An investigation of stress in a mammal on the brink of extinction: Implications for the re-establishment of the Vancouver Island marmot (*Marmota vancouverensis*)

The Vancouver Island marmot is a species of ground squirrel that is endemic to British Columbia, Canada. They were once widespread across Vancouver Island, but went into decline in the late 1980s. In 1997, a captive breeding program was established to safeguard the species from extinction. Despite 20 years of management, the Vancouver Island marmot remains critically endangered. It is possible that the marmot’s fitness is compromised by management activities and other human disturbances. To investigate possible sources of chronic stress among Vancouver Island marmots, we analyzed hair cortisol levels from marmots subjected to different disturbances associated with conservation: captivity, surgery and captive release. We also measured stress levels in marmot hair samples from 1910 and 1931, during an era when marmot population were stable. We found no evidence that surgery nor captivity are a source of stress in Vancouver Island marmots. However, marmots released into the wild for at least 12 months before sampling had higher cortisol levels than their wild-born or captive-born counterparts. We also found evidence that stress levels in free-ranging marmots have increased since the early 1900s. It is possible that habitats on Vancouver Island have become less suitable for marmots than habitats found on the island in an earlier era.
power energy-demanding short-distance flights or hovering. Unlike mammalian systems, hummingbirds
develop an insulin response to ingested sugars, relying on glucose transporters (GLUTs) at the cell-surface
level for hexose sensing and transmembrane transport. GLUT regulation may account for the rapid shift
to pure carbohydrate metabolism, and may also play a crucial role in sugar transport and damage
prevention by extreme blood hyperglycaemia (~40mM in fed hummingbirds). This study aims to observe
colocalisation of *A. colubris* GLUTs 1, 2, 3, and 5 with cell-surface membranes of intestinal, renal,
hepatic, and muscle tissue in response to availability of carbohydrates. We hypothesize that carbohydrate
ingestion will increase colocalisation of GLUTs 1, 2, 3, and 5 with the cell-surface membranes. We expect
to see a decreased colocalisation when fasted. This may provide an insight into a unique glucose sensing
and hexose-regulating system that both operates at a rapid pace and is also insulin independent.

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**Nitric oxide-based treatment attenuates muscle-disuse atrophy during hind limb suspension** / Une
traitement basé à l'oxyde nitrique atténue l'atrophie désuétude-musculaire durant la suspension du
membre postérieur

Effective treatment for muscle disuse atrophy is not available. Since nitric oxide (NO) activates muscle
stem cells, we tested the hypothesis that treatment with the NO-donor drug, isosorbide dinitrate (ISDN)
during hind limb suspension (18days) would reduce muscle atrophy (UM protocol F11-029). Suspended
and ISDN-suspended groups of C57BL6 mice (M+F, 3wk and 6-8wk old) were compared to age-matched
controls (n=4/group) for changes in muscle (weight, fiber diameter, atrogin-1, myostatin), liver lipid, and
hypothalamus (genes regulating metabolism, inflammation and microglial activation). Suspension
induced atrophy in quadriceps and soleus (p<0.01) and ISDN attenuated loss of muscle mass (quadriceps,
soleus) and fiber diameter (gastrocnemius) (p<0.05). Suspension-induced increases (p<0.01) in atrogin-1
(negative regulator of muscle mass) and myostatin precursor (which inhibits myogenesis) were attenuated
by ISDN (p<0.05). ISDN increased MyHC-1 and MyHC-2b in unloaded muscles at 6-8wk vs. suspension
alone. Suspension-induced fatty-liver changes in 6-8wk mice were attenuated by ISDN (p<0.05). Suspension-related
increased Agrp mRNA in 6-8wk hypothalamus vs. control (p<0.05). Suspension and treatment
effects varied with age and muscle, including forelimb muscles, and body positioning varied among mice.
Potential use of NO-based treatment could help attenuate disuse atrophy, delay the serious impact of age-
related sarcopenia, and improve metabolic health; findings merit further investigation. Supported by
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**Does the size of the tall-grass prairie’s spring-emerging pollinators change across latitude?** / Est-ce
que la taille des pollinisateurs émergent du printemps dans la prairie à herbes haute change en
fonction de la latitude?

Allen’s and Bergmann’s rules predict an animal’s body should become rounder and larger, respectively,
in cool climates because lower surface area to volume ratios help to maintain body heat. Studies of these
rules in insect taxa have been few, with most studies producing conflicting results. The size and shape of
pollinator can have strong selection effects on flowering plants, especially those with size restrictive
flowers. We conducted research on the pollinator community surrounding *Cypripedium candidum* across
its latitudinal range from Manitoba to Iowa. *Cypripedium candidum* is a threatened tall grass prairie
endemic orchid that is pollinated through a restrictive flower trap. Previous research has shown that size
constraints on pollinators may limit reproductive success. We found that larger insect genera were more
abundant in northern sites, and some taxa showed a within-genus size increase with latitude.
Corresponding changes in the size of orchid flowers were not apparent. Orchids in Iowa were smaller than the other areas, but flower size did not vary between other regions. Southern populations showed the greatest range of orchid fruiting success (2-84%) in comparison to plants from further north (11-34%). Ongoing analyses will explore the contribution of changes in insect size to variation in fruit production.

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Mite-y freeze-tolerant / Acariens qui se gèle, et survivre!
Freeze-tolerance, the ability to survive freezing of internal body fluids, is an adaptation that has been found in many insects. Thus far only one species of arachnid has been known to survive freezing: the scorpion Centruroides vittatus. However, we have discovered that a red velvet mite (Trombidium sp.), collected near London, Ontario, can also survive freezing during the winter (November - March). In winter, the average temperature at which the mites’ body fluids freeze ranges from -6.8 ± 0.2 °C in November to -8.4 ± 0.2 °C in January, and they survive to temperatures far below this value (between -17 and -24 °C). During the winter, their hemolymph osmolality dramatically increases from 428 ± 28 mOsmol in November to 1025 ± 85 mOsmol in January. Outside of the winter months, although they freeze at similar temperatures (-7.7 ± 0.2 °C, September), the mites do not survive this process. The mechanisms that underlie the red velvet mite’s freeze-tolerance are unknown. Our immediate future investigations will involve identifying the molecules that are involved with the increased osmolality of the red velvet mite hemolymph, thereby identifying any further similarities among freeze-tolerant organisms from different taxa.

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Landscape influences on spatio-temporal patterns of Arctic Charr migrations in Nunavut / L’influence du paysage sur les modèles spatiaux et temporels des migrations de l’omble chevalier au Nunavut
Aquatic habitats are heterogenous across landscapes in terms of suitability for growth, survival, and reproduction. Individual fish therefore maximise fitness by balancing the benefits of moving to more suitable habitat with the energetic costs and risks of migrating. Understanding which environmental factors influence these fitness decisions provides insight on population reactions to climate changes or anthropogenic impacts. Arctic Charr (Salvelinus alpinus) exhibits diverse life histories across Nunavut, with populations demonstrating differing proportions and patterns of anadromy. Previous studies have investigated charr migratory choices in specific systems or areas of Nunavut, but not at a landscape scale. Understanding Arctic Charr migration patterns and drivers across the territory will inform the management of a widespread, culturally and economically important fishery, as well as coastal planning and impact assessment. Inuit knowledge and tracking data will be spatially analysed against landscape variables including river length, predator presence, and aquatic productivity to assess drivers of annual charr migration patterns. The influence of these variables on life history choices will be investigated by comparing to age-at-first-migration, determined by otolith microchemistry, for 10 populations. Anadromy is expected to be the preferred life history choice in areas of greater marine productivity, lower freshwater survival, and easier ocean access.

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Preliminary genetic analyses of the population structure of narwhals (*Monodon monoceros*) / Analyse génétique préliminaire de la structure de la population des narval (*Monodon monoceros*)

Narwhals (*Monodon monoceros*) are ecologically and culturally important Arctic species. Their populations are expected to face increasing stress in the near future due to climate warming, human industrial development, and range expansion by killer whale (*Orcinus orca*) populations, narwhal predators. Given these threats and ongoing harvest, effective population management requires the identification of stock structure. Due to their elusive nature and the logistical difficulties associated with tracking large numbers of individuals, stock structure identification is best identified by conducting spatial analyses of population genetic structure. To identify stock structure, narwhals from across their range in Canada were genotyped at 32 microsatellite markers. I will present a preliminary analysis of the spatial population genetic structure of Narwhals.

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Responses from acute exposure to increased aquatic pCO2 in Lake Sturgeon (*Acipenser fulvescens*) / Réponses d'une exposition aigue à la pCO2 aquatique augmentée chez l'esturgeon jaune (*Acipenser fulvescens*)

Global climate change is expected to impact general health of aquatic organisms, however, it is unknown if species which have remained relatively unchanged for hundreds of millions of years would be robust to the rate of climate change currently experienced. It is assumed that natural rates of climate change progress over thousands of years with gradual increases or decreases of abiotic factors (e.g. temperature and CO2) presumably allowing sufficient time for adaptation to the changing environment. In northern latitude rivers snow melt and rain between winter and spring can release land-derived acids and CO2 into rivers and lakes, which results in sharp seasonal declines in pH and increases in pCO2. Consequently, acute changes in the aquatic environment can occur over short time periods that are coincidental with periods when resources are scarce and thus are particularly challenging for survival in age-0 fish. Recent research on White Sturgeon, *Acipenser transmontanus*, suggests a physiological tolerance to acute increases in pCO2. Here we investigate behavioural, metabolic and blood chemistry responses of Lake Sturgeon, *Acipenser fulvescens*, to acute exposure to increased pCO2. Results will be discussed in the context of seasonal changes overlaying global increases of pCO2 in freshwater aquatic environments.

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Use of passive acoustic monitoring (PAM) and automatic detection to determine presence/absence of Belugas in Clearwater Fiord, Nunavut, Canada / Utilisation de la surveillance acoustique passive et de la détection automatique pour déterminer la présence ou l'absence de bélugas dans le Fjord de Clearwater, Nunavut, Canada

The Cumberland Sound beluga whale population is genetically distinct and considered threatened by COSEWIC (Committee On the Status of Endangered Wildlife In Canada). Clearwater Fiord is critical habitat to the resident beluga population as they aggregate there during the summer months to feed and nurse their calves. Using the non-invasive technique of passive acoustic monitoring (PAM), continuous recording data were gathered from Clearwater Fiord for 20 days in August 2010 and 11 days in August 2011. An automatic detector developed by JASCO Applied Sciences was used to identify beluga vocalizations and determine presence/absence of the species. Manual analysis on a subset of data indicated presence/absence was successfully determined within a precision and recall range of 90-99%. Further, patterns of movement between hydrophones indicate changes in habitat selection over time. Given the
threatened status of the Cumberland Sound beluga, long-term population monitoring and assessment is imperative. In addition to providing a more complete understanding of critical habitat and factors influencing spatio-temporal distribution, findings to date demonstrate the reliability of automatic detectors for presence/absence data obtained via passive acoustic monitoring. Collectively, this information can aid in determining future observation and analysis methods, management plans, and conservation efforts for this threatened population.

