes damage due to not-well-understood mechanisms associated with solution concentration. I hypothesize that the latter phenomenon can be partially explained by the Workman-Reynolds effect, the generation of an electric field due to the separation of ions during ice solidification. The electric field may change a cell's transmembrane potential, possibly altering cell apoptotic gene expression. To evaluate this hypothesis, the objectives of this study are: 1) to examine the effect of cryoprotectant equilibration on mouse oocyte transmembrane potential at above zero temperature, 2) to explore the effect of extracellular ice propagation on the transmembrane potential of mouse oocytes; 3) to study potential impacts on the apoptotic of mouse oocytes during these processes; and 4) to design a solution by addition of channel modulators to improve the oocyte cryopreservation. The goal of this project is to identify and understand the mechanisms of damage during cryopreservation.

#28. DEBORAH M. HAWKSHAW & JEFFREY E. LANE. Sex-specific over-winter changes in body condition and hibernation expression in Canadian black-tailed prairie dogs (*Cynomys ludovicianus*). Department of Biology, University of Saskatchewan, Saskatoon, SK.

Canadian black-tailed prairie dogs regularly employ hibernation, an energy saving strategy, to survive over winter. Hibernation is characterized by recurring bouts of multiday torpor (decreased metabolism and body temperature (T_b)) which are interspersed with arousal bouts (a return to normothermic metabolism and T_b). Despite its energy savings, hibernation is costly; leading to predictions that individuals adjust hibernation expression according to their body condition and spring energy requirements. Adjustments in hibernation expression can ultimately influence changes in body condition (BC) over winter and vary between the sexes. My objective was to examine sexual variation in over-winter changes in body condition and investigate the effects of BC on hibernation expression. From 2018-2020, I abdominally implanted temperature-sensitive data loggers in prairie dogs of either sex and measured pre-and post-hibernation BC. In Fall 2019, I conducted supplemental feeding trials to increase variation in pre-hibernation body condition. Preliminary results indicate males experience a larger decline in body condition over winter compared to females. Additionally, individuals with higher pre-hibernation body condition appear to experience a larger decline in body condition. From this, I anticipate that individuals in good condition will reduce torpor use during hibernation and that females will employ a more energy conserving hibernation pattern compared to males.

#29. GABRIELA P. HEYER & JEFFREY E. LANE. Intraspecific variation in the hibernation phenotype of Columbian Ground Squirrel (*Urocyon columbianus*) populations across elevations. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Hibernation is an adaptive strategy used by many mammalian species to cope with extended periods of energy shortage during the winter. However, there is growing concern as to how hibernators will respond to our rapidly changing climate. The Columbian ground squirrel, for example, has experienced delayed hibernation emergence dates due to an increasing prevalence of late-season snowstorms, with corresponding decreases in annual fitness. Emergence dates have also been found to differ substantially across populations varying in elevation. The extent to which this variation is due to genetic variation or phenotypic plasticity can be crucial to predicting population resiliency in our changing climate. In addition, although previous studies have examined the effects of emergence dates on fitness, little is known about the expression of other hibernation traits. Thus, I am conducting both a field study and common garden experiment in two Columbian ground squirrel populations across elevations to investigate the cause of variation in several hibernation phenotypes that influence energy reserves (and thus fitness): body temperature, metabolic rate, and body composition. By focusing on multiple components of hibernation (rather than only emergence date as in most studies), my study will provide a more comprehensive understanding of plastic responses to climate change.

#30. Jonathan Hsin¹ & Maud C.O. Ferrari². Cerebral lateralization: Development, maintenance, and cognitive abilities associated with perceived predatory risks in wood frog tadpoles (*Lithobates sylvaticus*). ¹Department of Biology, University of Saskatchewan, Saskatoon, SK. ²Department of Biomedical Sciences, WCVI, University of Saskatchewan, Saskatoon, SK.

