DALHOUSIE
UNIVERSITY

39th
Annual

Cameron Conference

FOR BIOLOGY & MARINE BIOLOGY
HONOURS STUDENT RESEARCH

Saturday
1 February 2025
9:30 am - 12:00 pm

Sponsored by the Department of Biology

&

Dalhousie Association of
Biology Students

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DAMS

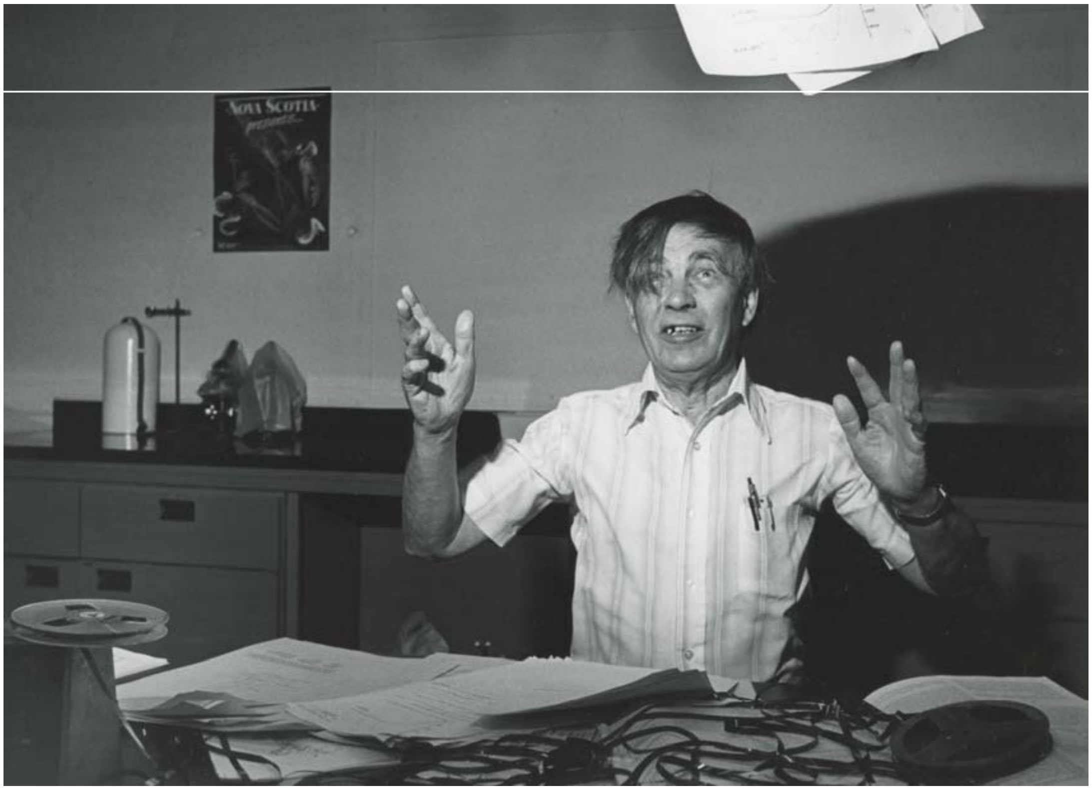
On the Origin of the Cameron Conference

The CAMERON CONFERENCE is named after the late Malcolm Laurence Cameron (1918–2011), always known as Laurence. A native of Cape Breton, Laurence taught at a number of rural schools in Cape Breton before serving with the Canadian Dental Corps during the Second World War II. Dalhousie University followed, where Laurence was awarded the Governor General's medal for his BSc (1949). He then completed his MSc in 1951 before going to England where he completed a Ph.D. (1953) at Cambridge University under the supervision of the world's foremost insect physiologist, Sir Vincent B. Wigglesworth. Two years as a postdoctoral fellow at the University of New Brunswick and ten years on the faculty of the University of Saskatchewan preceded Laurence's position in Dalhousie's Biology Department in the mid 1960s.