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Upregulation of anti-viral and pro-inflammatory transcripts in response to poly (I:C) in two *Xenopus laevis* spleen cell lines / Régulation positive des transcrits antiviraux et pro-inflammatoires en réponse au poly (I:C) dans deux lignées de cellules de la rate de *Xenopus laevis*
The capacity of spleen fibroblast and mesothelial cells to function as accessory cells in the initiation of a pro-inflammatory immune response in amphibians is largely unknown. Using two previously established continuous cell lines from *Xenopus laevis* spleen tissue, termed Xela S5m (mesothelial-like morphology) and Xela S5f (fibroblast-like morphology), we examined the molecular signatures Xela S5m and Xela S5f and their ability to upregulate pro-inflammatory transcripts levels in response to poly (I:C). Transcripts for cytokeratin 19, fibronectin and vimentin were detected in both Xela S5m and Xela S5f, while only collagen1A2 could be detected in Xela S5m using RT-PCR. Upon stimulation with poly (I:C), Xela S5m and Xela S5f exhibited a change in cell morphology and an increase in mRNA levels for interleukin-1 beta, interferon type 1 and inhibitor of kappa beta in a dose- and time-dependent manner. Together, these data suggest that Xela S5m and Xela S5f possess unique molecular signatures, participate in the recognition of microbial associated molecular patterns, such as poly (I:C), and can upregulate the expression of key anti-viral and pro-inflammatory cytokines important in initiating an immune response.

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Sociality and heat stress in the mangrove rivulus, *Kryptolebias marmoratus* / La socialité et le stress thermique chez le killi des mangroves, *Kryptolebias marmoratus*
Changes in the physical environment elicit physiological, molecular and behavioural responses in animals; however, we know comparatively little regarding how the social environment affects an animal’s response to environmental change. We used the self-fertilizing hermaphroditic fish, the mangrove rivulus (*Kryptolebias marmoratus*) to test the hypotheses that 1) social context will influence the phenotypic response to thermal stress and 2) thermal stress will affect social preferences. To determine if thermal physiology was influenced by social condition, we measured critical thermal maximum (CTmax) and heat shock protein (HSP70) levels after an acute heat shock event in fish living in pairs and fish living in isolation. Paired fish had higher expression of HSP70 than isolated fish, but there was no effect of social context on their CTmax. To determine if the thermal environment affected social preferences, we observed the amount of time fish spent alone as opposed to associating with conspecifics in control and heat-shocked conditions, and predicted that thermal stress would significantly affect social preference. However, fish did not change social preferences during acute heat shock compared to control conditions. We conclude that the social environment impacts thermal physiology at the cellular level but high temperatures do not affect social preferences.

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Thyroid hormone influences the molecular physiology of tight junctions in a primary cultured gill epithelium / L’hormone thyroïdienne influence la physiologie moléculaire des jonctions serrées dans une culture primaire de l’épithélium des branchies
Thyroid hormones (THs) are involved in the regulation of physiological functions including growth, metabolism, and metamorphosis. As a feature of vertebrates, TH producing glands and follicles and peripheral mechanisms of TH action have been widely investigated. Previous findings also suggest that THs play a strong supportive role in teleost fish osmoregulation. However, it is not known whether THs influence the molecular physiology of a central element in piscine salt and water balance, the epithelial tight junction (TJ) complex. Using a primary cultured trout gill epithelium model, we highlight the effects of 3,5',3'-triiodo-L-thyronine (T3) on teleost osmoregulation with an emphasize on the response of TJ proteins. T3 (10 and 100 ng/mL) supplemented media bathing trout double-seeded inserts (DSIs, composed of gill pavement cells and mitochondria-rich cells) caused a decrease in transepithelial resistance and increased paracellular permeability of \[^{3}H\]PEG-400. This increase in gill epithelium permeability was accompanied by changes in the abundance of select TJ proteins (i.e. claudins -8d, -28b, tricellulin) and an increase in the mRNA abundance of Na\(^+\)/K\(^+\)-ATPase \(\alpha1b\) isoform. Our findings suggest that T3 is capable of altering the permeability of the gill epithelium at least in part by its actions on the molecular physiology of the TJ complex.

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Examining the time-dependent responses of the Pacific spiny dogfish kidney to lowered salinity using comparative transcriptome profiling / Examiner les réponses dépendantes du temps du rein de l'aiguillat commun du Pacifique à la salinité abaissée en utilisant un profil de transcriptome comparatif

Salinity greatly dictates the environments that most aquatic organisms, including fishes, can inhabit. The majority of elasmobranchs are restricted to environments with minimal changes in salinity (stenohaline), while a few species are capable of surviving a wider range of salinities (euryhaline). Importantly, the underlying physiological and molecular mechanisms that impart euryhalinity in elasmobranches has not previously been fully investigated. The Pacific spiny dogfish, *Squalus suckleyi*, is a small, partially euryhaline elasmobranch that primarily inhabits ocean waters but has been found in brackish, estuarine waters to ~21 ppt. Previous studies have explored the temporal changes in physiology of these sharks after low salinity (21 ppt) exposure by measurement of plasma osmolytes, qPCR, and biochemical assays. Here, we applied a comprehensive, RNA-seq approach using Illumina HiSeq 4000 to characterize the temporal, large-scale changes occurring in the kidney following low salinity exposure. Dogfish were exposed to lowered salinity (21 ppt) for 0h, 12h, and 48h to capture short-term and long-term changes in gene expression. This is the first study to examine whole-transcriptome differential expression of an elasmobranch.

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Mitochondrial adaptations to high altitude in brown adipose tissue of highland deer mice / Adaptations mitochondriales à haute altitude dans le tissu adipeux brun de souris sylvestre en haute altitude

High altitude endotherms such as deer mice (*Peromyscus maniculatus*) must support high metabolic rates necessary to guard their body temperature against low ambient temperatures, despite a reduced \(O_2\) availability for mitochondrial respiration. Non-shivering thermogenesis (NST) in deer mice primarily takes place in brown adipose tissue (BAT), an organ specialized to produce heat using uncoupled mitochondrial respiration following activation of uncoupling protein 1 (UCP1) by free fatty acids. Past work has shown that highland deer mice have a greater NST capacity than acclimated lowlanders but no difference in BAT size with acclimation to cold and hypoxia. This suggests that highland deer mice modify BAT mitochondrial function, to increase NST capacity in cold and hypoxia. No population differences in
basal or coupled mitochondrial respiration were found before or after cold and hypoxia acclimation. When UCP1 uncoupled respiration was stimulated with palmitoyl-carnitine, both populations had equivalent rates of O₂-consumption before acclimation. After acclimation to cold and hypoxia, highland mice significantly increased uncoupled respiration to rates significantly higher than in acclimated lowland mice. These findings suggest that the enhanced NST capacity in highland deer mice acclimated to cold and hypoxia is partially the result of a greater fatty acid-stimulated uncoupled respiration per BAT mitochondrion.

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Effects of social ascension on growth and energetics in a group-living fish / Effets de l'ascension sociale sur la croissance et l'énergétique d'un poisson vivant en groupe

Individuals in social groups often form hierarchies. Social rankings usually reflect the outcomes of past agonistic interactions between group members, and influence access to limiting resources, such as shelter, food, and mates. Dominant animals generally monopolize these resources—maintaining larger energy stores, and exhibiting higher rates of feeding and growth. However, following a perturbing event, such as predation, long-standing hierarchies can become unstable, especially when vacancies provide subordinates an opportunity to attain dominant status. Few studies have explored the behavioural and physiological changes associated with such periods of social instability and the ascension from subordinate to dominant status. Using a group-living African cichlid, Neolamprologus pulcher, we assessed the behavioural and physiological changes that accompany social ascension. Specifically, we focused on whether fish adjust their activity, feeding, energy storage, metabolism, and growth. Overall, these findings add to our understanding of the mechanisms facilitating changes in social rank.

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Tracking muscle reinnervation during regeneration after pre-treatment with an NO-donor drug / Suivi de la réintégration musculaire pendant la régénération après un prétraitement avec un médicament donneur de NO

Satellite cell (SC) activation underpins muscle repair from damage, but function requires reinnervation of new fibers (myotubes). SC activation is mediated by nitric oxide (NO, a signaling free-radical molecule) which can enhance muscle repair and growth. SCs also up-regulate expression of a neural chemorepellent, semaphorin 3A (Sema3A) 6 days after muscle injury; Sema3A is thought to mediate axon growth toward regenerating fibers. We hypothesized that premature SC activation NO-donor treatment (2days before injury) would disrupt myotube reinnervation. Neuromuscular junction (NMJ) formation was examined in regenerating tibialis anterior muscle of adult mice (n=8/group) after injury by cardiotoxin (CTX, damages only fibers) or trauma (crush) (protocol UM#F14-015). Fiber formation was faster in CTX- than crush-injured muscle and accelerated by NO-donor treatment. NMJ maturity was classified from staining for acetylcholinesterase (AchE, silver) and Ach receptors. NO-donor treatment shifted NMJs to more immature patterns of early nerve-terminal formation and fragmented AchE at post-injury days 4 and 10 (CTX) and day 8 (crush) compared to untreated controls (Chi-square, p<0.05). Premature SC activation therefore advanced myogenesis but disrupted NMJ development, consistent with disrupted Sema3A action to repel motor axons. Manipulation of the timing and/or amount of Sema3A has potential to improve reinnervation after muscle damage. Supported by NSERC Discovery grant (JEA) and University of Manitoba Graduate Fellowship (ND).
Two potential treatments for white-nose syndrome in little brown bats (Myotis lucifugus) / Deux traitements potentiels pour le syndrome du nez blanc chez les petits chauves bruns (Myotis lucifugus)

Wildlife pathogens can cause extinctions and identifying potential treatments for such pathogens is increasingly important for conservation. White-nose syndrome (WNS) is a recently emerged fungal skin disease devastating populations of North American hibernating bats. Several treatments for WNS have been proposed but few have been tested on live bats. Treatments for WNS should target the pathogen (Pseudogymnoascus destructans (Pd)) with high specificity to avoid impacting delicate microbial communities in bat hibernacula. Our objective was to evaluate two treatments that should target Pd with high specificity: 1) Inhibitors targeting proteases secreted by Pd during skin invasion; and 2) Polyethylene glycol (PEG), which inhibits growth of fungi susceptible to water stress. We captured hibernating, WNS-negative little brown bats (Myotis lucifugus) from the wild. We matched bats for age and mass and then assigned individuals to one of four groups: inoculated with Pd and sham-treated; sham-inoculated with Pd and sham-treated; inoculated with Pd and treated with protease inhibitors; and inoculated with Pd and treated with PEG. Treatment groups are housed in separate cages within climate-controlled incubators to maintain hibernation conditions throughout winter. Our results will help identify, or rule out, potential treatments for a wildlife disease causing devastating impacts on North American bats.