Cerebral lateralization is a common phenomenon, observed in various species across different taxa, such that some neurological functions or cognitive processes are emphasized on one hemisphere of the brain. It is thought to be manifested by behavioural tendencies including visual field preference and turning bias. While it may seem to be disadvantageous to exhibit behavioural tendency for prey animals in reaction to predatory attacks, studies have suggested that laterality may lead to enhanced cognitive abilities, offering higher survival rates through sensation or learning. In this two-stage study, development and maintenance of laterality magnitude were examined by raising wood frog tadpoles (*Lithobates sylvaticus*) under different background risks in embryonic and larval stages. Moreover, neophobic antipredator response was monitored via survival trials consisting of lateralized individual tadpoles against single water beetle. Experimental data showed that individuals raised in high risk environments in their larval stage seemed to cease in their turning bias. Meanwhile, the survival rates differed significantly amongst tadpoles exhibiting different degrees of lateralization. These results suggest plasticity in cerebral lateralization, leading to enhanced environmental adaptation.

#31. MD NOIM IMTIAZY & JEFF HUDSON. Do different flow conditions and aquaculture operations affect dissolved organic carbon quantity and quality in Lake Diefenbaker? Department of Biology, University of Saskatchewan, Saskatoon SK.

Lake Diefenbaker (LD) is a large multi-purpose reservoir on the Canadian Prairie that has experienced multiple years of high (2011-14) and low flows (2015-18). Average annual inflow rates in LD during the high and low flow years were 317 and 182 m³/s, respectively. Also, the Wild West Steelhead aquaculture is located at Cactus bay in LD. The effects of different flow conditions and aquaculture operations on the

spatio-temporal variations in dissolved organic carbon (DOC) quantity and quality will be analyzed using the linear mixed effect (LME) analyses. DOC concentrations and several absorbance indices (i.e., $SUVA_{254}$, $E_2:E_3$, $E_4:E_6$ and S_R ratio) were measured from the samples collected from June to October between 2011 and 2018. Preliminary comparisons of the mean values suggest that DOC concentrations in LD were similar between high and low flow periods (3.8–3.9 mg/L). However, high flow periods had more allochthonous characteristics with higher $SUVA_{254}$ (4.3 L/mg-m), lower $E_2:E_3$ (2.6) and $E_4:E_6$ ratios (3.6) compared to the low flow periods ($SUVA_{254}$: 2.6 L/mg-m, $E_2:E_3$: 6.9 and $E_4:E_6$: 4.6). Moreover, DOC concentrations and qualitative characteristics were mostly similar among aquaculture site and reference sites. Extensive statistical examination will be performed on these data with LME analyses.

#32. BRANDEN T. NEUFELD¹, CLARA SUPERBIE¹, RUTH J. GREUEL¹, THOMAS PERRY, PATRICIA A. TOMCHUK, DR. DANIEL FORTIN², & DR. PHILIP McLOUGHLIN¹. Moose, Caribou, and Wolves Decouple from Disturbance-Mediated Apparent Competition in Saskatchewan's Boreal Shield. ¹Department of Biology, University of Saskatchewan, Saskatoon, SK; ²Department of Biology, Université Laval, Québec, QC.

We know most about the effects of disturbance-mediated apparent competition (DMAC) on caribou where the species is under threat by industry in relatively productive southern boreal and mountain systems. Yet, almost 2/3 of extant boreal caribou range in North America encompasses northern shield and taiga habitat: wildfire-dominated ecoregions of low productivity where caribou may compete with only one ungulate species (moose) in the context of DMAC. In this environment, we know little of how DMAC acts as a limiting factor to caribou. From 2014–18, using a combination of vegetation sampling, aerial surveys, and telemetry data, we searched for evidence of DMAC for a 87,193 km² section of Saskatchewan Boreal Shield, a poorly productive but natural region with a historically high fire-return interval. Despite the high levels of disturbance, moose density was relatively low. In contrast, boreal caribou density was relatively high for the species. Wolf density was also low as were pack sizes, while resident territories were exceptionally large. We conclude that wolf and hence caribou populations were not responding in accordance with the outcomes generally predicted by DMAC in our study area because the requisite strong, positive response of deciduous-browse and alternate-prey abundance to fire was lacking.

#33. KAROLINA PUSZ-BOCHENSKA^{1,2} & TYLER WIST² & JACK GRAY¹ & TIM DUMONCEAUX² & CHRYSTEL OLIVIER². Development innovative methods to detect the presence of aster yellows in canola crops grown in Western Canada.

¹Department of Biology, University of Saskatchewan, Saskatoon, SK; ²Agriculture AgriFood Canada, 107 Science Place, Saskatoon, SK.