Following interests and knowledge fostered at Cambridge, Laurence's scholarly interests turned to the history of medicine in Medieval England, a field requiring a mastery Latin and Old English that few trained scientists possess. In the 1983 Annual Report of the Department, Laurence lists his activity as *"special attention to the uses made of Roman and Byzantine treatises in the compilation of the English medical texts in Anglo-Saxon times"*. He is best known for his book ANGLO-SAXON MEDICINE (1993) published, appropriately, by Cambridge University Press. His studies also included *"an examination of the pharmacopoeia of these English texts, with a view to determining the use of non-native ingredients and a consequent determination of trade patterns in the medieval world"*. These may sound esoteric, but Laurence was in fact the "go-to man" for plant identification whenever a child was admitted to a Halifax hospital having tasted or swallowed a plant thought poisonous. More than one Biology faculty member owes their child's speedy recovery to Laurence's expertise. In 1998, Laurence co-edited THE OLD ENGLISH ILLUSTRATED PHARMACOPOEIA, again by Cambridge University Press.

Laurence Cameron devoted all his knowledge, enormous energy, and encyclopaedic knowledge to the teaching of Biology 1000 and to the fourth-year Honours class, roles he continued after formal retirement. The annual event we know as the CAMERON CONFERENCE was started by Laurence as a way for Honours students to showcase their research. It was then, and remains today, the biggest and best Honours conference at Dalhousie.

Thanks to Professor Brian Hall for this synopsis



Professor Laurence Cameron at the helm of BIOL 1000 (ca. 1985)

Third Floor Atrium - Life Sciences Centre

9:00 am

Warm drinks and snacks available

9:30 am

Conference Welcome

Professor Mark Johnston
Chair of Biology Department

9:30-10:50 ~ Poster Session

1	Aaraya Aad	Seasonal Changes of Biogenic Silica levels in the Bedford Basin
2	Hannah Budau	Pre-mRNA processing factor 4 kinase (PRP4K) as a potential regulator of nucleophagy in human MCF7 and HeLa cells
3	Violet Chilvers	Comparing the performance of diploid and triploid blue mussel (*Mytilus edulis*) larvae reared at constant and fluctuating temperatures
4	Steph Duffy	Bulk nitrogen fixation rates and optimal temperature range of the globally important diazotroph *Candidatus* Thalassolituus haligoni
5	Faust Faustova	Nrxn-1 +/- mice and Delta-S5 - exploring seizure-like activity in four mouse genotypes; effect of genotype, age, and sex

6	Clare Frymire	**Epigenetic clock: Creating a molecular aging method for brook trout (*Salvelinus fontinalis*) with methylation data**
7	Claire Girard	**Patterns of offspring care in northern bottlenose whales (*Hyperoodon ampullatus*)**
8	Jett Gleason	**Epifaunal diversity and assemblage patterns according to spatial and temporal differences of Halifax's Bedford Basin**
9	Claire Hamer	**Relating acceleration data of Atlantic cod (*Gadus morhua*) and European lobster (*Homarus gammarus*) to their behaviour**
10	Alex Hancock	**Age distribution of *Lophelia pertusa* colonial scleractinian cold-water coral fragments from the NE Scotian margin**
11	Siobhan Herold	**Aerial insect populations in the Halifax Backlands and their availability to the Common Nighthawk (*Chordeiles minor*).**
12	Euichan (Mark) Jung	**Nanobubble technology: a method to increase the growth rate of Atlantic salmon (*Salmo salar*) and reduce biofouling in recirculating aquaculture system (RAS)**
13	Madeleine Kurtz	**Spatial ecology of the Common Nighthawk (C*hordeiles minor*) in the Halifax Backlands**
14	Marin Marsala	**Quantifying species richness and variability among Nova Scotia eelgrass meadows using baited remote underwater video (BRUV)**
15	Rori Mulholland	**Reconstructing seasonal changes in surface particulate organic matter using carbon isotopes of amino acids**