The mosquito, *Aedes aegypti* inhabits ammonia rich septic tanks in tropical regions of the world that make extensive use of these systems, explaining the prevalence of disease during dry seasons. Since ammonia (NH3/NH4+) is toxic to animals, an understanding of how *A. aegypti* larvae can survive in this high ammonia environment is important. Aquatic animals typically excrete ammonia directly into the aqueous environment and the anal papillae of larval *A. aegypti*, in part, serve this function. Previously, we have shown that two Rhesus-like ammonia transporter proteins, *AeRh50-1*, *AeRh50-2*, and a MEP/Amt ammonia transporter-like protein, *AeAmt1*, participate in ammonia excretion by the anal papillae. The present study demonstrates that a fourth ammonia transporter – like protein, *AeAmt2*, is expressed in the anal papillae epithelium where it co-localizes with V-type H⁺-ATPase on the apical membrane. By feeding larvae *AeAmt2* dsRNA, protein abundance of this transporter was significantly reduced after two days. Currently, we are measuring the effects of *AeAmt2* knockdown on ammonia fluxes at the anal papillae and assessing effects on hemolymph ammonia levels and pH.

Comparison of metabolic rate analysis and white muscle enzyme activities in lake trout (Salvelinus namaycush) subjected to daily acute heat challenges / Comparaison de l'analyse des taux métaboliques et des taux d'enzymes dans le muscle blanc du touladi (Salvelinus namaycush) soumis aux défis quotidiens de la chaleur aiguë

Cold-water piscivores have an optimum temperature range for growth well below the summer water temperatures found in nearshore regions of lakes, where they obtain most of their energy. Lake trout (*Salvelinus namaycush*), which grow optimally at ~10°C, make rapid forays into nearshore waters during summer to feed; however, temperatures in these habitats are well beyond their optimum range for growth. Given lake surface water temperatures are expected to increase with climate change, we sought to test the effects of acute temperature increases on juvenile lake trout. First, we examined the effects of increasing temperatures (10°C control and daily acute challenges of 17°C and 22°C for 5 min) on metabolic rate, feeding and growth. Metabolic rate, including standard metabolic rate (SMR), maximum metabolic rate (MMR), and aerobic scope (AS), was measured via intermittent respirometry. Lactate dehydrogenase, pyruvate kinase and cytochrome c oxidase enzyme activity were measured in white muscle to examine relationships between enzyme levels and MR estimates across treatments. Metabolic rates showed no significant difference across treatments for SMR, but higher MMR and AS in treatment fish versus control. Despite altered MMR, muscle enzyme activities were not different among treatments. Further testing is required to determine potential relationships and/or effects.
New biomarkers of post-settlement growth in the sea urchin Strongylocentrotus purpuratus / Nouveaux biomarqueurs de la croissance post-établissement chez l'oursin Strongylocentrotus purpuratus

Sea urchins are a potentially important aquaculture species. Many sea urchin species develop via an indirect life history that is characterized by a drastic settlement process at the end of the larval period. Settlement is typically associated with high mortality rates of juvenile populations. Juveniles require several days to develop a functional mouth and digestive system. During this period, juveniles use up larval resources transferred to the juvenile stage. This perimetamorphic period is relatively poorly understood and mechanistic insights into processes underlying the onset of juvenile feeding and metabolism have implications for the recruitment of natural population as well as aquaculture. The insulin/IGF signaling (IIS) pathway is well conserved among animal phyla and regulates system-wide functions, such as growth, reproduction, aging and nutritional status. We analyzed the expression of FoxO, TOR and ILPs in post-settlement juveniles and conjunction with their early growth trajectories. We also tested how pre-settlement starvation is affecting post-settlement expression of IIS. We found that FoxO provides a useful molecular marker in early juveniles as its expression is strongly correlated with juvenile growth. We also found that pre-settlement starvation affects juvenile growth trajectories and IIS. Our findings provide preliminary insights into the mechanisms underlying post-settlement growth and metabolism.

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Parasite transmission in a heterogenous habitat: Does final host activity predict the presence of trematode parasites? / Transmission par parasite dans un habitat hétérogène: L'activité d'hôte final prédit-elle la présence de parasites trématodes?

Parasites have evolved strategies to increase the likelihood of transmission from host to host. Some two-host life cycle parasites complete transmission when cercariae encyst in the abiotic environment to become metacercariae. Since parasite transmission depends on the host consuming metacercariae, we tested whether metacercariae were more likely to be found in areas of final host activity. We focused on the trematode Quinqueserialis quinqueserialis which uses a mollusc first host and a muskrat final host. Six wetlands were sampled that had high prevalence of infection in muskrats (80%, 106/133) to compare the presence and intensity of metacercariae near (experimental) and 10 m away (control) from muskrat activity. Metacercariae were only detected in 5 of 12 paired samples indicating that cysts were unevenly distributed even in areas where the final host was active (feeding or housing). In addition, we found no difference in snail, plant, or metacercaria density between the treatments. By sequencing the 28S gene region, we confirmed that Q. quinqueserialis is using a novel first intermediate host, Promenetus sp. Future experiments will determine if the metacercariae have any preferences for encysting on a particular substrate to better understand the predictability of transmission for this parasite.

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Enhancement of reproductive quality in Pacific white shrimp using algal terpenoids / Amélioration de la qualité de la reproduction dans les crevettes blanches du Pacifique à l'aide de terpénoïdes d'algues

Industry production of Pacific white shrimp relies on eyestalk ablation (ESA) to induce rapid ovarian maturation and spawning, however, ablated females frequently produce abnormal eggs, have reduced reproductive output and a significant decrease in hatching success due to a diminished transfer of acyglycerides to their eggs. We are testing whether terpenoids from algal sources can be used to shorten ovarian maturation and enhance reproduction in Pacific white shrimp. Using GC-MS, we identified the
chemical nature of terpenoids produced and released by the mandibular organ (MO) of Pacific white shrimp as well as those produced in a taxonomically diverse set of microalgae. Preliminary injections of identified terpenoids in Pacific white shrimp promote changes in reproductive development. We also tested several biomarkers for shrimp reproduction, such as vitellogenin production, gonadosomatic index (GSI), reproductive output and offspring hatching success to assess the effects of exogenous terpenoids on the maturation of the shrimp reproductive axis. If terpenoids from algal food sources can be used to induce ovarian maturation at a faster or similar rate to ESA and enhance offspring quality, then this approach can be implemented in shrimp aquaculture feeds and serve a valuable and completely non-invasive alternative to ESA.

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The role of mitochondria in hypoxia tolerance of hibernators / Le rôle des mitochondries dans la tolérance à l'hypoxie des hibernateurs
Small hibernators, such as the thirteen-lined ground squirrel, spend most of the winter season in a state of reduced metabolic rate (MR) and body temperature (Tb), called torpor. Torpor bouts are punctuated by spontaneous arousals, where MR and Tb return to euthermic levels for several hours, called interbout euthermia (IBE). This rapid increase in MR may result in transient hypoxia in vivo, and ground squirrel tissues are more tolerant of hypoxia and ischaemia than non-hibernating rats. This tolerance likely translates to the mitochondrial level, as mitochondria contribute significantly to energy status and reactive oxygen species (ROS) production. Mitochondrial changes that accompany hibernation, such as suppression of electron transport system complexes, may contribute to tissue-level hypoxia tolerance. I will compare anoxia tolerance of liver mitochondria isolated from hibernating ground squirrels to those of rats and summer-active squirrels. Preliminary data from ground squirrels suggests that maximal mitochondrial respiration rates decline following anoxic exposure, but there is no difference between torpor and IBE. Moreover, the magnitude of this decline is independent of the duration of anoxia. This pattern suggests a large contribution from ROS-mediated damage in anoxia, which I aim to investigate by measuring markers of oxidative damage and activity of mitochondria-specific proteases.

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Acute and chronic effects of multiple stressors on microRNA in zebrafish / Effets aigus et chroniques de multiples facteurs de stress sur les microARN dans le poisson zèbre
As the human population continues to grow, increased anthropogenic stress is placed on the aquatic environment. Pharmaceuticals, such as venlafaxine (VFX), a heavily prescribed and readily detectable antidepressant, are found downstream of wastewater treatment plants. As a result of climate change, increased surface water temperatures and decreased dissolved oxygen levels have been observed. In this study, a multi-stressor approach was used to determine the cumulative, sublethal effects of the aforementioned stressors on microRNA (miRNA) in adult zebrafish (Danio rerio). MiRNA are small, conserved, non-coding RNA which act by decreasing mRNA translation. This impacts the functional responses of downstream targets and is a method of environmental and epigenetic regulation of phenotypic response. Adult zebrafish were exposed to control (27°C, 100% O2, 0 μg/L VFX) or stressed (32°C, 50% O2, 1 μg/L VFX) conditions for 24 hours or 21 days. RNA was extracted from liver, gonad, and muscle tissue and RT-qPCR was performed on specific miRNA related to proteins that respond to hypoxia, heat stress, or contaminants. This comparison between lengths of exposure showed differences between initial and acclimated responses. Due to the conserved nature of miRNA, this will improve our understanding of the effects that environmental stressors have on epigenetic regulation.

Edward Jenkins, Julia Gulka, Paloma Carvallo, Laurie Maynard, Kelsey Johnson and Gail Davoren
Examining dietary niche shifts of marine predators in response to capelin availability / Examen des changements de niche alimentaire des prédateurs marins en réponse à la disponibilité du capelan

Understanding complexities behind the structure and function of marine ecosystems are key challenges in marine ecology. In northeast Newfoundland, marine predators rely on capelin (*Mallotus villosus*), a dominant forage fish that migrates inshore to spawn in July, transforming prey biomass from low (pre-spawning) to high (spawning). During July-August, 2016, we investigated trophic shifts and dietary niche breadth of marine predators including; non-breeding great (*Ardenna gravis*) and sooty shearwaters (*A. grisea*), breeding herring gulls (*Larus argentatus*) and great black-backed gulls (*L. marinus*), and transient humpback whales (*Megaptera novaeangliae*), using stable isotope analysis (δ^{15}N, δ^{13}C). We predicted that trophic position would change and niche breadth would narrow as capelin biomass shifted from low to high, reflecting higher capelin-reliance. Blood (birds) and skin (whales) samples were divided into early, mid, and late periods determined by sampling dates and tissue turnover rates. Isotopic niche breadth, quantified in *SIBER* and representing diets over 2-3 weeks, narrowed and trophic position shifted toward higher δ^{15}N and δ^{13}C for all species, though shifts occurred to varying degrees. These findings suggest the diet of marine predators shift with capelin biomass, indicating reliance and underpinning the importance of the resource.

