

BIOLOGY

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University of Prince Edward Island

Exploring egg development in the invasive European green crab (*Carcinus maenas*) with a possibility for potential marketability

The European Green Crab (*Carcinus maenas*) is a non-indigenous species that has been found to be a nuisance to fishing and shellfish industries in Atlantic Canada. No effective or sustainable solutions have been found to control this species, probably due to the numerous information gaps on its life history and ecology in the region. One gap of particular relevance is the seasonal dynamics of females carrying eggs and the development of those eggs, which is important for the identification of better options in managing or preventing further invasions. This information gap is also interesting from an applied point of view, since there is a market potential in female green crabs and the use of their eggs and roe. The aim of this study was to describe the seasonal dynamics of females and eggs to provide the basis for studies assessing the feasibility of using egg roe for commercial purposes. Green crab populations were monitored during the spring-fall months of 2017 in four sites in Prince Edward Island (PEI) aiming to describe the dynamics of egg-bearing females while also observing egg/embryo development. Results suggest that late egg stages and the highest abundance of females are present during late spring and the fall months, indicating two possible fishing seasons for those stages. Further studies should focus on product suitability for the market, which would indicate whether eggs and roe can mimic the product collected from blue crabs (*Callinectes sapidus*) in USA. If suitable, these results may prompt a form of harvesting targeting females while aiming for alternative forms of control for green crab populations.

BLANCHE, EMMA¹; Easy, Russell¹; Cardinal, Sophie²

¹Acadia University; ²Agriculture and Agri-Food Canada, Ottawa, Ontario

Viral spread of Black Queen Cell Virus in managed and wild bees in Canada

Native and managed pollinators are vital to Canada's agriculture and biodiversity; however, these species are currently facing population declines. One of the most prominent viruses affecting the western honey bee (*Apis mellifera*) is Black Queen Cell Virus (BQCV), which is fatal to developing honey bee queens. Previous genomic analyses have shown that interspecies transmission of pathogens is common between managed honey bees and wild bumblebees, while the BQCV genotypes tend to be most similar within the geographic site where they were collected. The objective of this study is to trace the spread of BQCV across *Apis* and native bee species within Canada to better understand viral transmission in pollinators. Bees were collected from sites across Ontario, Alberta, and Nova Scotia and were tested for BQCV. Viral RNA was extracted and PCR was used to amplify viral cDNA targeting the helicase gene. PCR products were sequenced using the Illumina MiSeq Next-Generation Sequencing platform and sequences were analysed for genetic similarity. Phylogenetic analysis revealed sequences within Nova Scotia that clustered by geographic site, as well as some that clustered by bee genera. The viral sequences did not cluster neatly by province, though when compared to internationally collected sequences, they did cluster by country. These results suggest pathogen spillover between managed and native bee species across Canada, and that infected wild bees act as carriers for viral transmission even when appearing asymptomatic. Broader genomic analyses are needed to explore the transmission of BQCV across Canada, as the global data set remains limited.

BOKMA, JOSHUA; Yang, Zhan
Crandall University

Comparison of two instruments to measure frailty

Frailty is an increased vulnerable state associated with age-related decline in human body system, which has become a challenge in health care today. A frailer person tends to have worse health, which can lead to institution or even death. Various instruments have been developed to measure frailty in the elderly. However, general consensus on definition and measuring instrument of frailty is still lacking. In this study, two instruments, frailty index (FI) and FRAIL scale were developed to quantitatively measure frailty in an elderly population in Beijing, which the accuracy and validity of each instrument were compared. Data for this analysis were obtained from the Beijing Longitudinal Study of Aging that involved 3,257 community-dwelling Chinese people, aged 55+ years at baseline. The main outcome measure was 5-year mortality. Five health-related variables were selected to construct the FRAIL scale, which results were compared with the FI developed in our previous studies. Four of the five chosen variables to construct the FRAIL Scale were correlated with increasing age and had positive Attributable Risk values, which suggests that the presence of these four factors resulted in increased risk of mortality by five years. Compared with FRAIL Scale, all 35 variables constructing the FI were associated with an increased risk of mortality. In our study, both FRAIL scale and the FI demonstrated strong predicative validity for mortality.

BRADLEY, ASHTON; Barber, Colleen
Saint Mary's University

Do nestlings increase their begging in response to enhanced sibling competition in European Starlings, *Sturnus vulgaris*?

In parent-offspring interactions, nestlings signal their hunger to parents by begging. Parents typically respond by increasing their provisioning rate. This type of communication involves specific vocalizations, postures, and gaping. Begging intensity has been found to honestly reflect hunger levels in European Starlings (*Sturnus vulgaris*), and not be a result of sibling rivalry (dishonest signal). I examined whether begging was an honest signal in a Nova Scotia population of European Starlings, or if it could be influenced by sibling rivalry. I analyzed nestling vocalizations occurring over a 30-min period in 20 nestboxes; each nestbox underwent both a control (natural conditions) and an experimental trial (3-min loop of nestling begging vocalizations from the preceding day was played back for an hour to simulate increased sibling competition for food). I predicted that if nestlings were affected by the enhanced begging of their siblings, they would have an increased number of begging bouts, and beg for longer during the experimental trial compared to that of the control. As predicted, there were significantly more begging bouts during experimental than control trials. Similarly, nestlings begged for a significantly longer time over the 30-min period in the experimental than the control trials. These findings support the possibility that nestling European Starlings increase their begging as a response to enhanced sibling rivalry.

BRANCH, MAKENZIE; Easy, Russell; Langelan, David
Acadia University

Characterizing the oncogenic protein-protein interaction between the microphthalmia-associated transcription factor and CBP/p300

Human skin is an important barrier against pathogens and excessive water loss. Within the skin, specialized cells known as melanocytes synthesize melanin, which provides protection from damage caused by ultraviolet radiation, which can lead to skin cancer. During melanocyte development, several transcription factors are critical to control gene expression and coordinate cellular growth and differentiation. In particular the Microphthalmia-associated transcription factor (MITF) is the ‘master regulator’ that controls for melanocyte differentiation and melanin synthesis. Also, in the melanocyte-derived skin cancer, melanoma, MITF continues to influence melanoma properties and is essential for cellular proliferation. To control cellular properties, MITF binds to gene promoters using a central basic-helix-loop-helix DNA binding motif. The N-terminal and C-terminal regions of MITF then interact with the transcriptional co-activators CREBs binding protein (CBP) and p300 (CBP/p300), which acetylate histones and activate gene transcription. Despite the influence that MITF has on melanoma properties, there is very little structural or mechanistic knowledge of how MITF carries out its function. Using a combination of protein interaction assays, nuclear magnetic resonance spectroscopy and biophysical techniques, we determined that the N-terminal activation domain of MITF binds with high affinity to the TAZ2 protein domain of CBP/p300. These results will help to determine how MITF interacts with transcriptional co-activators to regulate gene transcription and melanoma properties and will provide strategies to disrupt MITF function for the potential treatment of melanoma.

BURGESS, BROCK¹; Shutler, Dave¹; Javorek, Steve²
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Nest density of orange-belted bumble bees

Pollination services are critical for global biodiversity and agriculture. Global pollinator declines have been well documented, putting the delivery of ecological services at risk. Despite global importance of wild pollinators such as bumble bees (*Bombus* spp.), little research has investigated their nesting preferences. As a ubiquitous species in Atlantic Canada, orange-belted bumble bees (hereafter, bumble bees), *B. ternarius*, provide important pollination services, making them an ideal candidate for this study. Objectives of this study were (1) to use microsatellites to estimate sibling relationships (and thus, indirectly, nest density) in worker bumble bees (*B. ternarius*) in agricultural systems, and (2) to evaluate the relationships between land cover and nest density. Six microsatellites were amplified from bumble bee workers collected from three different locations with different landscape configurations. Although the number of workers varied greatly among sites, the ratios of nests to workers were similar (0.79, 0.83, 0.85). More bees nested in evenly distributed, heterogeneous landscapes with agricultural components. This confirms that crops are valuable foraging resources for this bumble bee, and suggests that a diversity of landscape features is a driver of bumble bee nesting. Ultimately, nesting preferences of bumble bees need to be further explored, because this study was constrained to only three study sites.

COATS, COOPER¹; Wertman, Jaime²; Rassekh, Rod³; Ross, Colin⁴; Easy, Russell¹; Berman, Jason²

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Anthracycline-induced cardiotoxicity (ACT) prevention using RAR γ -agonists in a zebrafish model

Anthracyclines are potent anticancer drugs that play a prominent role in the modern era of chemotherapy. Unfortunately, the utility of these drugs, like doxorubicin, is limited by anthracycline-induced cardiotoxicity (ACT). Our collaborators have previously determined that a genetic mutation resulting in decreased activity of the retinoic acid receptor- γ (RAR γ) leads to increased susceptibility to ACT; thus, the current study aims to investigate whether *all-trans* retinoic acid (ATRA) and CD1530, known RAR γ -agonists, can prevent ACT in zebrafish, whilst maintaining the chemotherapeutic effects of doxorubicin. The previously established zebrafish larval doxorubicin-induced cardiac edema phenotype was employed as a preclinical model. I replicated this phenotype using 100 μ M doxorubicin at 24hrs post-fertilization (hpf), and these larvae were then co-treated for 72hrs with varying doses of ATRA and CD1530. While CD1530 was toxic, low doses of ATRA protected against the phenotype, with reduced cardiac edema at 3 days post treatment. To determine expression patterns of both zebrafish RAR γ -a/b orthologs, whole-mount *in situ* hybridization (WISH) was completed on 24,48 and 72hpf zebrafish. WISH was inconclusive based on their qualitative nature but there appeared to be low RAR γ -b expression levels near the heart and publicly available databases suggest low expression levels of RAR γ -a in developing zebrafish hearts (NCBI: GEO). Current efforts include using the zebrafish xenotransplantation model, with K562 myelogenous human cancer cells, to determine if ATRA impedes the anticancer effects of doxorubicin. Future studies will employ CRISPR/Cas9 technology to create a RAR γ -mutant zebrafish for pharmacogenomics studies, with the ultimate goal of clinical translation and personalized medicine.

CHARLES, MARIE; MacIntyre, Logan; Haltli, Brad; Kerr, Russell; Sweeney-Nixon, Marva
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Natural product discovery and development of a novel method to quantify bacteria from marine habitats in remote locations

Natural products are biological molecules that are not required for life, but whose production presents an adaptive advantage to the organisms that produce them. These compounds have broad implications for pharmaceutical and healthcare industries; however, their rate of discovery has been diminishing. Ultimately, compound discovery relies on the organisms that synthesize them, such as bacteria, fungi and plants. Bacteria are an important source of natural products; however, approximately 99% of all bacterial species are not readily cultivated through the use of standard laboratory methods. To isolate new bacteria and to possibly discover untapped resources of natural products, new isolation methods are required. In 2010, a research team from Northeastern University developed the 'isolation chip' (ichip). The Kerr lab modified this device for use in marine sponges. Preliminary field experiments were conducted in The Bahamas and isolated microbes were fermented in different media to source natural products. Additionally, the field research revealed that to effectively use this device it is necessary to quantify the bacterial densities of the environmental samples. In the laboratory, this can be achieved via fluorescent microscopy; however, this technique is not applicable to field studies. Alternatively, adenosine triphosphate (ATP) can be used as a measure of living cells. Due to the availability of relatively low cost portable luminometers and the commercial availability of ATP test kits, this approach is an appealing method for estimating bacterial abundance for ichip studies conducted in the field. Preliminary data will be discussed.

CLARKE, MADELINE; Lundholm, Jeremy
Saint Mary's University

The effect of spatial scale on heterogeneity and plant species richness in coastal barrens

There is a gap in knowledge on the effects of spatial scale as it relates to plant species diversity and environmental heterogeneity on coastal barrens habitat types. While coastal barrens are less than 3% of the area of Nova Scotia, they have provincially rare plant species, many of which are restricted to this habitat type. Heterogeneity is the variation of a measure in the environment. The size of the area being sampled (grain) can impact the relationship between these environmental variables and plant species richness. We hypothesize the relationship between heterogeneity and species richness will become stronger as the grain becomes larger with more room for variation and, also more room for more niche types. Using average conditions (mean) and spatial heterogeneity (standard deviation) of substrate moisture, substrate depth, topographic elevation, we were able to assess the strength of the relationship with species richness at three different grains: 0.5 m x 0.5 m, 1 m x 1 m, and 25 m x 2 m. Preliminary results from univariate and multivariate linear regressions show that average substrate depth was weakly correlated with richness at the smallest grain. At the middle grain, average substrate moisture was most strongly correlated. At the largest grain, spatial heterogeneity of substrate moisture was significantly correlated, including average substrate depth and average topographic elevation. These results provide some baseline data for coastal barrens and can impact sampling method designs for future studies.

CLUNEY, VICTORIA; Weir, Laura
Saint Mary's University

The relationship between anal fin size and behavioural traits of male Japanese medaka, and their importance in reproductive success across varying social settings.