16	Lillian Musselman	**The use of UV-LED in drinking water treatment as a response to climate-driven increases in natural organic matter**
17	Daniel Ng	**High-resolution mapping of Pacific white skate (*Bathyraja spinosissima*) nursery habitats at a Galápagos hydrothermal vent field**
18	Oscar Notman-Grobler	**Biogeography of Atlantic salmon (*Salmo salar*) in the Cape Breton Highlands**
19	Meghan Oliver	**Identification of Galápagos sperm whale (*Physeter macrocephalus*) vocal clans in 2022-2023 using a novel automated coda detection software**
20	Austyn Renaud	**Observing combined effects of ocean acidification and marine heatwaves on larval development of *Placopecten magellanicus***
21	Dave Ross	**Effects of substrate grain size composition on the ex-situ growth of eelgrass (*Zostera marina)***
22	Melika Sadeghi	**Design, construction, and function of a genetic circuit that regulates gene transcription in response to a pair of mutually exclusive induction events**
23	Freya Snow	**Time-tension line cutters: a possible tool to reduce whale entanglements in deepwater fisheries**
24	Jenna Wright	**Migratory behaviours and route choices of Atlantic salmon migrating through the Norwegian Sandsfjord toward the Suldalslågen river system**

Life Sciences Centre Room 242

11:00 - 12:00 Oral Presentations

Session Chair - Dr. Patrice Côté

1	Clara Hamm	Regeneration of *Aponogeton madagascariensis* through callus tissue.
2	Danielle Baribeau	Using life history traits to model the impacts of landing restrictions on North Atlantic sharks
3	Chris Latimer	Enhancing phytoplankton production of the essential omega-3 fatty acid eicosapentaenoic acid (EPA) by tryptophan fertilization
4	Dani Guerin	Spatiotemporal patterns in the production of audible and tonal calls by blue whales (*Balaenoptera musculus*) of the Scotian Shelf
5	KC Collings	Seasonal regulation of neurogenesis in vocal control and auditory perceptual regions of wild Black-capped chickadees *(Poecile atricapillus)*
6	Katie Smith	Using environmental DNA (eDNA) concentration to quantify abundance of American eels (*Anguilla rostrata*)
7	Paige Burns	*Arabidopsis Thaliana* as a model fungal-pathosystem for *Elsinoë brasiliensis* induced superelongation disease in *Manihot esculenta*
8	Aaron Ulrick	Caught on camera: exploring fish and invertebrate populations in Nova Scotian kelp beds using baited remote underwater video systems (BRUVS)

Abstracts

LISTED ALPHABETICALLY

BY

AUTHOR'S LAST NAME

Seasonal Changes of Biogenic Silica Concentration in the Bedford Basin

Author: Aaraya Aad
Programme: Concentrated Honours in Marine Biology
Supervisor(s): Dr. Joerg Behnke, National Research Council

Abstract

Biogenic silica (bSi) plays a key role in aquatic microbial life as well as overall biogeochemical cycling. The movement of bSi concentration has been well studied in many open ocean systems and has been used to help characterize microbial life and macromolecule/nutrient cycling. That said, bSi concentrations in estuary systems, relative to open ocean systems, have a lack of available data. To help characterize the changes in bSi concentration within estuary systems, we conducted macromolecule and nutrient assays from Bedford Basin samples collected over the course of a year at 5 meters depth. bSi to particulate nitrogen ratios show two peaks during the fall and spring algal blooms. Disregarding algal bloom peaks, bSi concentration holds a negative slope with respect to time, contrasting the other macromolecules/nutrients. Notably, samples filtered with a 3µm mesh size had a distinct peak during the spring bloom in March, far exceeding its 0.4µm counterpart. The bSi peaks with the 3µm mesh size indicate a considerable portion of bSi during spring blooms is generated by a relatively larger size fraction of microbes. This peak is specific to spring blooms and therefore indicates the species that bloom differs seasonally. Although further observations are required, the results also suggest that algal blooms are the driving force behind bSi generation in the basin, and without them bSi could be purged out of the system.