Aster yellows (AY), is a disease that infects over 300 species of plants, including Canola, wheat, barley, and pulses. Aster yellows disease is caused by '*Candidatus Phytoplasma asteris*' (AYp), a phytoplasma transmitted primarily by the migratory aster leafhoppers, *Macrostelus quadrilineatus*. Phytoplasma is very difficult to control, as no commercially available pesticide can control the pathogen directly, leaving the only control method for growers as an insecticidal spray to control the leafhopper vectors. This project proposes to generate data for the rapid and accurate development of an early warning system for AY diseases, by ascertaining the origin of the migrant aster leafhoppers that arrive in Western Canada and develop rapid, field-adaptable tests for AY phytoplasma detection in plants and leafhoppers. The origin of migrant leafhoppers will be studied using a combination of three techniques: DNA-based methods and wind trajectories coupled with analysis of radar data. The presence of AY in the early growth stages of the

crop will be studied using field-adapted DNA-based methods and with the use of remote sensing methods in combination with volatile analysis and satellite imagery to determine if these methods can also provide an early-warning of the presence of AY in target fields.

#34. ARASH SALAHINEJAD¹, SOM NIYOGI^{1,2} & DOUGLAS P. CHIVERS¹. Chronic Exposure to Bisphenol S Induces Oxidative Stress, Neuropeptide Signaling Dysfunction, and Abnormal Anxiety and Fear Responses in Adult Zebrafish (*Danio rerio*). ¹Department of Biology, University of Saskatchewan, Saskatoon, SK. ^{1,2}Toxicology Centre, University of Saskatchewan, Saskatoon, SK.

Abstract: Bisphenol S (BPS) is increasingly used in a wide range of consumer products, resulting in its ubiquitous distribution across environments, including aquatic ecosystems. Despite growing concerns about the estrogenic and antiandrogenic effects of BPS, little is known about the impact of BPS on anxiety and fear responses as well as the potential underlying mechanisms. We exposed adult male and female zebrafish to 1, 10, and 30 µg/L of BPS and 1 µg/L of 17-β-estradiol (E2) as a positive control for 75 days. Following exposure, changes in stress- and fear-related responses were evaluated by applying a novel tank test and by exposing focal fish to chemical alarm cues. Additionally, we evaluated the expression of genes involved in oxidative stress responses and neuropeptide signaling pathways in the central nervous system. Our results indicated that all doses of BPS and E2 significantly decrease bottom-dwelling behaviour and the latency to reach the upper water column. Furthermore, the highest exposure concentration of BPS and treatment with E2 induced a significant decrease in fear-related responses. The impaired anxiety and fear-related responses were associated with the upregulation of genes involved in oxidative stress response. Moreover, an altered expression of genes involved in the neuropeptide signaling pathways was also recorded.

#35. MUHAMMAD K. SARWAR & JAMES D. BENSON. Cryoprotocol, lipidome and membrane protein interactions in bovine sperm. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Cryopreservation of bull sperm is of keen interest for researchers due to its role in the strategic management of valuable genetic lines as well as the maximization of production and profit. However, post thaw recovery is only around 60% and thus there is considerable incentive to improve cryopreservation protocols. This project is founded on the hypothesis that bull sperm lipidome and proteome are important indicators for rational media design leading to optimized cryopreservation. To test this hypothesis, we will combine stopped flow cell volume kinetics studies with mass spectroscopy informed lipidomics and fluorescence based aquaporin densities that correspond to either bulls who typically have high post thaw motility— “good freezers”—or bulls with low post thaw motility —“bad freezers”. We will then use a Langmuir balance and Brewster angle microscopy to study interactions of membrane lipids with different cryoprotectants in relation to membrane phase transitions and membrane transport kinetics. In combination this study will move beyond existing data on the correlation of lipid and protein densities and post thaw motility, and give clues to mechanisms that key lipids and the abundance of transport proteins provide to increase post-thaw recovery, leading to rational media design for bull sperm cryopreservation.

#36. NICHOLAS G. SHEPHARD¹, ANN E. MCKELLAR², MATTHEW REUDINK³, DAVE MOORE⁴, JEFF COSTA⁴, STEPHANIE BEILKE⁵, ERIN ROWAN⁶. Migration Routes and Wintering Locations of North American Black Terns (*Chlidonias niger*) from Across Their Breeding Range, Revealed Through Light-level Geolocation.¹ Department of Biology, University of Saskatchewan, Saskatoon, Canada;² Canadian Wildlife Service, Prairie and Northern Wildlife Research Centre, Saskatoon, Canada;³ Department of Biology, Thompson River University, Kamloops, Canada;⁴ Canadian Wildlife Service, Burlington, Canada;⁵ Audubon Great Lakes, Lansing, United States of America;⁶ Detroit Audubon, Detroit, United States of America.