Sexual selection leads to the development of secondary sex traits and mating behaviours. Morphological and behavioural traits serve to increase reproductive success among individuals, however, under varying sexual selection types and intensities the relative importance of particular morphologies and behaviour will vary. This study examines the relationship between morphology and behaviour of male Japanese medaka (*Oryzias latipes*) and their importance in reproductive success across varying social settings. During mating, males perform a variety of behaviours including aggression and courtship. In addition, males use their anal fin to grasp the female during mating, and reduction in anal fin size is associated with lowered fertilization success. In this species, there is natural variation in sex ratio during mating across latitude, and this variation is associated with differences in reproductive behaviour and anal fin size. By subjecting the male medakas to four different operational sex ratios (defined as the ratio of fertilizable females and sexually mature males), we were able to manipulate sexual selection pressure intensity in the laboratory. Anal fin size, aggression and courtship behaviours were quantified for all treatments. Ongoing analysis suggests that as the operational sex ratio becomes extremely male biased, male aggression increases in frequency, and courtship behaviour decreases in frequency. These results indicate that the social environment influences the behavioural tactics used to obtain mates, and that males are plastic in their response to different intensities of sexual selection.

DAVIDSON, LAURA; Wallace, Helen; Bell, Mackenzie; Brebner, Karen; Kane, Daniel
Saint Francis Xavier University

H₁/H₂ histamine receptor blockade decreases substrate-dependent mitochondrial H₂O₂ emission in deep gastrocnemius muscle following a bout of prolonged exercise

Prolonged exercise increases oxidative metabolism in skeletal muscle mitochondria, which is facilitated, in part, by increased blood flow and delivery of nutrients and oxygen. Histamine mediates many acute exercise responses, including sustained vasodilation and associated delivery of substrates to muscle. We tested the hypothesis that H₁ and H₂ histamine receptor blockade would attenuate exercise-induced changes in skeletal muscle mitochondrial function. Adult male Wistar rats (83.42 ± 0.99 days old; 440.53 ± 6.80 g) were randomly assigned to one of three groups (*n* = 12/group): exercise, in the form of one hour of continuous treadmill running at 20 cm/sec (Group 1); mass-specific oral gavage with H₁ antagonist fexofenadine (7.11 mg/kg) and H₂ antagonist ranitidine (3.95 mg/kg) one hour prior to the same exercise protocol (Group 2); control, which received neither antihistamines nor exercise (Group 3). An hour post exercise, mitochondrial function was assessed in saponin-permeabilized myofibers from deep gastrocnemius (mixed fiber types) and soleus (oxidative) skeletal muscle. A sequential substrate-inhibitor titration protocol was used to examine multiple mitochondrial metabolic pathways (i.e., malate + octanoyl-carnitine, ADP, lactate + NAD⁺, pyruvate, glutamate, succinate, inhibitors of antioxidant defense glutathione peroxidase and thioredoxin). Substrate-dependent oxygen consumption (*J*O₂; high-resolution respirometry) was not different between treatments; however, H₁ and H₂ histamine receptor blockade significantly decreased hydrogen peroxide emission (mH₂O₂; fluorometric monitoring of Amplex Red oxidation) in deep gastrocnemius fibres (*P* < .05). Given the widespread use of antihistamines, further research into the effects of these antagonists on mitochondrial function, in the context of exercise, is warranted.

DIXON, SAGE; Qaderi, Mirwais
Mount Saint Vincent University

Interactive effects of temperature, carbon dioxide and nitrogen on canola growth and quality

Canola is an important oilseed crop around the world and one of Canada's crops with big economic impact. While many studies have investigated the effects of climate change factors, such as temperature and CO₂, on plants, few studies have considered the combined effects of temperature, CO₂, and nitrogen on plants, and no studies thus far have examined the interactive effects of these factors on canola. In this study, the effects of two temperature regimes (22/18°C and 28/24°C; 16 h day/ 8 h night), two CO₂ concentrations (400 μmol mol⁻¹ and 700 μmol mol⁻¹), and three nitrogen applications (no additional nitrogen (as control), 250 ppm nitrate every four days, and 250 ppm ammonium every four days) were studied on canola quantity and quality. Canola (*Brassica napus* L., cv. 6056 CR) seeds were germinated for one week. The seedlings were grown under a temperature regime of 22/18°C at ambient CO₂ for another week, followed by random assignment to one of the 12 experimental conditions. Plants were grown under each experimental condition for 21 days. At that time, plants were used for physiological, morphological and chemical measurements. Overall, this study revealed that, under increased temperatures, canola plants benefit from fertilization of ammonium, compared to that of nitrate. However, increased temperatures reduce plant biomass, regardless of fertilization of nitrogen and CO₂. Considering the importance of climate change effects on nitrogen utilization by crops, the interactive effects of temperature, CO₂, and nitrogen forms on canola should help us understand crop performance under climate change conditions.

DUFF, NICOLE; Litvak, Matthew
Mount Allison University

Analysis of yolk lipid quality and its effect on visual development, larval growth, and survival in zebrafish (*Danio rerio*)

The specific make up of the teleost yolk is important during larval development, as any nutrients utilized by the developing tissues are derived from this area. Of the yolk lipids, docosahexaenoic acid (DHA) has been found to be critically important to the development of the visual system. This study aims to investigate how lipid injections of DHA affect visual development, growth, and survival in zebrafish (*Danio rerio*). Direct yolk sac manipulation was used to administer lipid and control injections to 225 embryos. Another 30 embryos were used as unmanipulated controls. Larval growth and survival was monitored over 6 days post fertilization (dpf) using imaging techniques. Visual development was assessed using the optokinetic response (OKR) on 4, 5, and 6 dpf. These trials investigated the low light visual sensitivity of each larva under white, blue, green, and red light conditions. Light intensities were measured when an OKR was observed. At the end of the study, the eyes and head region of each larva was dissected for fatty acid analysis. Morphological development was not affected by lipid injection, however a significant decrease in survivorship was observed in manipulated embryos. Light intensities measured for the OKR were similar across treatment groups, but differed with light condition. Lower light intensities were required in blue light, which may suggest that these photoreceptors have a heightened sensitivity. Overall, lipid injections did not significantly affect visual development. However, fatty acid analysis will be required to determine if the developing embryos utilized the injected lipids for development.

FAULKNER, SALLY; Finkel, Zoe; Liefer, Justin
Mount Allison University

Macromolecular dynamics of *Thalassiosira weissflogii* under steady-state and non steady-state phosphorus stress

Phosphorus (P) is a key limiting nutrient in the global ocean. There is relatively little data on the links between P availability and the biochemical and macromolecular composition of marine phytoplankton. To better understand P allocation in phytoplankton across a gradient of P stress, we investigated P content and major macromolecular composition in the common marine diatom *Thalassiosira weissflogii* under three P stress regimes; steady-state P-replete conditions ($P_{5.0}$, 5.0 μ M phosphate), and two limiting P concentrations; 0.5 μ M and 0.25 μ M phosphate. Additionally, $P_{5.0}$ and P-limiting ($P_{0.25}$, 0.25 μ M phosphate) cultures were allowed to progress into non-steady state P starvation and sampled from exponential to stationary growth phase. Under $P_{5.0}$ conditions, cellular phosphorus (P_c) declined by 96% and total cellular protein declined by 40%. Under $P_{0.25}$ conditions, P_c declined by 63% and total cellular protein declined by 8%. Cellular phospholipid P and RNA P content account for an increasing proportion of P_c present as cells progress to starvation, and comprise an overall higher proportion of P_c under $P_{0.25}$ conditions. Based on these results we infer that diatom cells store more P when exposed to high phosphorus levels. Further work is required to characterize P storage molecules.

FORD, ALLISON; Hermanutz, Luise
Memorial University

The ecology and effects of the bark beetle species, *Dryocoetes krivolutzkajae*, on roseroot populations in Newfoundland, Canada

Plant pathogens and insect pests can have detrimental effects on plant populations by impacting growth, reproduction, and survival. *Rhodiola rosea* L. (Crassulaceae), commonly known as roseroot, is a culturally-important medicinal plant that grows in coastal ecosystems across the Northern Hemisphere. Since roseroot is endangered in parts of its range, studying the effects of pathogens and pests on this species is important for its conservation. *Dryocoetes krivolutzkajae* Mandelshtam (Coleoptera: Circulionidae: Scolytinae) is a bark beetle that infests the rhizomes of roseroot, forming galleries and causing belowground plant tissue loss. Prior to this study, *D. krivolutzkajae* had been found in roseroot in Labrador, but was unknown to the island of Newfoundland. The objective of this study was to determine the presence of *D. krivolutzkajae* on the island of Newfoundland, to gain insight into the ecology of this insect herbivore, and understand its effect on the growth and survival of roseroot. Sampling plants from coastal areas of Newfoundland, I tested whether *D. krivolutzkajae* exhibited an affinity for roseroot plants of different biomass, number of shoots, and sex, as well as plants growing in different sites, distances from the shore, and substrates. Substrate types consisted of organic soil, bedrock, soil over bedrock, limestone gravel, beach soil, and gravel. *D. krivolutzkajae* was found to be present in Newfoundland, and no apparent affinities to substrate, number of shoots, distance to shore, or plant sex were observed. Presence of beetle galleries and higher amounts of rhizome damage were associated with roseroot plants having significantly larger biomass.

GELDART, ERICA; Hamilton, Diana
Mount Allison University

Movement patterns of migrating Semipalmated Sandpipers (*Calidris pusilla*) and Semipalmated Plovers (*Charadrius semipalmatus*) in Eastern New Brunswick

Many shorebird species use stopover sites to rest and accumulate energy reserves during long-distance migration. Two such species, Semipalmated Sandpipers (*Calidris pusilla*) and Semipalmated Plovers (*Charadrius semipalmatus*) make extensive use of coastal habitats in New Brunswick. To improve our understanding of their activities in northeastern NB, I investigated: 1) duration of stay of each species in the Acadian Peninsula, NB and 2) local movement patterns of each species, and links between biotic habitat characteristics and site use. I used radio-telemetry and the Motus Wildlife Tracking System to track tagged individuals. Intertidal mud- and sandflats within the region were sampled for prey availability. There was no difference among years or species in mean length of stay (14-15 days) on the Acadian Peninsula. Nine percent of Sandpipers also used more southern regions in NB and NS, but their length of stay on the Acadian Peninsula did not differ from birds that used this region exclusively. Sandpipers that made use of multiple regions had an average overall length of stay within their stopover landscape of 27.25 ± 3.32 days in 2016 and 20.80 ± 4.50 days in 2017. In both years, Wilson Point was the most preferred site by both species. In 2016, this site had the highest invertebrate abundance, though in 2017, sites did not differ in prey availability. My results suggest that Eastern New Brunswick provides important staging sites for these species, but future study of biotic and abiotic factors across stopover sites is needed to understand variation in stopover strategies and habitat use.

GONZALEZ, VICTORIA; Brewer, Kimberly; Tremblay Marie
Dalhousie University

Using simultaneous PET/MRI to evaluate an orthotopic ovarian cancer model

Epithelial ovarian cancer is highly aggressive with a low 5-year survival rate of only 45%. It is the fifth leading cause of cancer related deaths among women and is a prime target for immunotherapies. Molecular imaging is desirable in immunotherapy research as it allows for individual immune environments to be characterized over time in response to cancer and therapy. Our goal is to use simultaneous positron emission tomography (PET) and magnetic resonance imaging (MRI) to evaluate tumour growth and metabolism, while tracking two immune cell populations in a humanized ovarian cancer mouse model. Mice engineered to express the human leukocyte antigen were implanted with syngeneic mouse ovarian cancer surface epithelial cells and injected with primed, superparamagnetic iron oxide labeled cytotoxic CD8⁺ T cells and dendritic cells. Ovarian cancer tumours were detected on both PET/MRI, allowing tumour progression and metabolism to be monitored (Figure 1). Other abnormalities, such as uterine horn and abdominal swelling, were detected, with abdominal swelling not always correlating with an increase in tumour volume. Both CD8⁺ T cells and dendritic cells were recruited to the primary tumours, with cell recruitment decreasing as tumour volumes increased. Overall, we demonstrated that simultaneous PET/MRI is an excellent tool for monitoring tumour growth, internal physiological changes and immune cell recruitment in a humanized ovarian cancer mouse model. Future work will evaluate the effects immune-based therapies on the recruitment and migration of CD8⁺ T cells and dendritic cells to tumours and lymph nodes.

GOUTHRO, MARTIN; Glassey, Barb; White, Kellie
Cape Breton University

Bean beetle (*Callosobruchus maculatus*) mating behaviour in relation to water and nutrient enrichment of males

Callosobruchus maculatus is an agricultural pest native to arid regions of Asia and Africa. It is also an important model organism for the study of behavioural ecology. Female *C. maculatus* lay their eggs on dried beans, and their larvae burrow, feed and moult within the bean. Adults emerging from beans do not require food or water. However, males transfer a spermatophore to females during copulation that may provide water and/or energy to females. To date the majority of research on the reproductive behaviour and the impact of adult nutrient supplementation and water has focused on females and neglected males. Preliminary observations made at CBU suggest that male *C. maculatus* exhibit a variety of mating behaviours similar to those reported in the literature for other species of Coleoptera. Through observations of 60 mating pairs I created an ethogram describing and cataloguing these behaviours. Additionally, I examined how providing the male with water and nutrients (5% sucrose) affects these reproductive behaviours and other life history characteristics of males and female *C. maculatus*. In total I observed and described five discrete *C. maculatus* pre-copulatory, eleven copulatory, and nine post-copulatory behaviours. Preliminary results of male supplementation show significantly ($p > 0.05$) greater spermatophore size and longevity for males provided with water and sugar compared to those that were not. My poster will explore further details of these results including how male supplementation impacted female fecundity as well as mating behaviour in both sexes.