Using life history traits to model the impacts of landing restrictions on north Atlantic sharks

Author: Danielle Baribeau
Programme: Combined Honours in Biology (Co-op) and Sustainability
Supervisor(s): Dr. Heather Bowlby, Bedford Institute of Oceanography

Abstract

In the North Atlantic, longline fishing industries have contributed to substantive declines in local shark populations, threatening the health of North Atlantic ecosystems. As such, developing strategies to protect North Atlantic shark populations has become increasingly important in the fisheries management sector. One popular shark conservation strategy is the use of size-based landing restrictions, which concentrate fishing on the life stage most resilient to fishing pressures. However, life history traits differ across shark species, affecting both population growth rates and which life stage contributes the most to overall population growth. It is also speculated that for some shark species, reproductive output of adult individuals increases with age, resulting in disproportionate contributions to population growth by “Big Old Fat Fecund Females” (BOFFFs). Both these species-specific differences in life history can influence whether a given size restriction will be effective at conserving different shark species. Using life history data, I modeled the effectiveness and sustainability of different size restrictions for 10 shark species known to inhabit the North Atlantic. I also incorporated a simulated increase in reproductive output with age into my model to investigate how the presence of BOFFFs could affect which size restriction was optimal for a given species. A minimum size restriction, which corresponds to fishing only on adult individuals in a population, was generally the most effective and sustainable way to manage population cross most shark species. This remained true for all but the most fecund species after the application of the BOFFF argument, indicating that the effectiveness of a given size restriction is highly dependent on both the reproductive output of a species, and to what degree this increases as individuals age. However, even under an optimal size restriction, some species still experienced overall population declines when fished, indicating that these species should not be targeted by any form of fishery. Based on these results, this research can provide decision-makers with guidance on the applicability of different size restrictions for species-specific conservation targets, and offers preliminary insights into the power of a minimum size restriction for limiting fishing pressures on North Atlantic sharks.

Pre-mRNA processing factor 4 kinase (PRP4K) as a potential regulator of nucleophagy in human MCF7 and HeLa cells

Author: Hannah Budau
Programme: Concentrated Honours in Biology
Supervisor(s): Dr. Graham Dellaire, Department of Pathology, Dalhousie University

Abstract

Cancer remains one of the leading causes of death worldwide, and improving our understanding of how cancer cells function is essential to designing novel treatments. The invasiveness of cancer is characterized by irregularities in cell processes such as cell division, cell death, and autophagy. Autophagy occurs when cytoplasmic materials are engulfed by a double membraned vesicle known as an autophagosome and shuttled to lysosomes for degradation and recycling. This process is central to both tumour suppression and cancer cell survival. Different subtypes of autophagy may target specific forms of cytoplasmic cargo, but a commonality of all subtypes is the fusion of the autophagosome carrying the cargo to the lysosome, which requires assembly of the ESCRTIII complex and its constituent proteins like the charged multivesicular body CHMP4B. Recent studies have shown that the tumour suppressor and splicing kinase, Pre-mRNA Processing Factor 4 Kinase (PRP4K), is a regulator of macroautophagy through its role in regulating the splicing of CHMP4B, without which autophagosome-lysosome fusion does not occur. What remains unclear is whether PRP4K also regulates other subtypes of autophagy, namely, nucleophagy. Nucleophagy involves the selective degradation of nuclear materials such as micronuclei, which can occur with chromosomal missegregation during cell division that is common in cancer cells. This project sought to investigate whether PRP4K plays a regulatory role in nucleophagy through CHMP4B, by inducing micronuclei formation in MCF7 and HeLa cancer cells with reversine and knocking down the PRP4K gene using siRNA. The effects of PRP4K knockdown on micronuclei clearance from the cytoplasm were observed with fluorescence microscopy, using fluorescent stains to distinguish micronuclei, the autophagosome marker LC3 and nuclear marker Lamin-B. Early results have shown that reversine effectively induces micronuclei formation, where MCF7 and HeLa cells exhibited increased micronuclei formation as the reversine dose increased up to a maximum of 0.75 µM. Further tests involving PRP4K knock down will be done to observe its effect on nucleophagy, using Western blot analysis to see whether these phenotypic changes coincide with decreased CHMP4B levels. This will provide insight into PRP4K's role in autophagic processes like nucleophagy, which may better our understanding of how PRP4K depletion affects autophagy within the cell and results in worsened cancer phenotypes.