Black Tern populations are declining across their range in North America. Although causes of decline remain largely unknown, past studies suggest that conditions during migration may be important. Little is known about the migratory timing, routes, stop-over sites, or the range and conditions of over-wintering locations of Black Terns. The strength of migratory connectivity across the breeding range is also unknown. In 2016, we deployed 30 light-level geolocators on Black Terns breeding in Ontario and Michigan; 13 tags with full-cycle data have been recovered. During southward migration, the Atlantic coast from the Carolinas to Florida stood out as a key funnel. Most birds wintered around Panama. Northward migration was mainly through the Gulf of Mexico. In 2018 and 2019, we deployed an additional 48 geolocators at colonies in Saskatchewan, which will be retrieved in 2020. In 2020 and 2021, we are expanding this project to new deployment sites in Maine, Oregon, Wisconsin, and Minnesota. Results derived from across North America will allow us to estimate the strength of migratory connectivity and identify critical time periods or locations used during the annual cycle where this species is most limited, shedding light on when and where conservation actions would be most impactful.

#37. REBECCA E. SMITH & JEFFREY E. LANE. Saving for a rainy day: how climate affects intraspecific torpor variation in a seasonal hibernator (*Uroditellus columbianus*). Department of Biology, University of Saskatchewan, SK.

Climate change is shifting weather patterns globally and, in the southeastern Rocky Mountains, delaying dates of snowmelt in the spring. How range-restricted hibernating mammals will cope with such abiotic pressures is not well understood. Using a single population of Columbian ground squirrels (*Uroditellus columbianus*) in Sheep River Provincial Park, Alberta, I test two hypothesized pathways through which weather affects hibernator energy budgets: (1) intraannual vegetation quality and (2) snowpack depth over hibernacula. In 2019, I conducted two field experiments (supplemental feeding and snow fence construction) to test the predicted interacting effects between pre-hibernation body fat stores and snowpack depth on torpor expression (e.g., number and depth of torpor bouts). When the squirrels emerge this spring, I will collect body temperature data and quantify body fat stores of all treatment and control individuals. I predict that fed individuals will emerge earlier than unfed individuals and express more energetically expensive torpor profiles (e.g., increased number of arousals). I also expect that increased snowpack will stabilize ambient temperature within the hibernacula but delay emergence. This project provides insight into the abiotic and biotic influences on a seasonal hibernator, thereby providing an important mechanistic understanding of how climate change affects hibernator biology.

#38. MORIAH S. TANGUAY¹ & KIRSTY E. B. GURNEY^{1,2}. Habitat selection by breeding scoters in the boreal forest of the Northwest Territories. ¹Department of Biology, University of Saskatchewan, 112 Science Place, Saskatoon, SK; ²Environment and Climate Change Canada, Prairie and Northern Wildlife Research Centre, 115 Perimeter Road, Saskatoon, SK.

North American breeding populations of scoters (*Melanitta* spp.), which breed predominantly in the rapidly changing boreal forest, have declined, yet habitat needs for these sea ducks remain poorly documented. To help prioritize key habitats for conservation of these species, the objective of my research is to identify landscape-level predictors of breeding scoters and the invertebrate prey that they rely on, by testing hypotheses about scale-dependent species-habitat relationships. I will meet this objective by addressing three questions: 1) Which pond and landscape characteristics influence wetland invertebrate community composition?, 2) Which landscape characteristics influence the selection of wetlands by scoters?, and 3) At which scale are landscape characteristics most influential on the selection of wetlands by scoters? I will begin to address these questions by considering two main hypotheses: (i) food-limitation – I expect to observe correlations between factors affecting invertebrate community composition and factors affecting scoters, and (ii) scale-dependency – I predict that scoters will be more responsive to landscape characteristics measured at a scale that corresponds with their home range than to those measured at smaller or larger scales.