Characterization of the estrogen biosynthetic pathway and 17α-ethinylestradiol disruption across the ovarian maturation cycle in mummichog (*Fundulus heteroclitus*) / Caractérisation de la voie de biosynthèse des œstrogènes et de la perturbation du 17α-ethinylestradiol à travers le cycle de maturation de l’ovaire chez le choquemort (*Fundulus heteroclitus*)

17α-ethinylestradiol (EE2), an endocrine disrupting compound (EDC), is linked to organism-level (hormone physiology/development) and population-level (egg production) effects in fish. Compared to model freshwater teleosts, estuarine *Fundulus heteroclitus* (mummichog) egg production is less sensitive to EE2 exposure, which may be due to differences in ovarian physiology including 17β-estradiol (E2) regulation. Plasma and ovarian follicles from maturing mummichog were collected and grouped into five stages of maturation, where steroid production and/or gene expression in hormone signalling and steroidogenic pathways were assessed. Plasma and follicular production of E2, testosterone, and maturation inducing steroid (MIS) increased as the ovarian maturation cycle progressed, and dropped after maturation. Gene expression of selected steroidogenic enzymes and gonadotropin receptors increased throughout the cycle and dropped at late maturation; however, P450 c17 and follicle stimulating hormone receptor dropped earlier in the maturation cycle. Estrogen receptor expression showed no clear trends. Stages of follicles were exposed to 50 - 250 nM of EE2 *in vitro*; after 24 hours, P450 aromatase and luteinizing hormone receptor expression showed no exposure differences. The dissimilarity in mummichog from other model teleosts in E2 regulation plus EE2 insensitivity in maturing follicles may be partially responsible for egg production differences in estrogenic EDC exposure.

Decoding Richardson’s ground squirrel (*Urocitellus richardsonii*) alarm vocalizations / Décodage des vocalisations d’alarme de l’écureuil terrestre de Richardson (*Urocitellus richardsonii*)

Alarm calls provide neighbouring conspecifics with information regarding predatory threats, facilitating appropriate anti-predator behaviour among receivers. Among Richardson’s ground squirrels (RGS), these signals are known to encode the nature of the presumptive threat (aerial versus terrestrial), response urgency, and the individual identity of the caller. Variation in call spectral structure, however, may also encode more fine-grained information regarding predator attributes and behaviour. To identify how alarm
vocalizations vary in structure relative to the context surrounding predator encounters, we recorded ~300 alarm calls emitted by free-living RGS in conjunction with the appearance of 18 naturally-occurring predator and non-predator species at an established field site in Winnipeg, Manitoba. Multivariate analyses corroborate previous studies, demonstrating that RGS alarm calls fall into two main categories: “whistles” (longer-duration, stable frequency calls) and “chirps” (shorter duration, frequency-modulated calls), associated with terrestrial threats and with aerial threats respectively. Further analyses elucidate the degree to which frequency, power, and temporal characteristics within these vocalization classes vary with predator attributes and behaviour, thus characterizing the degree of productional-specificity of RGS alarm vocalizations.

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Investigation of genes involved in testicular differentiation in the sea lamprey, Petromyzon marinus

Investigation des gènes impliqués dans la différenciation testiculaire chez la lamproie marine, Petromyzon marinus

Sex differentiation is the diversification of undifferentiated tissue into tissues and phenotypes associated with the male or female fate. In lampreys, ovarian differentiation occurs during the larval stage but testicular differentiation appears to be delayed until metamorphosis. Some of the genes involved in ovarian differentiation in lampreys have recently been identified, but nothing is known regarding the genetic factors involved in testicular differentiation. We therefore tested whether key Sertoli cell transcription factors involved in testicular differentiation and spermatogenesis in other vertebrates (e.g., SOX9, DMRT1, WT1, and DAZAP1) show differential gene expression prior to and during testicular differentiation in sea lamprey, Petromyzon marinus. Using qRT-PCR, we compared gene expression in ovaries and testes from larval, metamorphosing, and adult sea lamprey, and performed histological analysis on all testes. An increase in germ cells in the testes coincided with increased expression of SOX9, DMRTA2 (DMRT-family gene) and WT1, and higher DAZAP1 expression was observed during spermatogenesis and spermiogenesis. The increase in SOX9 expression was followed by an increase in DMRTA2, with significantly higher expression in larval males relative to females. Thus, genes involved in testicular differentiation appear to be conserved across vertebrates, although the involvement of lamprey-specific genes cannot yet be ruled out.

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Did a million squirrels come from two? Examining inbreeding in an invasive African ground squirrel (Atlantoxerus getulus) / Un million d'écureuils sont-ils venus de deux? Examiner la consanguinité dans un écureuil terrestre Africain (Atlantoxerus getulus) envahissant

The founder effect is a phenomenon where a new population is established by a small number of individuals, resulting in a limited gene pool that is not representative of the more diverse source population. Nascent populations established by a few founders are genetically depauperate and prone to the detrimental effects of inbreeding and genetic drift. The population of Barbary ground squirrels on the island of Fuerteventura, thought to have been founded by a single breeding pair that was recently introduced from nearby Morocco, provides an opportunity to study founder effects. We predicted that a sample of the island population (N = 30) when compared to samples from the source location (N = 10) will reveal little to no variation in the mitochondrial control region. Any variation present may be indicative of a second founder event or mutation. Preliminary results show no variation in the mitochondrial DNA of the island population, but some variation within the source population. This study
will give us greater insight into the effects of a single founder event on the genetic diversity of an invasive species of mammal.

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Let’s break it down: Mitophagy as a mechanism for metabolic suppression during diapause in the Colorado potato beetle / Déconstruisons-le: la mitophagie comme mécanisme de suppression métabolique pendant la diapause chez le doryphore du Colorado

Temperate insects spend over half their lives overwintering, during which most enter diapause; a pre-programmed state of developmental arrest. During diapause, insects cease development and suppress their metabolism. Some diapausing insects degrade their muscles during the winter, however the role that such atrophy plays in metabolic suppression during diapause, especially at the mitochondrial level, remains unknown. In this study, we found that Colorado potato beetles (Leptinotarsa decemlineata) suppress their whole-animal metabolic rate by 88% in diapause. During diapause, the mitochondrial respiration rate of flight muscles is lower, and virtually undetectable compared with non-diapausing beetles. Using MitoTracker staining, transmission electron microscopy, and citrate synthase enzyme assays, we will confirm that beetle flight muscle contains fewer mitochondria during diapause, suggesting that mitophagy underlies the observed metabolic suppression, rather than active suppression of components of mitochondrial electron transport. Our comprehensive investigation of mitochondrial metabolism in a diapausing insect will provide novel insights into the physiological mechanisms of insect diapause and metabolic suppression.

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Growth and recovery of gene expression in embryonic zebrafish exposed to untreated and ozone-treated oil sands process-affected water / Croissance et récupération de l’expression des gènes chez le poisson zèbre embryonnaire exposé à l’eau non-traitée et l’eau affectée par les sables bitumineux traités à l’ozone

The extraction of bitumen from oil sands is based on a hot water alkaline extraction process. The water is commonly referred to as oil sands process-affected water (OSPW), and is stored in tailings containment structures to enable it to be recycled for various uses such as bitumen extraction, material hydro transport, and process cooling. Recent studies have focused on the use of ozonation as a tool to expedite remediation efforts, as it has previously been shown to minimize the effects of OSPW exposure on embryonic fishes. This study characterizes the effects of OSPW exposure on embryonic zebrafish by measuring gene expression and focuses on the effectiveness of ozonation as a remediation process. Zebrafish were exposed to both raw and ozone-treated treated OSPW from 0-7 days post fertilization (dpf). Embryos were transferred to clean water at 7dpf for a 4-day recovery period to monitor recovery post-exposure. Gene expression was measured immediately after exposure at 7dpf, as well as after two and four days of recovery (9 and 11dpf, respectively). Raw OSPW exposure significantly increased the expression of biotransformation enzymes cytochrome P450 1a and 1b as well as decreased the expression of genes involved in neurodevelopment and cardiac development. However, ozone-treated OSPW exposure did not significantly change expression levels of any target genes. Following two days of recovery from exposure to raw OSPW, gene expression levels were similar to control. This study shows that embryonic fish recover relatively quickly after raw OSPW exposure and that ozone-treatment aids in reducing the observed changes in gene expression. By characterizing embryonic OSPW exposure and studying recovery time we can determine the length of time that OSPW-induced effects might persist and the effectiveness of ozone-treatment as a tool for remediation.
Use of beluga whale condition indices to meet objectives of the Tarium Niryutait Marine Protected Area in the Canadian Arctic / Utilisation des indices de condition de béluga pour atteindre les objectifs de la Zone Protégée Marine de Tarium Niryutait dans l'Arctique Canadien

The Tarium Niryutait Marine Protected Area (TNMPA) was the first Arctic MPA in Canada with the conservation objective to conserve and protect beluga whales and other marine species, their habitats, and their supporting ecosystem in the Inuvialuit Settlement Region (ISR) of the Beaufort Sea. Indicators can be useful monitoring tools for marine management as they can represent changes in the larger ecosystem. While multiple indicators have been proposed to monitor the TNMPA, there is a gap in understanding what trends are captured by proposed indicators and how indicators can advise marine management decisions. This research evaluates the proposed health indicators of the focal species in the TNMPA, beluga whale (*Delphinapterus leucas*). The three research objectives are: (1) evaluate body condition indices by analysing data quality and identifying any significant body condition trends; (2) determine if body condition trends correlate with environmental drivers; (3) work alongside management agencies to incorporate findings into future monitoring activities. Two body condition indices were selected for analysis, blubber thickness and girth and data was collected from 1989-2016 at whaling camps in the ISR. Results will improve marine management practices in the Canadian Arctic by evaluating the effectiveness of proposed indicators to meet management objectives.

Understanding host fish and habitat requirement helps to locate a vast population of the rare Hickorynut mussel (Unionidae) in the Ottawa River / Comprendre les poisson hôtes et les besoins d'habitat contribue à localiser une vaste population de moules Hickorynut (Unionidae) rare dans la rivière d'Ottawa

The Hickorynut mussel, *Obovaria olivaria*, is one of 55 Canadian native freshwater mussel species. It prefers deep-water habitats with strong water currents and occurs in only six rivers nationwide (status: Endangered). In Canada, the known host fish is the Lake Sturgeon, *Acipenser fulvescens*. The Ottawa River watershed has a rich freshwater mussel fauna with 21 species. Museum records point to this river as a prime location for Hickorynut populations. The goal of this study was to demonstrate that by locating the best host fish habitat, and aligning such information with habitat preferences of the Hickorynut, we would be able to find a healthy population of this rare freshwater mussel. The Finlay Island Ecological Reserve area, in the Lac Coulonge reach of the Ottawa River, was identified as ideal for sturgeon and presumably for the Hickorynut. SCUBA diving surveys revealed the presence of 5 species of mussels with the Hickorynut being the second most abundant species in the area (0.73 indiv. m⁻², and 22% of total live mussel counts). The Lac Coulonge reach favors the Lake Sturgeon and the Hickorynut mussel as it still a ‘wild’ sector of the Ottawa River that is unobstructed, with free-flowing water and no dams.