Arabidopsis Thaliana as a model fungal-pathosystem for *Elsinoë brasiliensis* induced superelongation disease in *Manihot esculenta*

Author: Paige Burns
Programme: Concentrated Honours in Biology
Supervisor(s): Dr. Sophia Stone, Department of Biology, Dalhousie University

Abstract

Elsinoë brasilensis is a fungal pathogen currently affecting Cassava crops across the Caribbean and Latin America. It causes Superelongation disease (SED) in cassava characterized by necrotic lesions, scabs, and rapid stem growth, leading to substantial decrease in yield. *E. brasilensis* produces the growth hormone gibberellic acid (GA) suggested to be responsible for the rapid elongation symptoms. The pathogen also produces elsinochrome pigments that are photosensitized perylenequinone phytotoxins. Similar phytotoxins from other fungal pathogens are known to be virulence factors. The overall purpose of this study is to determine if *Arabidopsis thaliana* could be used as a model pathosystem to research plant responses to the pathogen. Utilizing an *Arabidopsis* pathosystem will allow us to determine if 1) the elsinochrome toxin produced by *E. brasilensis* acts as the virulence factor and 2) if elsinochrome toxin affects GA synthesis and/or signalling. Three-week-old *Arabidopsis* leaves were infiltrated with elsinochrome toxin and monitored for incidence of cell death. Cell death was observed at the leaf infiltration site around two days post-infiltration. Additionally, ten-day-old *Arabidopsis* seedlings were treated with toxin in liquid media. Samples were collected at 0, 3, 6 and 24 hours post-treatment for gene expression analysis via reverse transcription-polymerase chain reaction (RT-PCR). Expression of select pattern-triggered and effector-triggered immunity (PTI and ETI) genes were examined at the four timepoints. A decrease in expression of some PTI genes and an increase in ETI gene expression were observed. The results indicate that an immune response consistent with exposure to an effector (virulence factor) occurred when *Arabidopsis* was exposed to elsinochrome toxin. Regulation of several GA synthesis and signalling related genes were also examined. GA signalling repressor genes increased in expression and the GA biosynthesis gene *GIBBERELLIN-3-OXIDASE 2* (*GA3OX2*) decreased in expression. This suggests that GA production and signaling suppression is a part of *Arabidopsis* response to elsinochrome toxin. Next steps include RNA sequencing analysis to observe changes in immune response global gene expression. Knowledge gained from this study will assist efforts to develop protection strategies to reduce cassava crop losses, including improving methods for early detection of the fungi and developing approaches to block the activity of the virulence factor.