HUBNER, JACOB; Staicer, Cindy; Gutowsky, Sarah
Dalhousie University

Comparing avian communities across habitats in Thomas Raddall Provincial Park, Nova Scotia

The ability to predict ecological change in wildlife populations is an important conservation tool. Habitats in Thomas Raddall Provincial Park, in Nova Scotia, Canada, are changing as the park undergoes ecological succession from shrubland barrens to forest. Changing habitats may lead to changes in the songbird communities and abundances of species that reside in the park. Satellite data and GIS segmentation-based land classification was used to classify the habitats within the park into six major types and to calculate their areas. Bird surveys were undertaken from 25 May - 6 July 2017 and the density of each species was compared across habitat types to assess differences in community composition. Results suggest a gradual shift in dominant bird species as the habitats move through successional stages, with contrasting communities on both ends of the successional spectrum. Deciduous-dominant forest had the most even distribution of species. Use of more than one habitat type by most species may be due to the tightly packed and patchy distribution of habitats within the park and lead to high avian species diversity within a habitat type. The common yellowthroat, chestnut-sided warbler, and grey catbird had high preference for the shrinking shrubland barrens area and thus may eventually be extirpated from the park. In addition, comparing results to surveys conducted in 1998, indicated a loss of species that typically prefer open or wet coniferous forest, such as ruby-crowned kinglet, dark-eyed junco, and pine grosbeak, possibly due to climate change.

HURLEY, EMILY; Staveley, Brian
Memorial University

TBPH in *Drosophila melanogaster* models of amyotrophic lateral sclerosis

Defects in the *TARDBP* gene which encodes TAR DNA-binding protein-43 (TDP-43), a DNA/RNA binding protein, can cause the neurodegenerative disease amyotrophic lateral sclerosis (ALS). Rare missense mutations and multiplications of *TARDBP* have been found to contribute to the constituents of pathological deposits that are found in infected neurons of patients with ALS. To model ALS in *Drosophila melanogaster* we have chosen to modify the expression of the fly homologue, *TBPH*. To modify the expression of TBPH, inhibition of the function by *TBPH* RNAi and overexpression of TBPH were carried out. Experiments in the eye and in the whole fly allowed us to evaluate the effects upon development of the eye and upon longevity and ageing. Analysis of the eyes were carried out using scanning electron microscopy (SEM) images obtained of the male eyes in which the number of ommatidia and bristles were counted and analyzed for each genotype. Interestingly, it was found that one of the RNAi transgenes produced significantly fewer ommatidia and bristles. Longevity and ageing analysis demonstrated in this same RNAi lead to a shorter life span than others, with one instance where they did not survive past the pupae stage (no adults). In regards to the overexpression of *TBPH*, we find that in one case of ubiquitous expression, a small portion did not survive past the pupae stage and the few that survived showed reduced life span. We conclude that loss of expression of *TBPH* may model ALS in *Drosophila melanogaster*.

KELLY, BRIANNA; Nuschke, Andrea; Tremblay, Marie-Laurence; Davis, Christa; Brewer, Kimberly
Dalhousie University

Using magnetic resonance imaging to track immune cell migration in a 4T1 mouse model

Immunotherapies are a highly promising new class of cancer treatments. Unfortunately, there have been challenges to clinical implementation due to their complexity and increased individual variation in response compared to chemotherapy or radiation. This project evaluated the checkpoint inhibitor immunotherapies anti-PD1 and anti-TIM3 in the 4T1 mouse model of triple negative breast cancer. In addition to evaluating tumour growth, the recruitment of immune cells to the tumour was monitored via quantitative magnetic resonance imaging (MRI) using the TurboSPI pulse sequence. Balb/c mice were implanted with 4T1 breast cancer cells, and measured twice weekly with callipers to record tumour size for up to 4 weeks. The mice received treatments of either anti-PD1 or anti-TIM3 checkpoint inhibitors. Using genetically and disease matched donor mice, either cytotoxic T lymphocytes (CTL) or myeloid derived suppressor cells (MDSC) were isolated and labelled with superparamagnetic iron oxide (SPIO) for use in adoptive cell transfer (ACT) to the respective recipient groups. Using quantitative MRI, it was found that of 3-10% of injected CTLs were recruited to the tumours in the 4T1 model and that the number of CTLs recruited did not correlate to the tumour volume regardless of treatment. Mice treated with anti-TIM3 had significantly decreased numbers of MDSCs in the tumour when compared to untreated mice, and had higher numbers of CTLs. The number of MDSCs recruited also correlated with tumour volume. However, treatment with anti-PD1 or anti-TIM3 did not have a significant impact on tumour volume.

KING, MORGAN; Hartwig, Sunny
University of Prince Edward Island

Defining the role of SOX4/SOX11 during nephrogenesis in vivo

Congenital anomalies of the kidney and urinary tract (CAKUT) account for the highest incidence of end-stage renal disease in children. To understand abnormalities in renal development, a greater understanding of nephrogenesis is necessary. *SOX* genes have been identified to be critical in a number of organogenesis processes, but they have not been extensively studied in the kidney. Previous research has characterized *Sox4*'s importance in the formation of nephrons – conditional ablation of *Sox4* resulted in end-stage renal failure. In a complementary study, it was determined that *Sox4/11* double knock-out mice die perinatally of renal failure. Analysis revealed a high number of immature nephrons. It was hypothesized that *SOX4* and *SOX11* cooperatively promote differentiation during renal organogenesis *in vivo*. Furthermore, it was predicted that the etiology of renal failure/death in *Sox4/11* double knock-out mice was due to a primary delay in nephron differentiation, leading to perinatal renal incompetence and subsequent death. To test the hypothesis, a morphometric approach was adopted. Nephrons were quantified in kidney sections using a virtual disector method in 5 different genotypes: *Sox4⁺/Sox11⁺*, *Sox4^{HZ}/Sox11^{HZ}*, *Sox4^{HZ}/Sox11^{KO}*, *Sox4^{KO}/Sox11^{HZ}*, and *Sox4^{KO}/Sox11^{KO}*. Mature glomeruli were quantified at embryonic day (E) 18.5 and postnatal day 21 using a combination of peanut agglutinin staining and haematoxylin & eosin staining. Mature glomeruli were also quantified at E14.5, E16.5, and E18.5 using WT1 immunofluorescence to assess whether there was a primary delay in nephron development. Results demonstrate that *SOX4* and *SOX11* have important independent roles, but cooperative signaling is required for normal renal development *in vivo*.

LANDRY, CARMEN; Wyeth, Russell
Saint Francis Xavier University

Using qPCR to measure gene expression in the great pond snail, *Lymnaea stagnalis*

The great pond snail, *Lymnaea stagnalis*, is commonly used for neurobiological studies. Previous research has been conducted on the structure and function of its central nervous system, however, its peripheral nervous system remains less explored. The overall goal of this research was to increase our knowledge of the function of the peripheral nervous system, which would provide insight into the sensory processing mechanisms of this organism. In order to study the function of the peripheral nervous system, we studied gene expression, since neurons are a function of the genes they express. This study establishes a quantitative polymerase chain reaction protocol to measure gene expression in the peripheral nervous system of *L. stagnalis*. First, appropriate reference genes, necessary to normalize expression levels, were established by measuring the relative stability of 4 candidate reference genes in the penis, tentacles, lips, central nervous system, foot and mantle of *L. stagnalis*. Elongation factor and glyceraldehyde 3-phosphate dehydrogenase genes were ranked as the best reference genes among the tissues. These genes were subsequently used to evaluate the relative expression of tyrosine hydroxylase, a neural specific gene, in the tissues of *L. stagnalis*. The relative expression of tyrosine hydroxylase was greatest in the foot and mantle, followed by the central nervous system and the lips. Further research is needed to explore the neurons and the expression of tyrosine hydroxylase in the foot and mantle of *L. stagnalis*. The established reference genes will be beneficial for future research measuring gene expression in *L. stagnalis*.

LEE, STACEY; Salazar, Vielka
Cape Breton University

Circadian and sex-linked gene expression of melanocortin receptor 5 and androgen receptor in the electric organ of *Brachyhyopomus gauderio*

Nocturnal weakly electric fish have evolved a unique electric signalling mechanism that allows them to emit an electric signal into the surrounding water to navigate their environment in the dark and to communicate with conspecifics. These fish generate their electric signal via continuous activation of their electric organ, which is composed of specialized electrogenic cells called electrocytes. One species in particular, the gymnotiform electric fish *Brachyhyopomus gauderio*, dynamically modifies the magnitude and timing of its electric signal to avoid predator detection, attract mates, or match its nighttime activity period. These electric signal changes differ between males and females and are mediated at the cellular level by melanocortins and androgens. Yet the specific receptors for these hormones have not been characterized in *B. gauderio*'s electrocytes. For my project, I characterized the sequences for the melanocortin receptor 5 (*mc5r*) and the androgen receptor (*ar*) genes and quantified the expression of these genes in electrocytes sampled from male (n= 14) and female (n= 24) *B. gauderio* during the day and the night. I have isolated and localized a complete MC5R and a partial AR sequence in the fully functional form within the electrocytes. Gene expression analysis of *mc5r* and *ar* within the electrocytes is ongoing. By establishing this connection between hormones and electric signal plasticity, I hope to provide further insight into the hormonal control of electrogenic cells.

LURETTE, OLIVIER; Hébert Chatelain, Étienne
Université de Moncton

The impact of mitochondrial Src kinase in breast cancer

Breast cancer is the most common type of cancer and the second leading cause of death from cancer among Canadian women. It is therefore important to better understand the molecular processes involved in this disease to enable the development of more effective treatments. Our lab has discovered that the protein Src, known for its involvement in breast cancer, is also present in the mitochondria. Mitochondria are important cellular organelles in the development of cancer cells because of their role in energy production, apoptosis and biosynthetic pathways. The objective of this project was to determine the role of mitochondrial Src in breast cancer cells. To do this, we generated a mutant of Src that is specifically targeted to mitochondria. Expression of this mutant revealed that mitochondrial Src decreases mitochondrial activity by targeting different proteins in breast cancer cells. The identification of these targets in future studies will benefit the generation of efficient and selective therapeutic strategies.

MACKELLAR, HANNAH; Hamilton, Diana
Mount Allison University

Diet and fattening rates of Semipalmated Sandpipers (*Calidris pusilla*) and Semipalmated Plovers (*Charadrius semipalmatus*) staging in the Acadian Peninsula, New Brunswick

I studied stopover ecology of Semipalmated Sandpipers (*Calidris pusilla*) and Semipalmated Plovers (*Charadrius semipalmatus*) at a previously unstudied staging area in North-Eastern New Brunswick. Birds were captured through mist netting during summer 2017. We collected blood samples from the branchial veins of 33 plovers and 23 sandpipers. I examined diet and fattening rate through stable isotope and triglyceride analyses of blood plasma. This information was then related to data on stopover duration collected using radiotelemetry of tagged migrants. Despite Semipalmated Plovers and Semipalmated Sandpipers exhibiting different bill morphology, they shared similar diets, consisting of a mixture of invertebrate prey and biofilm. However, Semipalmated Plovers had significantly lower average plasma triglyceride concentrations than Semipalmated Sandpipers ($p=0.009$). We found no significant relationship between days before migration and fattening rates in either species. However, fattening rates increased with increasing mass in plovers, meaning that rate of weight gain was exponential. This was not the case in Sandpipers, perhaps because they were gaining weight rapidly throughout their stopover. These data provide novel insight into the diet and fattening rates of migratory Semipalmated Plovers, which have received little study during migration. Moreover, this research supports previous findings that Semipalmated Sandpipers are flexible foragers, consuming different prey than what is eaten elsewhere in their stopover range. Finally, differences among the two species in fattening rate during migratory stopover, notwithstanding their similar diets, suggest that other factors such as migration distance and required fuel loads may affect foraging effort and resulting weight gain for these species.

MACKINNON, MORGAN; Weir, Laura
Saint Mary's University

Measuring the distribution of reproductive success and mating system structure across varying operational sex ratios in the Japanese medaka (*Oryzias latipes*)

The operational sex ratio is the number of fertilizable females to males. Change in this ratio is often associated with change in behaviour during mating, and, consequently, may lead to changes in the distribution of reproductive success. One behavioural change that can be observed is a form of alternative reproductive tactic known as sneaking in which small males attempt to get some fertilization success by sneaking sperm between a spawning pair. In Japanese medaka, a species of freshwater fish found around Japan, the operational sex ratio varies across latitudes; this variation is linked to differences in mating behaviour and morphology. The objective of this work is to determine whether paternal success varies with differing operational sex ratio and whether alternative reproductive tactics, such as sneaking, are more prevalent when competition is intense under male-biased sex ratios. In addition, we determined whether operational sex ratio had an influence on egg fertilization success, as sneaking males may offer some fertilization assurance. To measure this, we collected eggs from Japanese medaka under four experimental operational sex ratios. We determined fertilization success of the eggs and stored them for later genetic analysis of paternity. Our preliminary results suggest that there is no significant difference in fertilized eggs among all four treatments. Ongoing genetic analysis will lend insight into the distribution of reproductive success in the four treatments, as well as the prevalence of sneaking behaviour.