Phenotypic plasticity in the skin of the amphibious mangrove rivulus (*Kryptolebias marmoratus*) / La plasticité phénotypique dans la peau du killi de la mangrove amphibie (*Kryptolebias marmoratus*)

We assessed the cellular effects of air exposure and salinity on the skin of the air-breathing mangrove rivulus, *K. marmoratus*. We hypothesised that rivulus survive dramatic changes in environmental salinity and air exposure because of phenotypically plastic changes in specialized ion transport cells (ionocytes) in their skin. We predicted that there would be significantly more ionocytes in the skin of fish in 1) high...
salinity conditions (45 ppt) and 2) during air exposure compared to when fish are in brackish water (15 ppt). We also predicted that fish in 45 ppt would have a distinctive ion signature in their skin mucous and that mucous composition would differ between air and water. Using scanning electron microscopy (SEM), we did not observe differences in ionocyte number, type or area with air exposure or salinity. Notably, fish in 45 ppt had more mucous coverage compared to fish in 15 ppt, independent of air exposure. Using SEM elemental analysis, fish in 15 ppt had distinctive skin/mucous elemental composition compared to fish at 45 ppt. Our results indicate that the skin of this amphibious mangrove fish exhibits phenotypic plasticity, critical for ionoregulation in its extreme habitat.

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The analysis of in vivo expression of genes that encode erythropoiesis growth factors in goldfish during Trypanosoma carassii infection / L’analyse in vivo de l’expression des gènes qui codent pour les facteurs de croissance de l’érythropoïèse pendant une infection Trypanosoma carassii chez le poisson-rouge

Trypanosoma carassii is a flagellated bloodstream parasite of cyprinid fish. Pathogenesis of T. carassii infection manifests primarily as severe anemia in experimentally infected fish. The anemia is due to a substantial decrease in the number of circulating red blood cells (RBCs) during peak parasitaemia, indicated by significant drop in the packed cell volume and total RBC counts. Erythropoietin (EPO) and its associated receptor (EPOR) are important regulators of RBC production, and have been implicated in the resolution of anemia in other model systems. We previously cloned, expressed and characterized goldfish EPO (rgEPO) and showed that the recombinant molecule increase proliferation, survival and differentiation of erythroid progenitor cells in vitro. In this study, we describe the changes in expression of genes predicted to be important in the resolution of the anemic state, as well as the in vivo effects of rgEPO administration, during T. carassii infection. [Funded by NSERC, Canada]

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The expression of the alternative oxidase protein in the copepod Tigriopus californicus in response to temperature / L'expression de la protéine oxydase alternative dans le copépode Tigriopus californicus en réponse à la température

Alternative oxidase (AOX) is a terminal quinol oxidase that is located in the mitochondrial electron transport systems of some animals. AOX is non-proton pumping and bypasses complexes III and IV and is therefore often viewed as energetically wasteful. The copepod Tigriopus californicus lives in intertidal rock pools along the western coast of North America and as such experiences extreme daily fluctuations in their environment. The objective of this research was to determine whether T. californicus expresses the AOX protein and whether this expression changes with 24 hour and 1 week exposures to a variety of temperatures (6, 15, 23, 28, and 32°C). Our results indicate that in T. californicus: i) AOX protein is expressed and is ~50 kDa; ii) prolonged exposure to temperatures >28°C are fatal; iii) increased AOX protein levels are seen after exposure to higher temperatures. T. californicus is the first animal species in which it has been demonstrated that an AOX gene is present, the expression of AOX mRNA occurs, and the expression of AOX protein has been experimentally confirmed. We therefore expect that T. californicus will be an excellent model system for gaining a deeper understanding of the physiological function of AOX in animals.

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Aerobic scope is significantly affected by environmentally relevant diel thermal cycles in wild Atlantic salmon / La portée aérobique est significativement affectée par les cycles thermiques journaliers pertinents à l'environnement dans le saumon Atlantique sauvage

Stable temperatures are rarely found in natural temperate ecosystems. Daily fluctuations in mean, maximum, and rate of temperature change can affect thermally sensitive ectothermic fish inhabiting these environments. Recent research suggests that physiological responses to stable temperatures are different from those of thermally cycled fish. We tested the hypothesis that environmentally relevant diel thermal cycles would influence metabolism and swim performance compared to fish acclimated to stable temperatures. We acclimated wild Atlantic salmon parr for 3 weeks at either 16°C, a daily thermal cycle of 16-21°C, or 18.5°C (the average of 16-21°C) and measured resting and maximum metabolic rate, aerobic scope, and U_{crit}. We found no differences in the resting metabolic rate among these thermal treatments; however, there was a significant decrease in maximal metabolic rate and aerobic scope in thermally cycled fish (16-21°C). Despite this, we saw no difference in U_{crit} between groups. Our data show that, 1) aerobic metabolism in wild Atlantic salmon is significantly altered in natural diel thermal cycles, and 2) there is a disconnect between maximum metabolic rate and swimming performance. In the future, thermal laboratory experiments on wild temperate fish should incorporate diel thermal cycling to more accurately predict thermal effects in nature.

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Early growth in migratory and resident northern form Dolly Varden / Croissance précoce du Dolly Varden nordique migrante et résidentielle

Northern Dolly Varden char (Salvelinus malma malma) are listed as special concern by COSEWIC due to their limited distribution, population declines, and concerns over their ability to tolerate climate change. Research focus to date has been on the anadromous (migratory) life history form; information on resident (non-migratory) Dolly Varden and their overall role in populations is unknown, despite the fact that anadromous and resident Dolly Varden are genetically the same within rivers. Therefore, this research aims to compare resident and anadromous life histories and identify factors that contribute to the selection of different life history strategies, specifically looking at early growth rates and associated traits. Research will involve comparison of biological data collected in conjunction with ongoing stock assessment studies. Otoliths (ear-bones) will be analyzed to determine fish age and growth rates. Traits such as juvenile growth will be compared between resident and anadromous Dolly Varden within and among rivers to determine how growth influences life history selection. Results presented will include comparison of size-at-age of from three river systems. The results of this study will aid in management efforts for Dolly Varden and enhance the overall understanding of life history strategies within this species.

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High GLUT5 and GLUT1 transcript expression and capacity for rapid phosphorylation by hexokinase may facilitate rapid utilization of glucose and fructose in flight muscle of the ruby throated hummingbird (Archilochus colubris) / L'expression et la capacité de transcription GLUT5 et GLUT1 élevées pour une phosphorylation rapide par l'hexokinase peuvent faciliter l'utilisation rapide du glucose et du fructose dans le muscle volant du colibri à gorge rubis (Archilochus colubris)

Hummingbirds can oxidize both newly ingested glucose and fructose in flight muscle cells quickly enough to completely fuel energetically expensive hovering flight. To achieve this, hummingbirds must both transport the sugars into muscle fibers, and phosphorylate them, at exceptionally high rates. We hypothesized that hummingbird flight muscles have the highest densities of glucose and fructose transporters, as well as fructolytic enzymes, among vertebrates. We quantified sugar transporter and
fructolytic enzyme transcript expression in multiple tissues of the ruby-throated hummingbird (*Archilochus colubris*), and further investigated aldolase B protein expression. We found that hummingbird flight muscle had among the highest relative transcript levels of the glucose transporter GLUT1 and the fructose transporter GLUT5 ever observed in vertebrate muscle, but low expression of ketohexokinase and aldolase B transcript. Protein levels of aldolase B were consistent with transcript density. Finally, we measured the maximal enzyme activity of hexokinase in muscle and found that fructose phosphorylation rates were among the highest ever observed. Based on these findings we formed the alternative hypothesis that hummingbird hexokinase may rapidly phosphorylate fructose *in vivo*. We find evidence supporting an unusual capacity for metabolic flexibility in carbohydrate oxidation in hummingbird flight muscle.

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**Dietary overlap between ringed and harp seals in Cumberland Sound, Nunavut / Le chevauchement alimentaire entre les phoques annelés et les phoques du Groenland dans Cumberland Sound, Nunavut**

As the ocean climate continues to warm, northward range expansions of subarctic species and increasing abundance of temperate species in Arctic regions are predicted. In the Cumberland Sound region, locals have reported unusually abundant subarctic forage fish, namely capelin, since 2000. Coincident with this have been increases in harp seal summer distribution in recent years, and Inuit knowledge suggests that resident ringed seal populations have been declining. We hypothesize that, when sympatric, harp seals occupy a similar ecological niche to that of ringed seals and that this may be a factor in population changes. To address this, we examined ringed and harp seal stomach contents and muscle and liver stable isotopes (SI) from tissues collected by Inuit hunters during the open-water period from 2008-2016. Stable isotope analyses suggest high dietary overlap (43% muscle SI, 56% liver SI), though there appears to be some niche partitioning based on stomach contents. A greater understanding of the impacts of range expansions on ecosystem structure and function can better inform management of subsistence- and commercially-harvested species.

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**Transgenerational effects of elevated temperature on the upper thermal tolerance of *Salvelinus namaycush* and *S. fontinalis* / Effets transgénérationnels de la température élevée sur la tolérance thermique supérieure de *Salvelinus namaycush* et *S. fontinalis***

Global average temperatures are predicted to rise, however, the capacity of ectotherms to cope with climate change isn’t thoroughly understood. Some can respond to long-term changes in temperature through transgenerational plasticity (i.e. thermal experiences can be passed on to offspring, improving their ability to tolerate warmer temperatures). Previous studies have seen this in fish that are warm-adapted or eurythermal, but it’s unclear whether cold-adapted, stenothermal ectotherms are capable of the same response. My research examines transgenerational plasticity in *Salvelinus fontinalis* and *S. namaycush* to determine whether there’s potential for these fish to cope with anticipated warming. I hypothesize that the thermal tolerance of cold-adapted, stenothermal ectotherms can be improved through transgenerational plasticity. Adult trout, acclimated to optimal and elevated temperatures, were crossed to produce offspring from parents of matched and mismatched temperatures. At the fry stage, the offspring were acclimated to an optimal or elevated temperature and their thermal tolerance was determined by measuring their critical thermal maximum and metabolic rate during an acute temperature challenge. In both species, offspring
from elevated temperature parents had a higher thermal tolerance than those from optimal temperature parents. Future experiments will explore the influence of transgenerational plasticity on proximate mechanisms underlying thermal tolerance.