#39. HIMAL THAPA¹, ARASH SALAHINEJAD¹, AHMAD GHOBEISHAVI¹ & MAUD C.O. FERRARI². Effect of background risk on associative learning performance of zebrafish (*Danio rerio*). ¹Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada. ²Department of Biomedical Sciences, WCVN, University of Saskatchewan, Saskatoon, SK, Canada.

Repeated exposure to high-risk environment is known to induce high-risk phenotypic expression in aquatic prey. These high-risk phenotype display antipredatory response to any novel odour they encounter as well as improved ability to learn and retain predator related information. However, the role of risk on the cognitive ability of prey might be context-dependent. Here, we exposed zebrafish to risk for five consecutive days (three times a day) via injections of damaged conspecific skin (chemical alarm cues) which reliably indicates a predator risk. Then, high risk and control individuals (exposed to water) were subjected to eight training sessions in a plus-shaped maze to associate a visual cue (red card) with a social reward (group of conspecifics). During the probe trial, their learning efficiency were evaluated by means of latency to approach the rewarded arm, number of correct and/or incorrect arm entries, time spent in correct and/or incorrect arm. The high risk individuals were able to associate the visual cue with the reward, however, individuals in the control group were not able to establish the association after eight training sessions. These results suggest improved associative learning ability of high-risk phenotypes with social reward.

#40. Jessica T. Thoroughgood & Neil B. Chilton. True fleas conquer all: community structure of fleas on Richardson's ground squirrels. Department of Biology, University of Saskatchewan, Saskatoon, SK.

In 1985, George Holland described flea parasitism as an association to “primary” and “secondary” hosts. The primary host is considered the ideal host where the parasitism has derived from ancestral associations. In this study, we examined the community structure of fleas that parasitize Richardson's ground squirrels and thirteen-lined ground squirrels. We collected 169 Richardson's ground squirrels from

2016 to 2019, and 24 thirteen-lined ground squirrels from 2017 to 2019, in southern Saskatchewan. Each flea was identified to species using a PCR-based single stranded conformation polymorphism (SSCP) analyses of 450 bp of the nuclear 28S rRNA gene. Richardson's ground squirrels were mainly parasitized by *Oropylla rupestris* and *Oropsylla tuberculata*, whereas the most common species on thirteen-lined ground squirrels was *Oropsylla bruneri*. Hence, all three flea species do not have the same primary host species even though the host species occur in sympatry.

#41. SIMON P. TKACZYK, KAREN L. WIEBE, & DOUGLAS P. CHIVERS. Nest defence of male versus female Mountain bluebirds (*Sialia currucoides*) in response to a mountain predator. Department of Biology, University of Saskatchewan, Saskatoon, SK.

In many passerines, both parents contribute to nest defence but the conflict and cooperation between the sexes is still poorly understood. I studied breeding Mountain Bluebirds (*Sialia currucoides*) to determine whether sex, breeding stage, age, body condition, and body size influence nest defence. I was able to quantify the nest defence of the sexes to simulated predation by placing a taxidermy-mounted Red squirrel (*Tamiasciurus hudsonicus*) on the roof of their nestboxes during the incubation stage and again during the nestling stage to compare the different breeding stages. My data shows significant differences in the latency time between sexes for the nestling stage but not the incubation stage. It also shows differences between the stages within both sexes. These results do not support the Resource Hypothesis, where the females will invest more energy than males at early stages (because of egg formation and incubation) and so will defend less than the males. Also, the male's nest defence was greater than the female during the nestling stage and not relatively constant as I originally predicted. These differences in latency may suggest sex-specific pressures in parents' willingness to engage in nest defence.

#42. SIMON FRANKIE TU, MAAJID H. BHAT, & JAMES D. BENSON. Optimization of bovine sperm cryopreservation using machine learning. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Cryopreservation of mammalian gametes enables a multimillion-dollar bovine sperm industry in Canada. Sperm cryopreservation media can contain a large number of ingredients or design variables. Most cryopreservation optimization strategies explore one to two parameters or the effects of one additional additive at a time, ignoring interactions among other parameters. Traditional approaches are infeasible for developing an optimized bull sperm cryopreservation media with many components. Therefore, our approach to finding the optimal bovine sperm cryopreservation media uses Machine Learning, specifically Gaussian Process Regression (GPR) and Artificial Neural Networks (ANN). A Gaussian Process is a Bayesian inference model. ANNs are models that are inspired by biological neural networks. Both models are constructed and trained using methods found in the Python module Sci-Kit Learn, and data collected from cryopreservation experiments using post-thaw total motility as the endpoint. Continual evaluation of the convergence of these models towards optimal cryopreservation media is ongoing. Still, current training of the models with 232 trials results in Mean Squared Error (MSE) of 86 and 134 for GPR and ANN, respectively. With a mean per-generation improvement of 0.60%.