MCCOOMBS, CEILIDH; Barber, Colleen
Saint Mary's University

Nestling vocalization development in the European Starling (*Sturnus vulgaris*)

Nestlings vocalize while begging to elicit food from parents, and although many studies examine their begging behaviour, surprisingly little is known about vocal development in nestling passerines. European Starlings (*Sturnus vulgaris*) are a cavity-nesting passerine commonly found in anthropogenic environments. Adult males are open-ended learners, increasing the complexity of their songs with age. The objective of my study was to determine the ontogeny of vocalizations in nestling European Starlings over the nestling period (0 to ~22 days old). Using spectrograms, I observed and catalogued their calls every four days during the period between hatching and fledging. I predicted that the number of different types of vocalizations would increase with age. However, I found that the largest variation in vocalizations occurred when the nestlings were 5 to 13 days of age, and not when they were older. Nestlings appear to have increased consistency in their vocalizations as they grow older and settle in to their voices.

MCDERMOTT, EMMA; Sweeney-Nixon, Marva
University of Prince Edward Island

Effects of PEI Berries blueberry purée on renal oxidative stress

Cardiovascular diseases are the leading worldwide cause of death and, along with many other chronic diseases, have been associated with high levels of oxidative stress. Blueberries have been shown to have powerful antioxidant properties, a characteristic crucial for neutralizing reactive oxygen species and reducing the overall level of oxidative stress. PEI Berries Ltd. has patented a new blueberry processing method, called hydrothermodynamic technology, which they claim will allow their purée to maintain more of the blueberries' natural antioxidant properties compared to other processing methods. The objective of my research is to evaluate the bioefficacy of the PEI Berries product. 28 Wistar-Kyoto rats were divided into four feeding groups: a control diet, a control diet with blueberry purée, a high fat diet to induce oxidative stress, and a high fat diet with blueberry purée. It was hypothesized that the blueberry purée would cause a significant decrease in renal oxidative stress, shown by increased levels of antioxidants and related enzymes. Spectrophotometric assays were used to measure glutathione levels and the activity of three antioxidant enzymes. Compared to the control group, the rats fed a control diet with blueberries had a 46.8% increase in superoxide dismutase activity, but this was not significantly significant (Two-Sample T-Test, $p=0.278$, $n=7$). Similarly, there was a 24.9% and 28.1% increase in glutathione reductase and catalase activities, but these were not statistically significant (Two-Sample T-Test, $p=0.118$ and 0.246 , $n=7$). My study has not yet provided evidence that the product is effective at increasing endogenous antioxidants in rat kidneys.

MCDONALD, MICHON; Schiavi, Nathieli; Stone, Sophia
Dalhousie University

Role of XBAT31.1 in regulating iron uptake in *Arabidopsis thaliana*

A reduction in available iron, an essential macronutrient, prompts the iron deficiency response in plants. In this process three membrane proteins: AHA2 (ATPase), FRO2 (Ferric Reductase Oxidase) and IRT1 (Iron Regulated Transporter), responsible for iron uptake from the soil, are upregulated. AHA2 and FRO2 reduce environmental Fe^{3+} to Fe^{2+} which is transported into the cell by IRT1. Our goal is to determine if the ubiquitin ligase (E3) XBAT31.1 (XB3 ortholog in *Arabidopsis thaliana*) regulates IRT protein levels to facilitate iron uptake. E3s are the central enzymes of the ubiquitination pathway that covalently attaches ubiquitin to selected proteins. Ubiquitination targets the modified protein for degradation by the 26S proteasome. We believe that XBAT31.1 regulates IRT1 protein levels because, under iron deficiency, *XBAT31.1* mutants differ from wild type in two ways: decreased iron content and decreased IRT1 transcript levels. We hypothesize that the lower *IRT1* transcript levels in the XBAT31.1 mutants leads to lower IRT protein levels and subsequent iron import relative to wild type. Western blot analysis using IRT1 antibodies was used to detect and compare IRT1 protein abundance in *XBAT31.1* mutants and wild type *Arabidopsis* seedlings grown under iron sufficient and deficient conditions. We expect IRT1 protein levels to be lower in XBAT31.1 mutants compare to wild type under iron deficiency. Understanding the regulation of the iron deficiency response may help develop methods that will enable us to produce plants that will maintain yield despite growth on soil that lack sufficient iron.

MCINTYRE, MOLLY; Galway, Moira
St. Francis Xavier University

Extraction and preservation of DNA from microbes in soil

Microbes contained in soil are an essential part of the environment and therefore are of great interest for soil research. As such, a product for the accurate preservation of the soil microorganisms contained in a sample at any particular time is critical for soil sample analysis. The purpose of this study was to determine a DNA extraction method for consistent extraction of sufficient quantities of high molecular weight microbial DNA and to determine if a DNA Genotek (Ottawa, ON) proprietary preservation solution was capable of sample stabilization. Extraction methods were assessed based on DNA quantification, DNA quality, and user-friendliness. Denaturing gradient gel electrophoresis was used to create a fingerprint of the microbial DNA contained in a sample. Gels were then compared over time as a means to assess stabilization of the soil microbiome and mycobiome profiles. For a stabilizing solution to be successful the sample should contain the same diversity and density of microbes before and after experimental treatments of time and temperature. It was concluded that the Powersoil DNA Miniprep Kit (Mo Bio Laboratories, Carlsbad, CA) was capable of extracting sufficient yields of high molecular weight DNA. None of the tested DNA Genotek microbiome stabilizing solutions were capable of sufficiently preserving microbial DNA contained in the soil samples.

MCPHAIL, BROOKE; Rawlings, Timothy
Cape Breton University

An examination of composition and species richness in trematode communities using *Stagnicola elodes*

Human-induced changes to the environment due to climate change, pollution, and loss of habitat could alter the community of parasites associated with a given host species. This is particularly true for parasites with complex life cycles, such as digenean trematodes, that involve free-living and parasitic stages, and have highly specific relationships with their hosts. This study explored the species diversity and composition of trematodes associated with a well-studied freshwater snail, *Stagnicola elodes*, in Blacketts Lake, Cape Breton, in relation to previous studies in North America. Cercariae were collected from infected snails and differentiated based on morphotype and behaviour. Following DNA extraction, the Cytochrome Oxidase Subunit I gene was amplified using PCR, then sequenced at The Centre for Applied Genomics in Toronto. DNA barcoding was used to determine parasite identities, where possible, through comparisons to other parasite sequences on GenBank. Preliminary results indicate that a minimum of 11 species channel their lifecycles through *S. elodes* in Blacketts Lake, spanning the families Plagiorchiidae, Diplostomidae, Strigeidae, Schistosomatidae, and Echinostomatidae, all of which overlap with previous studies of *S. elodes* in Michigan, Cape Breton and Alberta. The species richness in Blacketts Lake is low compared to the pristine habitats of two lakes in Michigan in 1937, but is similar to these habitats following 20 years of human development, and is similar to the results of collections in Lake Ainslie in 1967 and in 5 Alberta lakes in 2016. This host-parasite system could potentially be used as a bioindicator for the health of aquatic communities.

MILLER, LAUREN; Lamport, Anna-Claire; Wilson, Brian; Robertson, George S.
Acadia University

Investigating the effects of peroxisome proliferator-activated receptor gamma agonist pioglitazone in a lysolecithin model of focal demyelination in mice

Multiple sclerosis (MS) is a chronic autoimmune demyelinating disease of the central nervous system (CNS) for which there is currently no cure. Pioglitazone is a PPAR-g agonist approved by the FDA for the treatment of type 2 diabetes. Pioglitazone has been shown to reduce disease severity in a systemic mouse model of MS (experimental autoimmune encephalomyelitis; EAE) and has exhibited anti-inflammatory properties in a number of *in vitro* studies, suggesting it may be capable of promoting remyelination. This study aims to fill the void that exists in restorative treatment options for MS by investigating the effects of pioglitazone in a mouse model of focal demyelination. Mice received a stereotactic injection of the toxin lysolecithin (LPC) into one side of the corpus callosum, and PBS into the other side. Mice received either vehicle or pioglitazone by oral gavage once daily for seven days beginning one day post-injection. After seven days, demyelination and microglia activation within the corpus callosum were measured using histology and immunohistochemistry, respectively. LPC lesion volumes and Iba1 density in mice treated with pioglitazone were larger on average relative to those in mice treated with vehicle. However, neither of these differences were statistically significant. Given that the LPC model allows the study of remyelination in relative isolation, it can thus be inferred that pioglitazone is not effective in directly enhancing remyelination. By ruling out the efficacy of pioglitazone in the LPC model, this study generates new questions into the mechanism by which pioglitazone is effective in the EAE model.

OAKLEY, DAVID; Oakes, K; Zhang, Shine (Xu)

Cape Breton University, Verschuren Centre for Sustainability in Energy and the Environment
Evaluating the electrochemical removal of bacterial biofilms

Bacterial biofilms represent a diverse community of surface-associated sessile bacteria enclosed within a hydrated extracellular polymeric substance matrix. The bacterial-produced matrix, consisting of polysaccharides, proteins, nucleic acids, and lipids, protects bacterial cells from desiccation and facilitates their attachment to various biotic and abiotic substrates followed by biofilm formation. Traditional antibacterial treatments and host immune responses can be ineffective in completely removing the compact structures of infecting biofilms, which can be hundreds of times more resistant than planktonic bacteria of the same species. This can result in persistent and chronic infections, including endocarditis, chronic otitis media, lung infections in cystic fibrosis patients, and healthcare-associated infections. The high prevalence of biofilm-based healthcare-associated infections and the ineffectiveness of current treatment methods (*i.e.* antibiotics) has stimulated research interest into developing non-antibiotic dependent treatment methods to remove biofilms. This work evaluates the electrochemical removal of bacterial biofilms using an electronic bandage designed to oxidize water for the continuous generation of hydrogen peroxide and the subsequent removal of *Pseudomonas aeruginosa* biofilms. Hydrogen peroxide can pass through channels in the protective matrix of biofilms and enter into bacterial cells via cell membrane porins. Once inside the cell, hydrogen peroxide will react with intracellular iron to produce hydroxyl radicals via the Fenton reaction. These radicals are powerful non-selective oxidants that destroy bacterial biomolecules leading to cell death without the possibility of acquiring resistance. In the long-term, this method could provide a highly efficient alternative treatment to deal with antibiotic resistant biofilms in healthcare settings.

OBODAI, NII; Barber, Colleen
Saint Mary's University

Does reproductive performance improve with age in female European Starlings, *Sturnus vulgaris*?

Studies have shown that the most energetically costly event in a bird's life cycle is that of breeding, particularly for females who lay nutrient-rich eggs. Studies also show that older males and females are often preferred as mates. Potential reasons include older individuals having experience with locating good feeding sites, and provisioning offspring, as well as being in better condition or possessing superior genes. European Starlings (*Sturnus vulgaris*) are cavity-nesting passerines with bi-parental care, and have hackles whose length of iridescence allows classification of adults into one of two age categories (Second year, SY, who are breeding for the first time; After Second Year, ASY, who likely bred at least once before). The objective of my study was to determine if older females had higher reproductive performance than younger females, using four years of data. I predicted that ASY females would be in better condition than SY females, and that they would have larger clutch sizes, a higher mean egg mass, and greater hatching and fledging success. In support of my predictions, ASY females were in significantly better condition than SY females, and had larger clutch sizes. ASY females also tended to have higher fledging success, although mean egg mass and hatching success did not differ between ASY and SY females. Condition and reproductive performance in this population of European Starlings were higher for older females than first-time breeding females, suggesting that these older females might be expected to be preferred as mates.

PETRITCHENKO, KATRINE JADE; Dufour, Suzanne
Memorial University

Reproductive strategies in thyasirid bivalves from Bonne Bay, Newfoundland

Thyasirids are widely distributed, cold water bivalves that live in soft-sediment. Within this family, reliance on sulphur-oxidizing bacterial symbionts varies among species. Bonne Bay, a fjord in Newfoundland, supports thyasirids, including currently undescribed new taxa: *Parathyasira* sp. (asymbiotic) and a complex of symbiotic and asymbiotic *Thyasira* cf. *gouldi*. Most research on this group has focused on adaptations for supporting chemosymbiosis. The reproductive strategies of thyasirid clams with different trophic pathways are largely unexplored. The co-occurrence of symbiotic and asymbiotic thyasirids in an environment subjected to seasonal change provided an opportunity to improve our knowledge of reproductive strategies in this family. Specimens of the different thyasirid taxa collected in Bonny Bay were studied through standard histological preparations. Specimens collected in April, June and September were investigated. Dioecious individuals were found in each taxon. Multiple stages of spermatogenesis were observable in all male specimens, and sperm size and shape differed among taxa. In females, eggs were relatively large and featured a thick capsule, resembling those previously described in other bivalves that form associations with sulphur-oxidizing bacteria. Abundant reserves were evident in the capsule as well as in the lumen of the ovary. The eggs of *Parathyasira* appeared to differ in capsule composition compared to *T.* cf. *gouldi*. Mature eggs were found at all sampling dates, suggesting continuous gametogenesis despite the presence of seasonal environmental cues. The presence of symbionts did not appear to influence reproductive strategies in thyasirids.