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The impact of raw and ozonated oil sands process-affected water exposure on prey capture and facial morphometrics in zebrafish larvae / L’impact de l'exposition de l'eau affectée par les sables bitumineux brut et ozonisé sur la capture des proies et la morphométrie du visage chez les larves de poissons zèbres
Oil sands process affected water (OSPW) from bitumen extraction processes is stored in tailings containment facilities to enable water to be recycled for production uses including extraction, process cooling, and hydro-transport of materials. Tailings reclamation strategies include development of aquatic or terrestrial habitat that will function similar to habitat naturally found in the oil sands region. Ozone treatment, a tertiary treatment commonly applied to municipal wastewater, is being investigated in an effort to expedite remediation of OSPW to a quality acceptable for various reclamation scenarios. The impact of OSPW exposure on early developmental stages of fish has been well studied, however, the sublethal impacts of untreated and ozonated OSPW on the complex behaviors of developmentally exposed fish have yet to be determined. In this study, we examined the effect of embryological exposure to raw and ozonated OSPW on the prey capture behavior of juveniles and avoidance behavior of adults in response to predator avoidance cues. The study of complex behaviors, such as feeding behavior and predator avoidance behavior on a well characterized teleost model species, such as the zebrafish, will increase our understanding of the effectiveness of ozone treatment and further characterize the potential impacts of OSPW exposure.

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Reductions in mitochondrial reactive oxygen species mimic the anoxic response in goldfish neurons / Les réductions des espèces d'oxygène réactives mitochondriales imitent la réponse anoxique dans les neurones de poissons rouges
Although the anoxia intolerant mammalian brain undergoes neuronal death within minutes, the common goldfish Carassius auratus, is able to avoid cellular damage in anoxic environments. Due to the suppression of action potentials in excitatory glutamatergic neurons and the increased action potential frequency in inhibitory GABAergic neurons, the goldfish is able to decrease its overall energy expenditure and survive weeks under low oxygen conditions. In conjunction with the decreased oxygen availability complication, these animals also have to overcome the homeostatic imbalance of reactive oxygen species (ROS). ROS in low concentrations has been proposed to function as part of signal transduction pathways. Given that the cellular mechanism of anoxia tolerance in goldfish remains elusive, we proposed that low ROS contribute to the anoxic response. Using the whole-cell patch-clamp technique, we measured changes in electrophysiological parameters of cortical pyramidal goldfish neurons in response to ROS scavengers. We found that 125 uM NAC was sufficient to depolarize the membrane by 8mV, similar to the anoxic response. In addition, firing frequency decreased in pyramidal neurons by approximately 50% and whole cell conductance increased by 150%- mimicking anoxia. MitoTEMPO, a mitochondrial scavenger, exhibited similar results. Together, this implies that ROS plays a signaling role in anoxia.

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Filling in the gaps of the IMD Immune pathway of the kissing bug *Rhodnius prolixus* / Remplir les lacunes de l'IMD voie immunitaire des triatomes *Rhodnius prolixus*

Arthropod defenses against pathogens rely entirely on an innate immune system. Upon detection of pathogens three antimicrobial signal transduction immune pathways are activated: The toll pathway, the JAK/STAT pathway, and the immune deficiency pathway (IMD). The Toll and JAK/STAT pathways are conserved throughout all arthropods. The IMD pathway, however, is reduced and apparently absent in some hemimetabolous insects. This pathway is important in eliminating Gram-negative bacteria, and all the insects identified with “non-functional” IMD pathways rely on Gram-negative symbionts for survival. In the hematophagous hemipteran *Rhodnius prolixus*, a major vector of Chagas Disease, membrane receptors and effector genes are present, but most signal transduction genes were not detected in the genome. Despite having a modified or absent IMD pathway, the effector immune genes normally regulated by the IMD pathway are expressed. Whether the IMD pathway functions through novel proteins linking existing IMD proteins or through a non-canonical pathway is unknown. We used HMMER, a tool to predict distant homologs, and found several genes that resemble the missing elements of the IMD pathway in *R. prolixus*. We have validated the expression of these genes and knocked down their expression using RNAi techniques, to determine where the classic IMD pathway is interrupted.

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Passive acoustic monitoring of beluga habitat use in the Mackenzie Estuary / Surveillance acoustique passive de l'utilisation de l'habitat du béluga dans l'estuaire du Mackenzie

Eastern Beaufort Sea beluga whales (*Delphinapterus leucas*) form large summering aggregations in the Mackenzie Estuary. The timing and location of beluga presence in the estuary is well documented; however, drivers for temporal and spatial patterns of occurrence are not understood. Recent research identified ‘hotspots’ within the estuary where belugas were likely to congregate year after year, providing a starting point to closely examine beluga habitat use. The objective of this study is to assess abiotic drivers for beluga occurrence in Kugmallit Bay (in the Mackenzie Estuary), by examining localized patterns of presence/absence alongside environmental (wind speed, wind direction) and oceanographic (temperature, depth, salinity) data. Passive acoustic monitoring has previously proven useful in determining localized presence/absence of belugas in the estuary. As such, five hydrophones will be moored with oceanographic sensors in Kugmallit Bay during the summer. Mooring placement will be based on beluga hotspots, unique oceanographic features, and traditional knowledge. A nearby weather station will record wind climatology. With rapid climate change, and increasing industrial activities, an understanding of drivers for habitat use within the estuary is needed. This knowledge will be used to assess climate change impacts, evaluate industrial proposals, and formulate management plans for Beaufort Sea beluga whales.

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The chromosomal inversion *In(3R)Payne* underlies clinal variation in body size among North American populations of *Drosophila melanogaster* / L'inversion chromosomique *In(3R)Payne* est à la base de variation clinale de la taille du corps chez les populations nord-américaines de *Drosophila melanogaster*

Chromosomal inversions are thought to play an important role in adaptation. In *Drosophila melanogaster*, the widespread inversion polymorphism *In(3R)Payne* shows clinal variation on at least two continents, Australia and North America. The existence of parallel latitudinal clines suggests *In(3R)P* may be maintained by spatially varying selection. As several fitness-related traits likewise display latitudinal
clinal variation, it is tempting to speculate that $In(3R)Payne$ might underlie some of these traits. Here, we investigate whether $In(3R)P$ affects body size, development time, chill coma recovery, and diapause incidence using homokaryon lines carrying $In(3R)P$ or the standard arrangement. For the first time, we report that $In(3R)P$ contributes to the body size cline along the North American east coast, consistent with previous findings from the parallel but evolutionarily independent Australian cline. Inversion lines are smaller than standard lines across both sexes. $In(3R)P$ also potentially contributes to incidence of reproductive diapause. By contrast, development time and chill coma recovery were unaffected by karyotype. Our results provide compelling evidence that $In(3R)P$ has parallel adaptive effects on size variation across two continental clines. In addition, the fact that $In(3RP)$ might affect several clinal fitness traits may be consistent with the idea that inversions can function as life history "supergenes".

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Trout enterocyte-macrophage co-culture system using RTgut-GC and RTS11-GFP cell lines as in vitro models to study gut physiology and enteritis / Système de co-culture entérocyte-macrophage des truites utilisant les lignées cellulaires RTgut-GC et RTS11-GFP comme modèles in vitro pour étudier la physiologie intestinale et l'entérite

The development of a permanently transfected monocytic/macrophage cell line derived from Rainbow trout spleen, expressing GFP (RTS11-GFP) opens many possibilities for physiological studies of immune cell interactions with other cell types. RTS11-GFP was developed over 7 years ago through nucleofection of RTS11, an already established trout monocyte/macrophage cell line that has been well characterized over its lifespan of 20+ years. In the present study we explore enterocyte-macrophage interactions using co-cultures of the established trout gut cell line RTgut-GC with RTS11-GFP and investigate effects of antioxidants, pesticides and fish feed components on their ability to enhance or disrupt the model enteroid barrier set-up with the two cell lines. Intraepithelial macrophage projections, changes in phagocytic ability and stabilized enteroid barrier function measuring trans-epithelial resistance, could be monitored in these co-culture systems using trans-well epithelial-immune cell set-up. This co-culture system provides a practical and reproducible culture model to investigate suitability of novel fish feed components to enhance or disrupt fish intestinal physiology and host responses that could prevent development of enteritis in novel feed formulation trials.

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Responses of a locust motion sensitive visual interneuron to changes in approaching object velocity / Réponses d'un interneurone visuel sensible au mouvement acridien à des changements dans l'approche de la vitesse des objets

Locusta migratoria is an established neuroethological system for the study of sensory coding within a well-defined motion-sensitive visual neural pathway consisting of two identified interneurons, the Lobula Giant Movement Detector (LGMD) and its postsynaptic partner, the Descending Contralateral Movement Detector (DCMD). The DCMD connects to thoracic interneurons and motor neurons and is implicated in initiating avoidance behaviours. The present study aims to determine if the DCMD looming response differs when approaching objects change velocity. We presented locusts with looming stimuli that increased or decreased in speed during approach. We presented stimuli against simple (white) or flow field backgrounds. Preliminary results suggest that the DCMD firing rate, number of spikes and peak width at half height decreased with an increase in velocity and decreased further when velocity was reduced during approach. Interestingly, the presence of a flow field mitigated velocity change-dependent alterations of DCMD activity. The peak firing rate was delayed in response to stimuli altering their velocity. These results suggest that this motion-sensitive pathway is capable of actively adapting to objects that alter their velocity during approach.
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Unraveling a complex puzzle: cryptic trematode parasite diversity in birds from Manitoba wetlands
/ Se démêler d'un casse-tête complexe: diversité de parasites du trématode cryptique chez les oiseaux des zones humides du Manitoba

Recent reviews have found that there are more cryptic species complexes present in trematodes relative to other helminth parasites. The presence of cryptic species indicates that estimates of trematode species diversity and host specificity are inaccurate. These traits are fundamental characteristics that are critical to understanding the evolutionary ecology of parasites. Genetic sequencing has suggested several cryptic complexes in echinostome trematodes. Many species in this group have broad geographic distributions and parasitize a wide array of vertebrate hosts such as birds and mammals. However, if cryptic species are present, each species within a complex may have a more restricted geographic and host range. To better understand the geographic and definitive host range of echinostomes, we surveyed 63 birds from 16 species in four Manitoba wetlands. Echinostomes were isolated from 12 infected hosts from four different species. Nineteen adult worms were sequenced at a nuclear and mitochondrial gene, which revealed three species considered to be part of cryptic complexes: *Echinostoma revolutum*, *Echinostoma trivolvis* lineage A and *Echinostoma robustum*. By integrating molecular analysis with morphological data and host use information, we will determine host specificity of echinostomes, which will allow us to better understand processes underlying parasite diversity and ecology.