#43. MATTHEW E. M. YUNIK & NEIL B. CHILTON. Cold hardiness and overwinter survivorship of adult *Dermacentor variabilis* during their active and dormant seasons near their northern distribution limits in the Canadian prairies. Department of Biology, University of Saskatchewan, Saskatoon, SK.

The American Dog tick (*Dermacentor variabilis*) is the most abundant tick in western Canada and is a vector of veterinary and medically significant pathogens. The tick's northern and western distribution limit is expanding through Saskatchewan where the winter climate is thought historically to be a key limiter in the species range. These ticks spend most of their life off host. Hence, they may require overwintering 2-3 times in the subnivean environment to complete their life cycle. As a freeze avoidant species, these ticks can cool their body fluids below 0°C before freezing solid and dying. We examined: 1) the overwinter survival of field collected adult ticks in Saskatchewan, 2) the temperature at which ticks freeze throughout their active and dormant periods and 3) some factors that might influence the distributions of these freezing points. Overall winter survival was lower than what we expected at 7% in March and 4% in the following May. During the active season the mean supercooling point remained relatively constant at ~ -12°C and warmed to -9°C in the winter. Sex and mass of the tick were not correlated to supercooling points however broad scale collection locality appears to influence it.

#44. LIYONG ZHANG & CHRIS AMBROSE. Live imaging of microtubule organization and cell geometry during spongy mesophyll morphogenesis and intercellular space formation in *Arabidopsis* Department of Biology, University of Saskatchewan, Saskatoon, SK.

In addition to their important role in photosynthesis, spongy mesophyll cells present the potential power as an experimental system to study complex cell shape development, as they are able to develop their large highly branched shapes starting from small, tightly packed boxes, but which is vastly understudied compared to the overlying epidermal cell layer, likely due to the technical hurdles inherent to any deep tissue imaging.

In the current study, we use mesophyll-specific promoters to drive stable expression of fluorescent markers for the plasma membrane and microtubule (MT) cytoskeleton, which allow clear and continuous imaging of mesophyll development over multiple temporal and spatial scales using confocal microscopy. Our results show that intercellular spaces initiate at multi-cell junctions and enlarge by selective expansion of the surrounding free cell walls, which form the cell branches. Cell branches connecting cells develop varied degrees of surface curvature, the direction of which correlates with local accumulations of stable MT bundles. Presumably cortical MTs act to locally fortify these unpaired cell walls in a manner that promotes curved cell wall expansion, which is fundamental to creating the large surface areas in these cells. Our data provide new insights into spongy mesophyll morphogenesis in *Arabidopsis*.

#45. SINAN ZHANG & JOHN R. GRAY. Population Coding of Visual Information and Control of Avoidance Behaviours in Locusts. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Locusts can perform complicated flying maneuvers, which relies on rapid detection of moving objects to generate appropriate behavioural responses. An identified neural pathway, comprised of the LGMD (lobula giant motion detector) and the DCMD (descending contralateral motion detector), responds preferentially to approaching objects. As an angular threshold detector, the LGMD-DCMD pathway has been implicated as critical for initiating evasive behaviours, although its specific role remains to be fully described. Importantly, numerous other motion-sensitive neurons have also been identified in locusts. These neurons have distinct firing properties and response preferences. Information from these neurons likely contributes to production of avoidance behaviour. However, few studies have investigated the contribution of these neurons on a neural population level. To better understand how visual information is perceived by locusts, we constructed a multichannel recording system within an existing flight simulator and presented various complex visual stimuli to rigidly tethered locusts. Preliminary analyses have identified functional units that responded to visual stimuli. Common trends, which reflect the activity of neural ensembles, were extracted from these functional units.

The Department of Biology expresses gratitude to the Associate & Adjunct Faculty and their affiliated institutions for supporting the 2020 Biology 990 Symposium

Thank you to the graduate students for all their patience, hard work and their 990 submissions.