PRETI, FLAVIO; Bjornson Susan
Saint Mary's University

Effects of a microsporidium pathogen, *Nosema adaliae*, on the general predator Chinese mantis, *Tenodera sinensis*

Biological pest control defines the practice of regulation and control of pests through the use of other living organisms. A common procedure is to use more than one biological control agent on the same area. Even though this procedure could create great benefits, it is also possible to obtain opposite results due to intraguild predation. In this experiment we use intraguild predation to study the transmission of the microsporidium pathogen *Nosema adaliae* from the two-spotted ladybird (*Adalia bipunctata*) to the Chinese Praying Mantis (*Tenodera sinensis*). Three treatments were made; Control was fed two uninfected *A. bipunctata* larvae, Treatment1 was fed one microsporidia-infected and one uninfected larvae, and Treatment2 was fed two microsporidia-infected larvae. Infection status was confirmed through staining in 5% Giemsa solution and examination by light microscopy. All the Praying mantis in the study resulted to be microsporidia-free, indicating a transmission of 0%. Longevity and overall mortality did not present any significant difference among treatments. Control was significantly more likely to fail molting than Treatment1 as well as Treatment2. Control also fed statistically less on average compared to both Treatment1 and Treatment2. The data suggests the microsporidia from the Two Spotted Ladybeetle is unable to be transmitted to the Chinese Praying Mantis. Even though the results do not match our prediction, we were able to find statistical difference among the treatments, leading us to believe that the infection could cause effects in the production of alkaloids by ladybeetle, making them less toxic to other organisms.

PRIEST, JENNA; Shutler, Dave; Stewart, Don; Boudreau, Mike
Acadia University

Relationships between parasite intensity and body condition in coyotes

Fat and other nutrient reserves can have profound influences on an individual's fitness. An organism's condition is defined as its surplus of fat relative to body size. The kidney-femur fat index (KFFI) is often used for measuring body condition in mammals. Variables that can influence condition include age, sex, food availability, and parasites. Parasites impose costs on hosts via upregulated immunity, repairing tissue damage, and loss of nutrients, all of which may lower a host's condition. I quantified condition in coyotes (*Canis latrans*), a carnivore widely distributed across North America. Coyotes are vulnerable to a variety of endoparasites, but whether this translates into measurable reductions in condition is unknown. I quantified parasite intensity (number of parasites/host) by collecting endoparasites from the lungs, tracheae, and guts of 72 coyotes from Nova Scotia. Parasite intensity for each individual species of parasite was not significantly associated with host condition. However, combined parasite intensity was significantly associated with lower condition. Few studies have observed this relationship.

RAPPOLDT, LIAM¹; Wilson, Brian¹; Miller, Donald²

¹Acadia University; ²University of Manitoba

Investigation of the molecular growth factors contributing to BBB restrictive permeability

Endothelial cells and paracellular tight junctions of the blood-brain barrier (BBB) restrict the passage of most compounds between the vascular system and brain parenchyma. Tight junctions are modulated by cadherin interactions separating the vascular endothelial cells of capillaries. Under neuropathological conditions i.e. cancer, these tight junctions become compromised, leading to alterations of BBB permeability. Moreover, the restrictive permeability of the BBB is an obstacle for the delivery of potential treatments. Primary cultures of endothelial cells have been used to develop a better understanding of the molecular mechanisms regulating permeability of the BBB. However, evidence suggests a lack of growth factors in monoculture models creates uncharacteristic leakiness of in-vitro tight junctions. As the secretion of these factors is thought to be of astrocytic or microglial origin, this study attempted to quantify the expression of sonic hedgehog (SHH), wingless (Wnt) and norrin (NDP) proteins in the sub-ventricular zone (SVZ), hippocampus and cerebellum respectively. Organotypic brain slice cultures were prepared and cultured for two weeks, then fixed in paraformaldehyde for immunofluorescence detection, or flash-frozen with liquid nitrogen for molecular studies using RT-qPCR. Media aspirates from SVZ slice culture were probed for SHH using western blotting. Western blotting and immuno-labelling of the SVZ showed high levels of expression of SHH protein. Hippocampal slices showed high levels of expression of Wnt-7a immunofluorescence. We are currently analyzing western blot data from brain slices containing hippocampus and cerebellum for Wnt-7a and NDP. Furthermore, we are optimizing primers for SHH, Wnt-7a, and NDP for use in RT-qPCR studies of gene expression.

SANCHEZ, MILAGROS; Lidgard, Damian; Broell, Franziska

Dalhousie University

Investigating dive characteristics of resting and non-resting behaviour in grey seals (*Halichoerus grypus*)

The study of marine mammal behaviour is typically impeded by the inability to maintain visual observations while the animals are underwater. Recent developments in telemetry technology have allowed researchers to monitor marine mammals beneath the surface, and these tagging techniques have allowed researchers to construct dive profiles for several species of marine animals. Over time, different dive profiles have become linked with specific behaviours, however there is a certain degree of assumption associated with this system. This study focuses specifically on square shaped dives, which are used to estimate foraging effort in several species of marine animals. Tri-axial accelerometers provide additional information on the degree of movement occurring during dive phases when overlapped with dive data. Preliminary results of this study found minimal movement during the bottom phase of some square-shaped dives, suggesting that some square shaped dives are “resting dives”. Head mounted accelerometers, GPS tags and depth loggers were attached to twelve female adult grey seals on Sable Island. Using the data from all three tags, the goal was to identify specific characteristics of resting and non-resting dives (such as bottom duration, maximum depth and descent/ascent rate). Overall, resting dives have a significantly longer bottom duration. Determining other dive characteristics will enable the identification of resting and non-resting behaviour in future and existing data sets, without the use of accelerometers. Square shaped dives comprise of both resting and non-resting behaviour, therefore, square shaped dives should no longer be used as an estimate of foraging effort in marine animals.

SMITH, RYAN¹; Lawrence, Janice¹; Nie, Xianzhou²

¹University of New Brunswick, Fredericton; ²Fredericton Research and Development Centre)

Detection, identification, and characterization of viroids in ornamental plants, with an in-depth look at *Coleus blumei* viroids

Viroids are the smallest known plant pathogens and cause a wide range of symptoms ranging from asymptomatic to severe. They are comprised solely of ~246-401 nucleotides of single stranded, circular RNA that does not encode any proteins. It has been hypothesized that ornamental plants can serve as reservoirs for viroids infecting important crop species. To explore this hypothesis, leaf tissue from 25 cultivars belonging to 5 species of ornamental plants was collected through the summer of 2017 at a nursery in Fredericton, NB, Canada. Total RNA extracted from the plant tissue underwent return-polyacrylamide gel electrophoresis and reverse transcription-polymerase chain reaction to detect viroids biophysically and by sequence, respectively. Complimentary DNA of detected viroids was subject to Sanger sequencing and next-generation sequencing to determine the identity of viroids; previously-unreported sequences were analyzed further with various molecular tools. To further study viroid prevalence, screening was performed on individual plants (n=246) from different origins. *Coleus blumei* viroids (CbVds) and tomato chlorotic dwarf viroid were detected in 10 cultivars from 2 of the species tested; sequence analyses provided the first detection of CbVd-5 and the first molecular confirmation of CbVd-1 in coleus plants in Canada, as well as the discovery of a new CbVd. Further screening indicated that CbVd-1 is both prevalent and the dominant CbVd. This study supports the hypothesis of a viroid reservoir in ornamental plants and suggests measures to control the spread of these pathogens may be necessary considering their prevalence, ability to mutate/recombine, and effects on important horticultural crop species.

STACK MILLS, ALEXA; Barbeau; Myriam

University of New Brunswick, Fredericton

Does the salt marsh snail (*Melampus bidentatus*) show a preference for live or dead grass species in Maritime salt marshes?

Melampus bidentatus is an abundant snail and apparent detritivore in salt marshes on the east coast of North America. In the United States, where it has been studied, *M. bidentatus* is restricted to the high marsh zone (typically the *Spartina patens* zone). However, in Maritime Canada, *M. bidentatus* occurs throughout both the high marsh and the low marsh (*Spartina alterniflora* zone), and is observed on both live and dead plants. These observations raise questions about the snails' diet, including preference between live and dead grass. In summer 2017, I conducted laboratory experiments with continuous behavioural sampling to determine the relationship between *M. bidentatus* and the state (live or dead) of *Spartina* species, at high and low tide, and in choice and non-choice situations. With *S. alterniflora*, snails did not show a strong preference of dead or live plants, spending similar amounts of time on both types, independent of tide state and whether the snails were offered a choice. With *S. patens* and when given a choice, snails actively selected dead plants more often than expected at low tide. Snails did not show a preference at high tide; overall snails spent more of their time inactive at high tide. The results of my study contribute to better understanding the ecology of *M. bidentatus* in Maritime salt marshes. Their association with both live and dead plants, as well as their presence throughout a salt marsh suggest that they may play a larger role in our northern marshes than they do farther south.

STEWART, MADISON; Feyrer, Laura; Whitehead, Hal
Dalhousie University

Connectivity of endangered Northern Bottlenose Whales (*Hyperoodon ampullatus*) between two populations along the eastern Canadian continental shelf

Northern bottlenose whales (*Hyperoodon ampullatus*) are found along the Scotian Shelf and off the northeast Grand Banks of Newfoundland. This study uses photo-identification and mark-recapture analysis to estimate the size of these two populations and aims to determine whether migration occurs between them. Photographic data was collected yearly from 1988 to 2008 for Scotian Shelf and in 2016 and 2017 for Newfoundland. Using the unique notches and markings on the dorsal fin and surrounding body of the whales, individuals were identified across sampling years at each site, with left and right-sided photographs analyzed separately. Using SOCPROG, the number of resighted individuals between each year was counted and mark-recapture analysis was carried out to estimate the population size over time at each location. The Scotian Shelf population was found to have approximately 170 (95% CI: 131 - 225) individuals from left side photos and 223 (95% CI: 163 - 317) individuals from right side photos. No support was found to indicate population change over time. Newfoundland had no resighted individuals between 2016 and 2017 and the population was estimated to have a minimum of 210 ($p=0.05$) individuals from left side data and 301 ($p=0.05$) individuals from the right. To determine if evidence of migration between the Scotian Shelf and Newfoundland exists, the identified whales from both sites were compared for matches. To date, no matching whales were found, indicating that these are distinct populations and should be managed separately.

TRELA, OLGA; Campanya i Llovet, Neus; Snelgrove, Paul
Memorial University

Fatty acid and stable isotope composition in sea urchins, sea cucumbers, and sediments in a shelf-break canyon off British Columbia, Canada.

Complex topography in deep-sea canyons may result in uneven supply and quality of organic matter on the seafloor. This study examines organic matter in sediments and in deposit feeders in from Barkley Canyon, a 6-km long shelf break submarine canyon off the coast of British Columbia, Canada. The two echinoderms, an urchin (*Strongylocentrotus fragilis*) and a sea cucumber (*Apostichopus leukothele*), are both deposit feeders occupying similar habitats in the canyon. One of the remotely operated vehicle (ROV) dives in the canyon documented aggregations of urchins on the seafloor, perhaps responding to organic matter deposition and suggesting that sea urchins and sea cucumbers may access different food resources. This study examines potential sources for the organic matter on which the two species feed, and whether they partition their food resources. I also look into how they allocate these resources into different types of tissue (intestines, muscles, and gonads). Preliminary analysis suggests a significant difference in fatty acid biomarkers and $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ isotopes between the two species, as well as some difference in allocations among tissue types in sea urchins. These results suggest some partitioning of food resources between these two echinoderms in the areas, where they might compete for the common resources.

WALSH, SINDY; Hunt, Heather
University of New Brunswick, Saint John

Effects of ocean acidification on respiration and burrowing behaviour of infaunal marine invertebrates in the Bay of Fundy

Coastal areas experience large variation in water and sediment pH, which will be exaggerated by ongoing ocean acidification. Ocean acidification alters the metabolic rate and behaviour of some marine invertebrates. The mechanism behind changes in behaviour has been suggested to be interactions between HCO_3^- and Cl^- ions concentrations and GABA_A receptors. In this study, I examined whether water column acidification affects respiration rate of marine infaunal invertebrates, as well as whether GABA_A receptors are the mechanism involved in the change in their burrowing behaviour at reduced pH. First, oxygen consumption in clams (*Mya arenaria*), snails (*Tritia obsoleta*), and a crustacean (*Corophium volutator*) was observed after 6 weeks in either ambient-pH seawater (7.89) or reduced pH (7.64). Then, *T. obsoleta* and *C. volutator* were treated with a GABA_A neuroinhibitor, gabazine, and left to burrow in either control sediment (pH = 6.98) or reduced pH (pH = 6.51) sediment. The respiration rate of all three species was higher in the reduced pH treatment than the control treatment, although these differences were not statistically significant. Burrowing by *C. volutator* decreased in reduced pH versus control sediments, but not when treated with gabazine. In contrast, burrowing behaviour by *T. obsoleta* did not differ among treatments. Results suggest that reduced water column pH put stress on the animals, and increased their respiration rates. Further, it appears that GABA_A is the mechanism behind altered burrowing behaviour for *C. volutator* but not for *T. obsoleta*.

WEST, CLAIRE; Currie, Suzie
Mount Allison University

How does the social environment affect responses to thermal stress in Mangrove Rivulus (*Kryptolebias marmoratus*)?

The goal of our study is to investigate the effect of social environment on the response to an acute heat stress in mangrove rivulus (*Kryptolebias marmoratus*). More specifically, we are interested in whether acclimation in isolation or in pairs affects the heat shock response following an environmentally relevant acute thermal stress. Fish were acclimated for two weeks in either pairs or isolation, following which all experimental fish were exposed to an acute heat shock at 39°C for one hour. Additionally, fish in pairs were studied in two groups: full interaction and mesh separation, allowing for chemosensory and visual interaction but not physical interaction in the latter condition. We measured heat shock protein 70 (HSP70) after the environmentally relevant acute thermal stressor, then compared HSP70 levels between the two social conditions. Preliminary data indicates that social condition does not alter the normal heat shock response, but also demonstrates that the degree of interaction within the pairs affects the level of variation in heat shock responses. Further analysis of results will contribute to our understanding of the social-physical environmental interactions in mangrove rivulus (*Kryptolebias marmoratus*).