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The relationship between life stage-dependent changes in ammonia excretion patterns and Rhesus glycoprotein distribution in the gills of an ancient vertebrate / La relation spécifique au stade de vie entre les modèles de changements d'excrétion de l'ammoniac et la distribution de glycoprotéines Rhésus dans les branchies d'un ancien vertébré

Sea lamprey (*Petromyzon marinus*) are jawless vertebrates that spend their first 3-7 years as filter-feeding larvae before metamorphosing into free swimming parasitic juveniles that migrate downstream to feed on the protein-rich blood of fishes. They then migrate back upstream to spawn and die. The increased protein intake during the parasitic phase is accompanied by increases in both amino acid catabolising capacity and nitrogenous waste (N-waste) excretion rates. However, it is not known if these changes in life stage, diet, and N-waste excretion rates are accompanied by changes in the abundance and distribution of Rhesus glycoproteins, transport proteins known to facilitate ammonia excretion in other fishes. Accordingly, we collected gills from larvae, metamorphosing (stages 1-7), and post-metamorphic juveniles, and used heterologous Rhesus glycoprotein antibodies for immunohistochemical localization. This analysis revealed Rhcg-like staining in the gills suggesting that, like other fish species, sea lamprey use Rhesus glycoproteins to excrete ammonia. Subsequent analysis will determine if these transporters are upregulated throughout metamorphosis, increasing the lamprey’s capacity to excrete N-wastes during life stages where large amounts of protein rich blood are consumed. The information from my study will provide insight into the evolution of N-waste excretion mechanisms in the jawless and jawed fishes.

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Does acclimation temperature influence the cellular response to an acute heat shock in a basal chordate, the sea lamprey (*Petromyzon marinus*)? / Est-ce que la température d'acclimatation influence la réponse cellulaire à un choc thermique aigu chez un chordé primitif, la lamproie marine (*Petromyzon marinus*)?
Sea lamprey (Petromyzon marinus) are a basal craniate, and a successful invasive species in the Laurentian Great Lakes which, prior to an intensive international control effort, decimated the fisheries. A characteristic which likely facilitated their range expansion, and may enable future expansions under current warming trends, is their broad thermal tolerance. Recent sequencing of the sea lamprey transcriptome has allowed for a more comprehensive exploration of the genetic control of the heat shock response (HSR) in sea lamprey than was previously feasible. In the proposed study, ammocoetes will be acclimated to 5, 12, or 19°C and subsequently exposed to one of three different heat shock treatments for one or four hours. Differential expression of specifically targeted genes associated with the HSR will be evaluated using qPCR. These will include heat shock proteins (hsp), immediate early genes, genes associated with apoptosis pathways (casp), cell cycle regulation (cdk), and proteolysis (ub). Evaluating the genetic response to an acute stressor in this generalist may shed light on some of the physiological characteristics of successful invasive species from a cellular perspective. Comparing the response to that of more derived teleosts will provide an evolutionary perspective of the HSR in vertebrates.

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Life on the land: Thermoregulatory decisions in the mangrove rivulus / La vie sur la terre: Les décisions thermorégulatrices chez le killi des mangroves

The Mangrove rivulus, Kryptolebias marmoratus, emerges onto land when encountering conditions such as elevated water temperature, decreased dissolved oxygen, or elevation in hydrogen sulphide. We previously suggested that this emergence behaviour was thermoregulatory in nature, since on land, the fish could utilize evaporative cooling. In the wild, these fish inhabit small, stagnant bodies of water that are prone to frequent flooding and drying, and during the dry season, oxygen levels decline, while noxious gases rise. The mangrove rivulus survives for weeks on land through their enhanced cutaneous respiration capacity. Whether they choose to emerge simply to cool down or to avoid unfavourable aquatic conditions is unknown. Using a split-choice thermal gradient, providing fish with voluntary access to a range of temperatures in water and on land, we demonstrated that 25°C acclimated fish of two strains (Belize and Florida) preferred lower temperatures on land (~25°C) compared to water (~28°C). Both strains voluntarily emerged onto land; the Belize strain only did so ~2% of the time, the Florida strain ~10% of the time. A subsequent, short-term (1 week) 30°C water acclimation eliminated this land vs. water thermal preference difference, such that fish selected similarly warm temperatures (~28°C) when provided access to a land and water temperature gradient. We conclude that terrestrial emersion behaviour in the mangrove rivulus may serve thermoregulatory needs, but is itself a plastic behaviour.

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Characterization of the gills of the Louisiana red swamp crayfish (Procambarus clarkii) / Caractérisation des branchies de l'écrevisse des marais rouges de la Louisiane (Procambarus clarkii)

Procambarus clarkii is a freshwater crayfish species native to Louisiana in the Atchafalaya River Basin and contributes to 90% of Louisiana’s crayfish export. This industry grosses 181 million US dollars annually. Previous research on this species has identified two different cell morphologies in the trichobranchiate gills. Inner filaments located towards the base of the gill, consist of a thicker epithelium, are more mitochondria rich and have more infolding than the outer filaments. Dissections of the inner filaments, outer filaments and lamella of 8 crayfish were conducted and RNA was isolated for transcript abundance comparisons of several osmoregulatory genes of interest. Whole animal ammonia excretion, an important function of the gills, in response to acute exposure to buffered water, and 7ppm S NaCl was also investigated. There was a significant decrease in ammonia excretion when animals were placed in
buffered solution (p-value = 0.0133, N=5) and a trend toward reduced excretion in slightly saline water (p-value = 0.06, N=5). Silver staining indicated that the inner filament regions showed higher Cl\(^{-}\) concentrations compared to the outer filament and lamella. Initial PCR results confirmed transcript expression of Na\(^+/K^+\)-ATPase, H\(^+\)-ATPase, Rhesus protein, NHEs and AE in all three branchial regions.

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**How do cuttlefish (Sepia officinalis) respond to a moderate hypoxia exposure? Insights from whole animals and isolated tissue** / **Comment la seiche (Sepia officinalis) répond-elle à une exposition modérée à l'hypoxie? Perspicacité des animaux entiers et des tissus isolés**

Naturally occurring hypoxic conditions in warm coastal waters may increase in frequency and severity in the near future. Understanding how marine organisms respond to ecologically relevant hypoxia is therefore important. For sepioids like the common cuttlefish (Sepia officinalis) suboptimal dissolved oxygen content (DO\(_2\)) is thought to range from 65% to 35%. We challenged cuttlefish for one hour to 50% DO\(_2\) and observed a decrease in oxygen consumption of 37% associated with an 85% increase in ventilation rate. Octopine levels, a marker of anaerobic metabolism, increased by a small but significant level in mantle, whereas there was no change in gill or heart levels. Similarly, the hypoxic period did not result in changes in HSP70 or polyubiquinated protein levels in mantle, gill, or heart. It seems that although metabolic rate decreases there is only a minor increase in anaerobic metabolism and no biochemical changes that are hallmarks of alterations in protein trafficking. Experiments with isolated preparations of mantle, gill, and heart suggest that pharmacological inhibition of protein synthesis could decrease oxygen consumption by 32% to 42% or Na\(^+/K^+\) ATPase activity by 24% to 54% dependent upon tissue type. The decrease in whole animal oxygen consumption is potentially the result of a controlled decrease in the energy demanding processes of both protein synthesis and Na\(^+/K^+\) ATPase activity.

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**The interactive effect of digesting a meal and thermal acclimation on maximal enzyme activities in the gill, kidney, and intestine of goldfish (Carassius auratus)** / **L'effet interactif de la digestion d'un repas et de l'acclimatation thermique sur les activités enzymatiques maximales dans les branchies, les reins et l'intestin des poissons rouges (Carassius auratus)**

Ectotherms can compensate for changes in environmental temperatures at one or more biological levels, or allow temperature to dictate processes such as enzyme activities. Digestion also alters enzyme activities, therefore the interacting effect of thermal acclimation (8°C and 20°C) and digesting a single meal on maximal enzyme activities in three tissues of the goldfish (Carassius auratus) was investigated. Warm-acclimation reduced branchial Na\(^+\), K\(^+\), ATPase (NKA) activities, but did not affect renal NKA, nor glutamate synthetase (GS). Citrate synthase (CS) and pyruvate kinase (PK) activities were not altered in any tissue. An enhanced capacity for increasing post-prandial enzyme activities was observed in the intestines and gills for NKA, and in intestinal GS in warm-acclimated fish. Digestion had no impact on renal NKA nor GS activities. NKA and GS were the only enzymes investigated that showed intestinal zonation, with their activities increasing toward the distal intestine, with warm-acclimated animals demonstrating a more distinct zonation pattern for NKA than for GS. However, this amplified capacity was ameliorated by alterations in tissue protein content. Amplified NKA activity may ultimately have
implications for ATP demand in these tissues, while increased GS activity may beneficially increase intestinal ammonia-detoxifying capacity. Funded by an NSERC Discovery Grant.

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Background trace element concentrations in Manitoba water bodies and their relationship to fish otolith chemistry / Concentration des éléments traces du fond dans les masses d'eau du Manitoba et leur relation avec la chimie des otolithes de poisson
The Coordinated Aquatic Monitoring Program (CAMP) is a long-term, system-wide water management program for much of Manitoba Hydro’s impounded and many of Manitoba’s non-impounded sub-basins. Two main areas of monitoring in CAMP include water quality (e.g., trace element measures) and fish communities, which involves the archiving of fish age structures (e.g., otoliths). Fish otoliths (or ear bones) are metabolically-inert, calcified structures used to potentially determine trace element exposure history over time through studying otolith chemical signatures. The CAMP program presents a unique opportunity to test several hypotheses around trace elements in water and corresponding otolith trace element concentrations. In this study, CAMP water quality data from 2008-2014 (for the elements Ba, Mn, Sr, Mg and Na) was compared to otolith chemistry of two commercially relevant fish species, lake whitefish (Coregonus clupeaformis) and walleye (Sander vitreus) (caught in 2013-2014) from multiple CAMP water bodies. The effect of fish species, underlying water body geology, and water body impoundment status were analyzed for their influence on the observed otolith signature. Preliminary results indicate walleye take up Ba and lake whitefish take up Mn and Sr more so than each other in the same waterbody. Also that Na and Mg water concentrations correspond poorly to otolith concentrations.