ZINCK, NICHOLAS; Franz-Odendaal, Tamara
Mount Saint Vincent University

An examination of protein expression during embryonic chick eye development

In the chicken *Gallus gallus* eye, the development of boney elements, the scleral ossicles, is spatiotemporally related to vasculogenesis. Administration of a glucocorticoid, hydrocortisone, has previously been shown to disrupt the formation of the vasculature and the scleral ossicles. The current study aims to examine the expression of vascular endothelial growth factor A (VEGFA) in the embryonic sclera of the chicken eye following hydrocortisone injection. It is hypothesized that scleral VEGFA levels will be diminished in embryos exposed to hydrocortisone compared to a control group exposed to saline. Embryos were injected twice with either a hydrocortisone or saline solution at Hamburger Hamilton Stages HH29 and HH30. Cell lysates were prepared from the anterior eye segments of embryos and were examined via western blot for levels of VEGFA expression. To ensure valid comparisons are made between samples, the linear dynamic ranges of antibodies used to detect the protein of interest, VEGFA and a housekeeping protein were determined. Comparisons between groups were made using ImageJ software by analyzing antibody density with a colorimetric substrate. Through studying changes in protein expression after teratogenic treatment with hydrocortisone, a greater understanding of the molecular processes involved in intramembranous ossification and its relation to vascular development has been obtained. A firm understanding of the effect of glucocorticoid treatment during bone formation is important due to the prevalence of prenatal and postnatal glucocorticoid treatment of mothers and children.

AQUACULTURE & FISHERIES

ARMSTRONG, ETHAN¹; Salvo, Flora²; Dufour, Suzanne¹; Hamoutene, Dounia²

¹Memorial University, Department of Biology; ²Fisheries and Oceans Canada

Investigating single-beam sonar as a tool to detect the benthic footprint of aquaculture in Newfoundland

In Newfoundland, finfish aquaculture has grown substantially in the last decade, and production is expected to double by 2020. Intensive aquaculture production is associated with organic enrichment, which occurs as uneaten feed and animal excretions settle on the seafloor and form a layer of flocculent matter. Sustained deposition alters seafloor conditions, with high organic loading resulting in changes in benthic communities. Aquaculture-linked organic enrichment can be monitored through diver surveys, grab sampling and substrate imaging along defined transects. In Newfoundland, deep water and the predominately hard-bottom seafloor largely preclude the use of divers and grab sampling; instead, monitoring is performed using drop camera imaging, which is time intensive and limited in scale. Single-beam sonar is an attractive alternative to benthic imaging due to its ability to survey larger areas of the seafloor at lower cost. Here, we examine whether single-beam sonar could be used to detect flocculent matter deposition in our region. Data collected from four single-beam surveys around aquaculture sites were overlain with drop camera images that serve as substrate type ground-truthing. With machine learning, algorithms will be constructed using feature data from the single-beam sonar to create and refine predictive models. From these candidate models, we will test whether machine learning can discriminate and identify the footprint of aquaculture production.

BARD, BRITTANY; Kieffer, Jim

University of New Brunswick, Saint John

The effects of repeat acute thermal stress on the critical thermal maximum (CT_{max}) and physiology of juvenile shortnose (*Acipenser brevirostrum*)

The shortnose sturgeon (*Acipenser brevirostrum*) is a species of special concern in Canada, but little is known about their thermal biology. Information on the upper thermal tolerance of shortnose sturgeon becomes valuable for predicting future survival particularly with climate change and improving species management. Using standard critical thermal maximum (CT_{max}) methodology, the objective is to determine whether previous thermal stress affected the CT_{max} of juvenile shortnose sturgeon when exposed to a secondary thermal stress event. Prior exposure to thermal stress did not affect CT_{max} of juvenile shortnose sturgeon, when a 24h recovery period is allotted between tests. Plasma glucose, lactate and osmolarity were all significantly affected by thermal stress, but values returned to control levels within 24hrs. Hematocrit, plasma chloride and protein concentrations were not significantly affected by thermal stress. The data supports the hypothesis that repeated thermal stress does not affect the CT_{max} of juvenile shortnose sturgeon.

BARTLETT, CHARLOTTE; Sacobie, Charles
University of New Brunswick, Fredericton

Optimizing zebrafish reproduction (*in vitro* and *in vivo*) through the use of LHRHa on females to accelerate ovulation

The frequency of zebrafish, *Danio rerio*, use in the laboratory has increased to match and surpass that of rats in research settings. Because zebrafish are a model organism for vertebrates and other finfish, they may be used in a variety of research ranging from human health and aquaculture studies. Due to the increase of use of zebrafish in laboratory settings, there is an increase in demand of these fish. Their small size, model organism qualities and rapid maturation and reproductive cycles make them an ideal research subject. This study set out to investigate potential methods for optimizing zebrafish reproduction using luteinizing hormone releasing hormone analogue (LHRHa) exposure on the female fish in attempts to accelerate their ovulation process. Two experiments were completed to observe reproductive patterns through IVF (*In Vitro* Fertilization) as well as natural or laboratory spawning patterns. Fish were initially spawned before the females experienced treatments of control (vehicle only, sterile H₂O), low dose (0.5µg/L LHRHa – used in both experiments), or high dose (1.0 µg/L LHRHa – only used in the IVF experiment). Fish were checked for embryos at Four Days Post Exposure (DPE) (both experiments) and 8DPE (only used in IVF experiment), both of which are less than their typical ten-day spawning interval. Preliminary results show that early reproduction was observed from control and treatment groups. This study displays the need for research into the use of reproductive hormones to optimize zebrafish ovulation on a long-term scale.

BATE, CAITLIN; Whoriskey, Fred
Dalhousie University

The impact of temperature on the migration of juvenile female blue sharks (*Prionace glauca*) through Nova Scotian waters

The blue shark (*Prionace glauca*) occurs off Nova Scotia from July to October, displaying sexual segregation in inshore areas where juvenile females dominate the population. Adult blue sharks are known to prefer waters between 13 and 22°C, but the impact of temperature on juvenile movements and habitat choice has not been determined. This study investigated whether the availability of water of temperatures $\geq 13^{\circ}\text{C}$ drives the synchronous and sequential migration of juvenile female *P. glauca* from offshore to inshore in spring, with a return offshore in the autumn. The coastal distributions of juvenile blue sharks from spring to autumn were determined by acoustically tagging and tracking the locations of 74 sharks from 2013-2016. A statistically significant change in median distance from shore occurred between June and July (animals moved closer to the coast), and again between October and November (animals moved farther offshore; $H(8) = 123.59$, $p\text{-value} < 0.001$), at the time that temperatures first exceeded then fell below 13°C sea surface temperature, respectively. The productivity, seasonal availability of water $\geq 13^{\circ}\text{C}$, and scarcity of larger animals, especially sexually mature males that pose a threat to juvenile females, likely makes the Scotian Shelf an ideal summer feeding ground and safe haven for juvenile female blue sharks. If refuges such as the Scotian Shelf are no longer thermally optimal, due to future climate change, this may have negative impacts on juvenile female survival.

BROWN, ALEXANDRA; Easy, Russell
Acadia University

A phylogenetic classification of Nova Scotian longfin squid species (*Doryteuthis pealeii*)

The Scotian shelf, located in the Northwest Atlantic, comprises approximately forty cephalopod species. These include sympatric populations of the Atlantic longfin squid (*Doryteuthis pealeii*) and the Northern shortfin squid (*Illex illecebrosus*). The development of next generation sequencing and DNA barcoding technologies have broadened taxonomic studies which have further evolved to allow detailed species identification where morphological classification can be unreliable on its own. This study uses molecular techniques to identify a phylogeny of longfin squid caught off the Nova Scotian coast. Total DNA was extracted from squid tissues collected from both Bramber and Chester, Nova Scotia. End-point PCR was performed using primers targeting *cytochrome b (cytb)*, *cytochrome c oxidase subunit I (COXI)* and 18S rDNA genes. Following sequencing, bioinformatic tools (e.g. BioEdit and MEGA) were used to align and explore the phylogeny/molecular taxonomy of local squid species in comparison to other sequences available on international databases. Phylogenetic trees of various topologies were constructed in order to draw relationships between species. Refining these methods will be helpful in future studies to reduce species misidentification and to develop more accurate squid stock assessments for conservation policies. These results may also provide valuable information for prospective commercial squid fisheries in Nova Scotia.

BUJOLD, JORDAN; Duston, James
Dalhousie University, Faculty of Agriculture

Gonadal germ cell response to photoperiod manipulation in Arctic charr (*Salvelinus alpinus*)

24 hour lights (LL) in winter is used globally in salmon farming to prevent unwanted sexual maturation, yet the physiological mechanism is unclear. Histological analysis of the response of the primary germ cells to LL is an essential approach. Fraser River Arctic charr (*Salvelinus alpinus*) are a good model as both sexes exhibit a high maturity rate at age 2, which can be suppressed by LL application. During the winter 'decision period' for onset of maturation, gonads were sampled from 30 fish/month from each of four experimental groups: natural day length control (LDN; Latitude 45°N); LL from hatch to age 2; LL from November to February, otherwise LDN; LL from November to October. The maturity rate among the remaining fish at age 2 (n=90-120/treatment) ranged from 65% under LDN to 46% under LL (Nov-Oct), 36% under LL (constant), and 22% under LL (Nov-Feb). Gametogenesis commenced in the fall, evident by the development of spermatocytes and oocytes at the oil-drop stage, with variation between individuals. The LDN to LL signal in November stimulated gonadal development among some individuals, while inhibiting others. The switch from LL to LDN in February then arrested a maturation process that had already begun.

BUNGAY, ASHLEY¹; Mckenzie, Cynthia²; Matheson, Kyle²; Merschrod, Erika³; Couturier Cyr¹
¹Memorial University, Marine Institute; ² Fisheries and Oceans Canada; ³ Memorial University
The performance of biocide and non-biocide coatings to prevent biofouling by invasive and non-native species in Newfoundland

Biofouling, the unwanted growth of aquatic organisms can characterize invasion hotspots and vectors for spread of non-native species with implications for industries (e.g. aquaculture). In shellfish aquaculture, fouling by invasive tunicates directly on the species can reduce oxygen and food acquisition, leading to slower growth. For example, biofouling by vase tunicate (*Ciona intestinalis*) in Prince Edward Island, Canada causes significant increases in time and labour to remove and process product. Traditionally, antifouling coatings are used in aquaculture industry to limit fouling, not the spread of non-indigenous species. Self-polishing copolymer coatings contain biocides; others, foul-release coatings, rely of physical properties of the coatings (smoothness. Concerns of toxicity of biocides (e.g. copper) have led to development of new coatings. In our study, deployed wood settlement panels tested eleven coatings (and two controls) at four sites that characterize Newfoundland fouling communities and three invasive tunicate species (*C. intestinalis*, *Botrylloides violaceus*, and *Botryllus schlosseri*). Four coatings contained cuprous biocides, two used zinc biocides, one used zinc and EconealTM as biocides, two were foul-release coatings (non-biocide), and two were non-antifouling marine paints. We photographed panels monthly (May to December 2016) to determine changes in percent coverage of biofouling communities. Preliminary results suggest biocide coatings prevent growth of fouling organisms most effectively (as low as 0% coverage), while panels with non-antifouling marine paints exhibited up to 100% coverage, including invasive tunicates. Although, the most effective coatings contained biocides, one foul-release coating showed limited biofouling and may present a non-biocide alternative for use in the aquaculture industry.

CHEN, ZHIYU¹; Westcott, Jillian¹; Boyce, Danny² and O'Brien, Nicole^{1,3}
¹Memorial University, Marine Institute; ²Memorial University, Department of Ocean Science;
³Newfoundland and Labrador Department of Fisheries and Land Resources - Aquatic Animal Resources

Proof of concept: efficacy of cleaner fish (cunner, *Tautogolabrus adspersus*) for sea lice (*Lepeophtheirus salmonis*) mitigation and control

One of the major pathogens of concern for Atlantic salmon farmers globally is a naturally occurring marine ectoparasite referred to generically as the sea louse. Cleaner fish (or wrasse) have recently reemerged as an environmentally friendly technology for the biological control of sea lice. Cunnners have been identified as a potential cleaner fish species for sea lice mitigation and control in Newfoundland and Labrador, although limited information exists with respect to the efficacy of cultured juvenile cunnners for removing sea lice from Atlantic salmon or their adaptability to captive culture conditions. The objective of this laboratory study was to investigate the effect of stocking density on the delousing efficiency of cultured juvenile cunner (*Tautogolabrus adspersus*) cohabitated with Atlantic salmon (*Salmo salar*) smolts artificially infested with sea lice (*Lepeophtheirus salmonis*). Following the artificial infestation of Atlantic salmon smolts with laboratory reared *L. salmonis* copepodids, cultured juvenile cunnners (20-25g) were cohabitated with Atlantic salmon smolts at three densities (0%, 4% and 10%). A systematic random sampling of smolts (n=25 out of 50 per tank) was conducted for each tank on the day prior to addition of cunner (T0); 3, 5 and 7 days post-addition of cunner (T1, T2 & T3) and the total sea lice number per fish, body weight and fork length were assessed. There was no significant effect of stocking density on the mean sea lice number per fish ($P \geq 0.05$), suggesting that cultured juvenile cunner were not active in delousing Atlantic salmon smolts during the experiment.