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Man’s best friend or an uneasy ally? Stress responses of domestic dogs (Canis familiaris) to human hugging / Le meilleur ami de l'homme ou un allié mal à l'aise? Les réponses de stress des chiens domestiques (Canis familiaris) aux étreintes humaines
Stanley Coren sampled 250 still photographs of humans hugging pet dogs from the internet, and, based on the fact that 81.6% of photographs were scored as showing at least one behavioral indicator of stress or anxiety, concluded that human hugging proves stressful for dogs. This result is surprising considering the intimate and long-standing evolutionary relationship between humans and dogs. Further, Coren’s study did not account for the context in which the hug occurred or the dog’s relationship to the human hugger. We thus tested whether hugging of dogs by either the dog’s owner or a stranger activates the dog’s physiological stress response (i.e. the hypothalamic-pituitary-adrenal axis) by collecting saliva and quantifying salivary cortisol concentrations. Saliva was collected from 20 dogs prior to hugging and after hugs administered by the dog’s owner or a stranger in alternating order. Behavioural responses to hugs were video recorded and owners completed a pre-trial questionnaire to document the history, individual characteristics, and behavioral propensities of each subject dog. Our findings definitively address whether human hugging stresses dogs based on physiological and behavioural indicators of stress, elucidate whether owner- versus stranger-administered hugs differentially stress dogs, and reveal dog-specific correlates of stress responses to human hugging.

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Evaluating the effectiveness of headstarting for Wood Turtle (Glyptemys insculpta) recovery / Évaluation d’un programme d’élevage et réintroduction pour récupérer une population de Tortue de Bois (Glyptemys insculpta)

Headstarting is a conservation tool applied to turtles that includes collection of wild eggs, hatching and rearing the hatchlings in captivity for some period of time, and then releasing them back into the wild once they have reached a size that should increase survivorship. A population of endangered Wood Turtles (Glyptemys insculpta) declined by 70% after a suspected poaching event in the mid-1990s. A population viability analysis determined that extirpation was inevitable if no intervention was undertaken and so a headstarting project was initiated in 2003 and the first cohort was released in 2005. Our objective is to model population demographic parameters to evaluate recovery efforts that have occurred to date and determine the next phase of recovery. To meet our goal, we are conducting intensive mark-recapture surveys, along with radio telemetry of wild adult turtles (n=20), headstarted turtles (n=30), and wild hatchlings (n=15). Given the growing number of headstarting projects globally, our study will aid in bettering the practice.

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Characterization of the ΔNHX3 knock-out mutant in C. elegans: How to create a zombie / Caractérisation du mutant ΔNHX3 dans C. elegans: comment créer un zombie

In order to evaluate the role of the hypodermally expressed cation-proton exchanger NHX-3 in C. elegans, hypodermal H+ and Na+ fluxes (SIET) as well as whole body ammonia excretion rates were assessed in wild-type worms (N2) and a NHX-3 knock-out mutant (ΔNHX-3). Compared to N2 H+ and ammonia excretion rates decreased by ca. 48% and 30%, respectively, while Na+ uptake rates remained unchanged. ΔNHX-3 exhibited also significant reduced cytochrome c oxidase activity. More importantly, out of the 8 remaining other NHX proteins expressed in C. elegans, 7 showed vastly different mRNA expression levels when compared to the wild-type. Also, two out three cation proton antiporter from the CPA-2 family (NHA-1, NHA-3), as well as the V-ATPase showed reduced mRNA expression levels. More puzzling data: In contrast to findings in N2, exposure to EIPA caused a significant increase in H+ and ammonia efflux rates. Application of amiloride, a non-specific blocker for Na+ channels and NHEs caused an increase in hypodermal Na+ up-take by ca. 200%. These data demonstrate clearly that extreme care must be taken when knock-out mutants are employed to evaluate the function of the target protein and its role in a physiological process.

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Characterisation of the HIF1a cellular pathway and its response to hypoxia during lake whitefish development / Caractérisation de la route cellulaire de HIF1a et sa réponse à l'hypoxie pendant le développement du grand corégone

Exposure to hypoxia during development has been shown to activate the hypoxia-inducible-factor 1(HIF-1) cellular pathway but little is known about the physiology of low oxygen tolerance in fish embryos. This study assessed the ontogeny of the HIF1a cellular pathway in embryonic lake whitefish (Coregonus clupeaformis) (LWF), and its response to hypoxia. Changes in gene expression were quantified for HIF1a and known HIF1a target genes: Insulin like growth factor binding protein 1 (IGFBP1), vascular endothelial growth factor A (VEGFA), erythropoietin (EPO) and lactate dehydrogenase A (LDHA), as well as heat shock proteins (HSP) 70, 90α and 90β. LWF embryos were exposed to one of three treatments:
severe, mild and control for 6 hours at 21, 38, 63, 83 and 103 days post fertilization (dpf). Results indicate that HIF1α mRNA levels are stable throughout embryogenesis until 103dpf where they decline. In low oxygen environments, HIF1α mRNA is down-regulated compared to control until 103 dpf, where they increase significantly. IGFBP1 levels increase throughout embryogenesis and are first up-regulated in response to low oxygen at 38 dpf. HSP70 was significantly upregulated in response to low oxygen at all time-points studied during embryogenesis. Data on EPO, VEGFa, LDHa, HSP90α and HSP90β will also be presented.

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Population genetics analyses assist in fisheries management of Inconnu (Stenodus leucichthys) in Great Slave Lake, Northwest Territories / Les analyses de génétique de la population aident à la gestion des pêches d'Inconnu (Stenodus leucichthys) dans Great Slave Lake, Territoires du Nord-Ouest

Inconnu (Stenodus leucichthys) are important in commercial and subsistence fisheries in Great Slave Lake (GSL). Intense fishing pressure has caused some Inconnu stocks to decline while others are thought to be healthy and productive. However, areas experiencing higher catches could be caused by the expansion of productive stocks, effectively concealing a decline in a genetic stock. We hypothesized that each river with a population of Inconnu migrating into GSL represents a discrete genetic stock due to Inconnu philopatry. From 1992 to 2016, Inconnu tissue samples (muscle/fincips) were collected in GSL and eight lakes and surrounding river systems. Multilocus genotypes for >800 fishes were generated from 17 microsatellite loci. There was evidence for population structuring by sampling location according to pairwise genetic differentiation and Bayesian clustering analysis. The latter results indicated at least five genetic populations, and evidence of unsampled populations from unknown sources. Within the eight locations, most loci were in Hardy-Weinberg equilibrium (HWE) though overall four locations were not in overall HWE. This research will assist future management decisions for an important Canadian fishery by estimating the number of distinct genetic stocks and their geographic distributions, and help determine whether or not a genetic stock has declined.

Thomas J. Wood and James Hare

Stress and fitness implications of central versus peripheral territories in Richardson’s ground squirrels (Urocitellus richardsonii) / Les implications du stress et de la condition physique des territoires centraux versus périphériques dans les écureuils terrestres de Richardson (Urocitellus richardsonii)

Selfish herd theory predicts that central individuals benefit disproportionately over individuals on the edge of a group. Higher predation pressure at a group’s edge should decrease survivorship and reproductive output of peripheral group members through both direct and indirect effects predator encounters. Predation is a major source of mortality for ground-dwelling squirrels, while non-lethal encounters with predators have been proposed to affect prey through increased activation of the hypothalamic-pituitary-adrenal axis, resulting in lower reproductive output. Richardson’s ground squirrels (Urocitellus richardsonii) defend territories within their colonies, and thus may experience differential fitness outcomes based on the location of their territory within the colony. To examine this, we recorded ground squirrel alarm vocalizations with Wildlife Acoustic SM3 audio recorders placed at centre and edge locations of a colony to estimate predation pressure and predator type (airborne vs. terrestrial), quantified faecal glucocorticoid metabolite concentration as a measure of stress, and tracked offspring production and survivorship of females and their young for a year. The results of this project quantify the indirect effects of predator
presence on members of this social, group-living species, and provide insight into the factors promoting the evolution and maintenance of sociality.

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Glucose metabolism and adaptive sex allocation by Richardson’s ground squirrels, \textit{Urocitellus richardsonii} / Le métabolisme du glucose et l'allocation adaptative du sexe par les écureuils terrestres de Richardson, \textit{Urocitellus richardsonii}  

Circulating glucocorticoid and blood glucose levels during early gestation affect offspring sex ratio in many mammalian species. These findings are consistent with the glucose metabolism hypothesis as a mechanism promoting adaptive sex allocation, but are correlative. We experimentally manipulated blood glucose concentrations in otherwise free-living Richardson’s ground squirrels, \textit{Urocitellus richardsonii} by surgically implanting osmotic minipumps releasing controlled glucose doses. Subject squirrels received a high glucose dose (7.14 mg/kg/day; \textit{n} = 4), moderate glucose dose (3.57 mg/kg/day dose; \textit{n} = 3), normal saline (\textit{n} = 4), or no implant (\textit{n} = 3). Blood glucose concentrations of subjects were measured every 4th day throughout gestation and lactation with a hand-held glucometer and fecal samples were collected to assess fecal glucocorticoid levels. While biased offspring sex ratios were detected for certain litters, offspring sex ratio was unrelated to glucose treatment. Further, no difference in the number of placental scars and the number of offspring weaned was detected. Our data thus fail to support the glucose metabolism hypothesis, though our negative results may be attributable to the squirrel’s ability to regulate blood glucose levels rather than any failure of the mechanism itself. Pancreatic tissues were collected to examine this possibility, but analyses are presently incomplete.

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How \textit{Drosophila} become winter warriors: Describing the ionoregulatory adjustments that underlie cold acclimation in \textit{Drosophila} / Comment les \textit{Drosophiles} deviennent des guerriers d’hiver: Décrivant les ajustements ionorégulateurs qui sous-tendent l’acclimatation à froid chez la drosophile  

At low temperatures \textit{Drosophila}, like most insects, lose the ability to regulate ion and water balance across the gut epithelia, which leads to a lethal accumulation of K\textsuperscript{+} in the hemolymph (hyperkalemia). Cold-acclimation, prior to low temperature exposure, can mitigate or entirely prevent these ion imbalances, but the physiological mechanisms that facilitate this process are still not understood. Here, we investigate the potential modulation of Na\textsuperscript{+}/K\textsuperscript{+}-ATPase (NKA) and V-Type H\textsuperscript{+}-ATPase (VA) activities in the gut and the Malpighian tubules of \textit{Drosophila} in cold acclimation. Upon adult emergence, \textit{D. melanogaster} females were subjected to seven days at 25°C (warm acclimation) or 10°C (cold acclimation). Cold-acclimation reduced the critical thermal minimum (CT\textsubscript{min}), sped up recovery from chill coma, improved survival following prolonged cold stress, and mitigated cold-induced hyperkalemia. NKA and VA activities were lower in the midgut and the Malpighian tubules of cold-acclimated flies. This coincided with increased Malpighian tubule secretion rates across a variety of thermal conditions and the maintenance of K\textsuperscript{+} secretion at low temperatures. Our results suggest that the modification of Malpighian tubule activity mitigates cold-induced hyperkalemia in cold-acclimated flies and that this process is not driven by increased VA and NKA activities in the Malpighian tubules.