DORT, HILLARY; Avery, Trevor; Easy, Russell
Acadia University

Identification of protein biomarkers in epidermal mucus of Striped Bass (*Morone saxatilis*) as a consequence of angling stress

Striped Bass (*Morone saxatilis*) are native to the Atlantic coast of North America and are recognized for their ecological, economic and cultural significance. Anthropogenic effects such as handling and angling, can negatively affect the health of striped bass populations. These effects can cause physiological and behavioral changes which are noticeable at individual, population, and ecosystem levels. Proteomic techniques were used to isolate, identify and characterize novel protein biomarkers in Striped Bass epidermal mucus and to investigate changes in protein profiles as a result of angling. Our methods included isolating proteins of interest in the epidermal mucus, as well as quantifying and exploring how specific protein biomarkers may play a role in determining fish health. Data obtained from 1D polyacrylamide gel electrophoresis and mass spectrometry analyses has identified putative protein biomarkers in Striped Bass epidermal mucus. Changes in protein profiles were correlated with known stress indicators and previously identified biomarkers. We have also characterized proteolytic activity in the mucus using zymography, which provides information on the class of proteases activated during stress-related events. By identifying biomarkers of stress in Striped Bass epidermal mucus we have defined a novel method for measuring stress in these fish which may contribute to a better understanding of the effects of angling stress on fish in general. We anticipate by recognizing the potential pitfalls in the handling and treatment of Striped Bass that this study may improve conservation decisions and regulations that will help to maintain healthy populations of Striped Bass, while still allowing recreational fishing.

DUNCAN, KATHLEEN¹; Weir, Laura¹; Bowlby, Heather²
¹Saint Mary's University; ²Department of Fisheries and Oceans

Temporal patterns of sex-specific size at maturity of porbeagle sharks (*Lamna nasus*)

Examining population dynamics within fisheries science is an effective way to investigate the size and age structure of a given fish population, and to understand how that stock might change over time. Porbeagle sharks are an endangered, pelagic shark species, for which there was an active Canadian fishery until 2013. The objective of this research is to do a temporal study of size and maturity before and after the fishery closure. Using longline fishing equipment at approximately 50 locations in the Northwest Atlantic Canadian waters, the sharks were caught and fork length, interdorsal length, and maturity were measured. Comparing length and maturity data from 1999-2001 (before fishery closure) and 2017 (after fishery closure) has provided insights into the changes that have occurred in the last 16 to 18 years. We used generalized linear models to analyse changes in size at maturity, body shape, and body size. We found that maturity was influenced by fork length, year, and sex. This shows that there is a difference between the years, although it could be a lack in data in some of the years it was collected. In addition, body shape was affected by sex alone, whereby the relationship between fork length and interdorsal length was steeper for males than females. Overall, our results indicate that there has been a temporal change in life history traits of porbeagle sharks.

GALLAGHER, PATRICK; Sacobie, Charles
University of New Brunswick, Fredericton

The effects of repeated hypoxia stress on PO₂ at loss of equilibrium and hematological parameters in brook charr, *Salvelinus fontinalis*

With current trends in climate change it is becoming increasingly important to understand how increased temperatures and hypoxic conditions will affect fish physiology. The aims of this study were to expose brook charr (*Salvelinus fontinalis*) to three severe hypoxia challenges (blocks), each two weeks apart, to determine hypoxia tolerance and to analyze their physiological response. This was accomplished by bringing brook charr to one of three ecologically relevant temperatures (16, 20, or 24°C) then rapidly reducing the oxygen tension (PO₂) of the water and determining the PO₂ at which they lost equilibrium (LOE). Hematological parameters, such as red blood cell count (RBC), total blood hemoglobin content, hematocrit, RBC volume, and RBC major/minor axis dimensions were used to document the physiological response at baseline and after each of the three blocks of the experimental trials. PO₂ at LOE was not significantly different between the repeated trials, but PO₂ at LOE increased significantly with increasing temperature. The RBC count decreased significantly from baseline as the experiment progressed, although hematocrit did not differ from baseline values. The RBC major/minor axis dimensions increased across the experimental blocks, indicative of cell swelling. Overall, these results suggest that hypoxia tolerance does not change with repeated severe hypoxia exposure; however, their physiological response differed across blocks of experimental trials. Given these changes in hematological parameters after an acute hypoxia challenge, future studies are warranted to determine if PO₂ at LOE differs between blocks after a more prolonged hypoxia stress.

HURLEY, ISABELLE¹; Lotze, Heike¹; Shackell, Nancy²
¹Dalhousie University; ²Fisheries and Oceans Canada

Spatio-temporal mapping and analysis of the Atlantic Halibut (*Hippoglossus hippoglossus*) fisheries bycatch in Atlantic Canada

Atlantic Halibut (*Hippoglossus hippoglossus*) is currently the most valuable commercial groundfish species per unit weight in Atlantic Canada. The fishery is performed by longliners using bottom gear with approximately 1000 hooks per fishing set, which are known to accidentally catch substantial amounts of non-targeted species (bycatch). Since 1998, Fisheries and Oceans Canada and the Halibut fishing industry have performed annual joint surveys on the Scotian Shelf and Southern Grand Banks to monitor both the Halibut catch and bycatch. This survey data was used to examine the spatial and temporal bycatch trends from 1998 to 2016. Maps were produced to observe spatial patterns and linear regressions were used to determine temporal trends in these metrics in different fishing areas. Over 95 species were identified in the bycatch of the Atlantic Halibut longline fishery, including: marine mammals, seabirds, benthic invertebrates, finfish, sharks and skates. Some of these species are listed under the Species at Risk Act (SARA), specifically the threatened Northern Wolffish (*Anarhichas denticulatus*) and Spotted Wolffish (*Anarhichas minor*), and 15 species are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). From 1998 to 2016, Spiny Dogfish were caught at nearly a 3-fold higher frequency than Atlantic Halibut. The produced maps indicate highest bycatch amount and species richness on the Southern Scotian Shelf and the Southern Grand Banks. The revealed temporal trends and spatial patterns of bycatch help to understand the ecosystem impact of the Atlantic Halibut fishery and can inform fishery management and marine conservation.

KATAN, TOMER; Xue, Xi; Caballero-Solares, Albert; Taylor Richard; Rise, Matt; Parrish, Chris
Memorial University, Department of Ocean Sciences

Growth performance, tissue composition, gene expression and fatty acid biosynthesis in Atlantic salmon (*Salmo salar*) fed plant-based diets with different ratios of ω 6 to ω 3 fatty acids

To date, inclusion of vegetable oils as a fish oil replacement in aquafeeds has had little influence on fish performance. However, most vegetable oils provide inadequate ratios of omega-6 to omega-3 (ω 6: ω 3) fatty acids (FAs). This ratio plays an important role in fish immune response and FA metabolism, and there have been concerns that farmed seafood may not supply an adequate ω 6: ω 3 ratio for human consumption. The current study examined the impact of five plant-based diets (12-week exposure) with varying ω 6 (soy oil) to ω 3 (flaxseed oil) ratios (0.35-2.7) on the growth, lipid tissue composition and hepatic transcript expression of lipid and eicosanoid synthesis genes (using qPCR) in salmon smolts (initial weight 203 ± 24 g). Growth performance, organ indices and apparent feed intake were not affected by dietary ω 6: ω 3. The liver and muscle FA composition was highly reflective of the diet (ω 6: ω 3 of 0.2-0.8 and 0.3-1.9, respectively) and indicated elongation and desaturation of the ω 3 and ω 6 precursors. Compound-specific stable isotope analysis demonstrated significantly higher synthesis of arachidonic acid (ARA, 20:4 ω 6) in the liver of the high ω 6 compared to the high ω 3 fed fish. Furthermore, significant correlations were observed between liver tissue FAs and the transcript expression of genes related to long-chain polyunsaturated fatty acid (LC-PUFA) synthesis and eicosanoid metabolism. In conclusion, while dietary ω 6: ω 3 did not affect growth performance, the liver and muscle tissue composition and the hepatic transcript expression of key lipid and eicosanoid synthesis genes were significantly affected by ω 6: ω 3 variation.

KERR, QUENTIN; Ruzzante, Daniel; Fuentes-Pardo, Angela
Dalhousie University

Temporal stability of genomic differentiation between spawning season components in Atlantic Herring (*Clupea harengus*)

Atlantic herring (*Clupea harengus*), a vital ecosystem component in the Northwest Atlantic, is the target of the largest pelagic fishery in the region. Complex seasonal spawning and feeding migrations result in intricate and elusive population structure. Herring spawn mostly during two distinct seasons, fall and spring, and significant genomic differentiation has recently been detected between these groups. The present study used a subset of this differentiation, 32 highly discriminatory Single Nucleotide Polymorphisms (SNPs) to answer two questions. First, is this genomic differentiation between fall and spring spawning components temporally stable in the Gulf of St. Lawrence? Secondly, can these SNPs be used as a proxy for spawning season in Bras d'Or Lake herring, where traditional morphological tests might fail? Overall, 276 herring were sequenced and genotyped at these 32 loci. An analysis of molecular variance found no variation in the seasonal differentiation between 2005 (N=90) and 2014 (N=71) in the Gulf of St. Lawrence, suggesting long term temporal stability. Furthermore, a discriminant analysis of principle components assigned 85 Bras d'Or herring to the fall component, and 12 to the spring component, with >99% posterior probability. This large fall spawning presence in the Bras d'Or Lakes likely indicates population change in these herring following the 1999 stock collapse in this region. Overall, this study suggests long-term genetic diversity between spawning components, and demonstrates an application of these SNPs to determine stock structure.

KNIGHT, ROBYN¹; Verhoeven, Joost¹; Salvo, Flora²; Dufour, Suzanne¹; Hamoutene, Dounia²
¹Memorial University, Department of Biology; ²Fisheries and Oceans Canada

Benthic bacterial communities at hard-bottom aquaculture sites in Newfoundland

Salmonid aquaculture is a profitable industry in Newfoundland, providing employment opportunities and economic growth to many rural areas. Where salmon are raised in net pens, benthic substrates receive flocculent matter, which is comprised of organic-rich fish pellets and fish feces. In Newfoundland, white bacterial mats develop on flocculent matter and are key indicators of organic enrichment; however, little is known on the composition and dynamics of bacterial communities that degrade this flocculent matter. Preliminary work in our region identified three bacterial genera as being dominant in flocculent matter from an aquaculture site after three months of fallowing. Here, we use high-throughput sequencing of 16S rDNA to characterize bacterial communities in flocculent matter from a production, a fallowed and a reference site, obtained in two different years and at a range of distances from salmon pens. We also report on the organic content and trace element composition of flocculent matter from the same samples. Bacterial communities were more diverse as distance from salmon net pens increased. An examination of bacterial community composition showed that samples grouped into three clusters with distinct bacterial communities; these groupings were explained by distance from salmon pens more so than by production status (i.e. samples from production and fallow sites could be highly similar). This work illustrates how bacterial marker-gene approaches can be used to monitor benthic effects of aquaculture. Further, our results highlight the potential for benthic bacterial communities associated with aquaculture activity to persist in the environment, even after fallowing.

LASKEY, EMMA; Stokesbury, Michael
Acadia University

Freshwater diet of alewife, *Alosa pseudoharengus*, during their spawning run

The alewife, *Alosa pseudoharengus* (Wilson, 1811), is an anadromous clupeid that plays an integral role in commercial and recreational fisheries along the Eastern seaboard of North America. Every spring, alewife enter freshwater systems where they spawn in lakes before returning to the sea. The feeding habits of alewife were examined during their spawning period in three river systems of the Isthmus of Chignecto, Canada. Stomach content analysis of 35 fish post spawning, captured as they returned to the sea, revealed that they were feeding in freshwater. The most important fresh water prey item of alewife was Calanoida, determined by both mean volume and occurrence. Other prey items of alewife included Cladocera and Malacostraca. Results of this study clearly show that alewife feed in fresh water before returning to the ocean, which has not been previously reported.

LEEuwIS, ROBIN; Nash, Gord; Sandrelli, Rebecca; Zanuzzo, Fabio; Gamperl, Kurt
Memorial University, Department of Ocean Sciences

Metabolic physiology and environmental tolerances of sablefish (*Anoplopoma fimbria*)

The sablefish is an emerging aquaculture species on Canada's west coast. However, very little is known about the metabolic physiology of this species, or its environmental tolerances. Such information is important for the industry as the life-history and habitat(s) of this fish differ greatly from that of salmonids, and coastal areas (including those in Canada) are likely to experience increasing water temperatures and/or hypoxic conditions due to accelerated climate change. We used intermittent-flow respirometry to characterize the metabolic response and tolerance of 10 °C-acclimated sablefish (~10 g juveniles and ~660 g adults) to acute incremental decreases in oxygen (10% air saturation/h) and increases in temperature (2 °C/h). Further, we performed identical measurements on adult Atlantic salmon (~1130 g). We used the salmon as a comparative species and given its importance to the Canadian aquaculture industry. Adult sablefish were very hypoxia tolerant [e.g., critical oxygen tension (P_{crit}) and O_2 level at loss of equilibrium (LOE) were ~15.5 and 5.4% air saturation, respectively] and could tolerate a maximum temperature (CT_{max}) of ~24.9 °C. Both these values were significantly lower as compared to adult salmon (O_2 at LOE ~24.2% air saturation; CT_{max} ~26.2 °C), and this is surprising given that adult sablefish and salmon had similar values for routine metabolic rate and aerobic scope. Juvenile sablefish were only slightly less hypoxia tolerant than their adult counterparts (e.g., P_{crit} ~18.9% air saturation), however, they had a much higher routine metabolic rate and their upper temperature tolerance was ~2.5 °C lower (~22.6 °C).

MACKIE, CONNOR; LaRoche, Julie
Dalhousie University

Exploring the presence of diazotrophs in the tissues of cultured oysters and the surrounding waters

Chemosynthetic, autotrophic bacteria are commonly seen to be living symbiotically in the tissue of many bivalve species. Much of the research up until now has focused on carbon transfer between the bacteria and their host, however in 2016 two studies discovered sulfur oxidizing symbionts that were also capable of transferring nitrogen. This kind of symbiont, one that is both chemosynthetic and nitrogen fixing, had never been seen before. The purpose of this study was to look for evidence of these kinds of symbionts in bivalves obtained from oyster farms on the east and west coasts of Canada. It was predicted that there would be a difference in composition and abundance of bacteria in the oyster tissues compared to the surrounding water, which could indicate the oysters retaining certain bacteria. DNA was extracted from water and bivalve tissue from farms in Nova Scotia and British Columbia. All samples were sequenced for 16S, and those that tested positive for *NifH* also had their *NifH* genes sequenced using Tag Illumina sequencing. Results from 16S sequencing show a noticeable difference in bacteria found in oyster tissue and water, which is mirrored in the most abundant *NifH* sequences. These results lend evidence to the oysters retaining certain bacteria within their tissue, although further study is needed to definitively prove the presence of a symbiont. If the symbionts are within the oyster, it could have implications for aquaculture in that oysters with these bacteria may be better suited for growth in high densities.

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Is there geographic variation in development rate of American lobster (*Homarus americanus*) embryos?

The American lobster fisheries in Canada are managed based on 45 distinct Lobster Fishing Areas (LFAs) with separate sets of rules and regulations. These LFAs are mainly divided based on sociopolitical considerations and do not represent biological stocks. To ensure sustainable management of these fisheries, we must gain a better understanding of the identity of biological stocks and the connectivity between them. One tool that is contributing to this goal is bio-physical models of larval dispersal, which attempt to predict larval dispersal and settlement based on physical and biological parameters such as hatch time, mortality, currents, winds, and temperature. The usefulness of these models depends on the accuracy of their parameters. One important biological parameter is the hatching time of lobster embryos, which has a large impact on the conditions larvae experience (e.g., temperature, currents), and hence how many will survive and where they will be transported. Development functions based on water temperature and changes in embryo eye size can be used to predict hatch time of lobster. This study aims to determine whether these development functions need to be location-specific. We sampled eggs from 12 females at each of six locations from N.B., P.E.I., and N.S., reared them at constant temperature of 9°C in the lab, and photographed them weekly to track embryo development on the basis of changes in eye size. The results from this study will suggest whether different development functions are required for lobster embryos from different locations in attempting to model the dispersal of larvae.

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Fish movement patterns and habitat suitability in Kejimikujik National Park and National Historic Site

Aquatic connectivity is vital to the health of fish populations. Brook Trout (*Salvelinus fontinalis*) have specific connectivity and habitat needs due to physiological limitations requiring cold-water temperatures and specific breeding site requirements. Parks Canada is currently considering a plan to construct a physical barrier to limit the inevitable spread of Smallmouth Bass (*Micropterus dolomieu*) and Chain Pickerel (*Esox niger*). These alien invasive species are not currently within the park however they are present in the greater Mersey-Tobeatic (M-T) watershed. When invasive populations invade and become established they have significant negative effects on abundance and diversity of native fish species. The Peskowsk sub-watershed of the M-T watershed is the ideal barrier site to prevent invasion. Therefore, to improve our understanding of fish movements through this site, 244 fishes were tagged in the Peskowsk sub-watershed with passive integrated transponder tags and movements were recorded using multi-antenna readers. 32 Brook Trout were detected with certain individuals spending multiple days near antennas. Temperature and dissolved oxygen profiles were recorded to assess presumed summer time cold-water refugia and allow comparison with historical data from 1971 and 2005. Movement patterns of Brook trout within the Peskowsk sub-watershed from historical tagging data (2002–2015) will be used to characterize changes in habitat use. Increased knowledge of current habitat suitability and movement patterns are critical to the decision-making process for potential barrier construction and provide preliminary information for subsequent aquatic monitoring activities.

NORTON, EMILY; Brown, Alyson; Whyte, Shona; Purcell, Sara; Fast, Mark; Hale, Lawrence
University of Prince Edward Island

Vaccine-induced protection against bacterial kidney disease in Arctic charr (*Salvelinus alpinus*)

The lack of effective treatments (i. e. vaccines and antibiotics) for Bacterial Kidney Disease (BKD) are a foremost concern for the aquaculture industry. The objectives of the study were to test the efficacy of vaccines on survival and immunological responses in Arctic charr (*Salvelinus alpinus*) exposed to *Renibacterium salmoninarum* (*Rsal*; ie. causative agent of BKD). There were four treatment groups: sham (PBS control), Renogen® Forte Micro®, and Renogen® + Forte Micro® (MicroRenogen®) and the fish were sampled at three time points. At 30 dpi there was approximately a two-fold higher survival in MicroRenogen® and Micro®-vaccinated fish compared to sham and Renogen® vaccinated fish, however by the end of the study (time 2; 43 dpi) survival in MicroRenogen® was reduced to 25.5% compared to the 20% survival of Micro® fish; the sham group had a survival of 19.2%. Gene expression analysis was completed using reverse-transcriptase quantitative polymerase chain reactions. Three genes involved in the immune response were unchanged between the treatment groups. Changes were observed in head kidney expression of *B-cell linker* over time. MicroRenogen® and Micro® groups showed significantly higher expression at 43 dpi compared to 19 dpi. In the control fish kidneys, higher expression was observed at 43 dpi compared to 19 dpi and pre-infection levels. There were no changes in gene expression in the Renogen® group over the study.

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Use of functional genomics to determine modulatory effects of diet on transcription of immune and metabolism relevant genes in Atlantic salmon (*Salmo salar*)

Aquaculture is a growing economic sector in Canada; however, disease outbreaks among farmed fish cause severe economic losses. The Integrated Pathogen Management of Co-infection (IPMC) project aims to develop health-promoting feeds to reduce mortality in farmed salmon due to co-infection. To do this, we are studying dietary modulation of salmon physiology (e.g. metabolism and immunity) using functional genomic techniques. In the first IPMC trial, Atlantic salmon were fed five experimental diets for twelve weeks to assess the impact of different oil mixes on expression of relevant metabolism- and immune-related genes. In this presentation, procedures for obtaining and assessing quality and integrity of Atlantic salmon head kidney RNA samples will be discussed. Additionally, the processes of cDNA synthesis and real-time quantitative polymerase chain reaction (RT-qPCR) analysis will be described. Furthermore, guidelines for ensuring reliability of qPCR analysis results will be illustrated. Use of RT-qPCR allowed relative quantification of the effects of diet on transcription of metabolism- and immune-related genes. Our preliminary results show diet significantly modulated transcription of genes involved in eicosanoid synthesis [cyclooxygenase-2 (*cox2*), prostaglandin-D synthase (*pgds*), and arachidonate 5-lipoxygenase b (*5loxb*)], chemotaxis [C-C motif chemokine 19b (*ccl19b*)], and lipid metabolism [delta 5 fatty acid desaturase (*fadsd5*), fatty acid elongase 5a (*elovl5a*), and sterol regulatory element binding proteins 1 and 2 (*srebp1*, *srebp2*)]. In conclusion, functional genomic techniques allow assessment of dietary impact on salmon physiology, which will help in development of health-promoting feeds for Atlantic salmon.

RAYNER, GEMMA; Bird, Tomas; McGaw, Iain
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Effects of the invasive green crab (*Carcinus maenas*) on the American lobster (*Homarus americanus*) fishery in Newfoundland

The American lobster (*Homarus americanus*) is the most commercially important decapod species in Newfoundland. Since the 1990s, fishery landings in Placentia Bay, Newfoundland have been steadily decreasing. The invasive green crab (*Carcinus maenas*) was first recorded in North Harbour (Placentia Bay) in 2007, and during this year lobster landings decreased by 34% compared to previous years. Analyses of the behavioural interactions between the two species around a baited trap were used to better understand the potential impacts green crabs will have on lobsters in the natural environment. Green crabs significantly affected lobster behaviour around a baited trap; when green crabs were present and could freely move around the trap, lobsters approached, attempted to enter and were caught less frequently compared to when no crabs were present. Analyses of predator-prey interactions between adult lobsters and green crabs were also used to determine if lobsters from Newfoundland would recognise green crabs as a potential prey item. It was found that lobsters originating from both Nova Scotia and Newfoundland do actively consume green crabs of all sizes and that the size of the green crab determined the likeliness of it being damaged and consumed by a lobster. The longer a green crab remained in the presence of a lobster the more likely it would be captured and eaten. This research will provide information on the potential impact of green crab on the lobster fishery in Newfoundland and Labrador and can be used by stakeholders in the management of this fishery.

SATURNO, JACQUELYN; Favaro, Brett; Liboiron, Max
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An experimental study of microplastic generation from fragmenting fishing gear

Fishing gear made from polymer materials have been observed to contribute to microplastic pollution in the marine environment of Newfoundland. This is of particular concern because microplastics - plastic particles smaller than 5 mm - can be readily ingested by many species of marine life, including fish. Previous plastic ingestion studies conducted in Newfoundland have identified green threads, which have been speculated to derive from plastic fishing gear. In communities with high fishing activity like Fogo Island, fishing gear has a direct influence on microplastic pollution, yet there are no studies on microplastics that focus on the wearing and fragmentation of fishing gear. In this presentation, we will describe a forthcoming experiment to evaluate how polyamides, polyethylene and polypropylene ropes are susceptible to fragmentation and contribute to microplastic pollution. In a controlled setting, each polymer rope will be worn down through abrasion and we will quantify the amount of microplastics that fragment off. This will simulate the wearing and weathering that fishing gear undergo out in the field. We hypothesize that if fishing gear undergoes abrasive force while in use, then the material that generates the most microplastics contributes to the most pollution. This study aims to establish an understanding of how abrasive wear on fishing gear being used in communities like Fogo Island may directly cause the generation of microplastic pollution. This study will also provide the first empirical examination of which fishing gear materials are likely to generate microplastics into the marine environment.

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Immune response of Atlantic cod (*Gadus morhua*) primary macrophages to *Aeromonas salmonicida* infection

The Atlantic cod (*Gadus morhua*) is one of the most important commercial fish species in the North Atlantic fisheries. Atlantic cod lacks the major histocompatibility complex class II (MHC-II), which it is essential to produce antibodies and prevent bacterial infections. The mechanisms by which *G. morhua* effectively fights bacterial infections and respond to vaccination are not understood. First described in the 19th century, *Aeromonas salmonicida* subsp. *salmonicida* is one of the oldest known fish pathogens, endemic worldwide in both fresh and marine water, and the etiological agent of furunculosis. *A. salmonicida* is a recurrent infection in cultured and wild fish, including Atlantic cod. Macrophages are one of the first responders to bacterial infection and the link between innate and adaptive immune response. Here, we evaluated the gene expression of cod primary macrophages to *A. salmonicida* infection. We found that Atlantic cod macrophages are very resistant to *A. salmonicida* infection. Macrophage cells contain intracellular *A. salmonicida* survive for long period of time in contrast to Atlantic salmon (*Salmon salar*) infected macrophages. Moreover, Atlantic cod macrophages showed a fast response to the bacterial infection, upregulating key genes involved in the inflammatory response and bacterial pathogen recognition. These results represent an important opportunity to understand the mechanisms used by Atlantic cod to fight against bacterial infections.

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Contribution of variability in embryo development rate and status at hatch to the protracted hatch period of individual female American lobsters *Homarus americanus*

Many marine organisms attempt to avoid larval starvation by syncing hatch time with the variable onset of phytoplankton and/or zooplankton blooms, a strategy referred to as the “Match/Mismatch Hypothesis”. Female American lobsters have a protracted hatch period of upwards of 5 weeks, which may be a strategy to increase the likelihood of some of a female’s offspring being in the water column at the same time as their prey. It has been hypothesized that this protracted hatch period results from female control of hatch via rapid movement of her swimmerets. However, no study has quantified the development and hatch of embryos separated from a female’s clutch, and hence the contribution of the female to the protracted hatch period is unproven. In this study, 374 lobster embryos collected in June 2017 from 12 females in each of six locations in Atlantic Canada (NB, PEI, NS) were reared in the lab at constant temperature (9°C), and photographed on a weekly basis to monitor their development and hatch. Eye measurements were used as a proxy for embryo development. The hatch period of these individual-raised embryos was compared to literature estimates for embryos attached to a female, and various multiple regression modelling approaches were used to assess the contribution of i- embryo development rate in fall-winter-early spring prior to sampling, ii- embryo development rate in spring-early summer prior to hatch, and iii- embryo “development status” at hatch to the observed variation in hatch time.