Comparing the performance of diploid and triploid blue mussel (*Mytilus edulis*) larvae reared at constant and fluctuating temperatures

Author: Violet Chilvers
Programme: Concentrated Honours in Marine Biology
Supervisor(s): Dr. Ramón Filgueira, Marine Affairs Department, Dalhousie University
Dr. Eric Ignatz, Department of Biology, Dalhousie University

Abstract

Farming triploid bivalves has gained favour due to their enhanced growth rate and effective sterility; however, triploids are suspected of exhibiting a lower upper thermal tolerance limit. The lower thermal tolerance of triploid mussels could lead to mortalities, an issue for the industry that will be exacerbated by climate change. Despite production advantages, commercial triploid blue mussel production has yet to be established in North America. Environmental conditions influence the performance of ectotherms, potentially resulting in natural intraspecific variation across geographic regions through local adaptation or developmental phenotypic plasticity. Notably, mussels in Sober Island Pond, Nova Scotia (NS) experience elevated marine temperatures in summer, exhibiting a higher thermal tolerance compared to those in Georgetown, Prince Edward Island (PEI), where temperatures are lower. Additionally, thermal stress exposure during early ontogeny can enhance thermal tolerance at later life stages through carry-over effects. This study aimed to assess the performance of blue mussel larvae using a fully factorial design incorporating three factors: 1) ploidy (diploid vs. triploid) 2) source (NS vs.PEI); and 3) temperature regime (constant vs. fluctuating). The experiment was performed using a hatchery standard constant temperature of 18ºC and a fluctuating temperature of 16-20ºC. After fertilization, mussel eggs were either pressure shocked to induce triploidy or placed directly into constant or fluctuating rearing systems. Flow cytometry was used to confirm triploidization, while survival and growth were measured approximately every other day until settlement (22 days post-fertilization). The findings suggest no significant differences by ploidy or source in fluctuating treatments; however, PEI mussels performed better under constant temperature conditions. Moreover, this study is an initial step in informing hatchery techniques to improve mussel performance under variable thermal conditions. Future studies should investigate the long-term survival and performance of the triploid treatments and explore whether exposure to fluctuating temperatures could result in carryover plasticity at later life stages.

Seasonal regulation of neurogenesis in vocal control and auditory perceptual regions of wild Black-capped chickadees (*Poecile atricapillus*)

Author: KC Collings
Programme: Combined Honours in Biology & Psychology
Supervisor(s): Dr. Leslie Phillmore, Department of Psychology and Neuroscience, Dalhousie University
Broderick Parks (PhD Candidate), Department of Psychology and Neuroscience, Dalhousie University

Abstract

Songbird vocal behaviour changes across seasons – and these behavioural changes are often mirrored by changes (or plasticity) in the neural structures that support vocal behaviour. One measure of neural plasticity is neurogenesis – the birth, differentiation, migration and incorporation of neurons into neural structures and circuits. In this study, I evaluate seasonal differences in neurogenesis within four brain regions: two vocal control nuclei involved in the production and learning of vocalizations (HVC [proper name] and Area X), and two perceptual regions involved in the processing of auditory information (caudomedial nidopallium [NCM] and caudomedial mesopallium [CMM]). We captured wild male and female Black-capped chickadees *(Poecile atricapillus)* across three seasons: spring, summer, and winter. To assess neurogenesis, we labelled brain tissue for doublecortin (DCX), a microtubule-associated protein expressed in newborn neurons. I quantified both percent coverage of DCX+ staining and counted DCX+ cells by morphology (multipolar, fusiform, and round). Preliminary results for coverage show neurogenesis is seasonally stable in females but in males neurogenesis was higher in winter in HVC, and higher in spring in Area X. DCX+ percent coverage is positively correlated with multipolar and fusiform cell counts, thus I expect that in HVC and Area X, females will have seasonally stable numbers of multipolar and fusiform cells, and these cells will vary seasonally in males. Less is known about seasonal neurogenesis in NCM and CMM, but immediate early gene activity is higher in birds in non-breeding than breeding condition. As neuronal activation is correlated with neurogenesis, I expect overall cell counts to be highest in NCM and CMM during winter when birds are not yet in breeding condition. This study will reveal whether seasonal patterns of neurogenesis vary between regions with different functions (i.e., vocal control vs. auditory perception) and whether this pattern differs between male and female Black-capped chickadees. I will also consider how these differences can be understood in the context of changes in songbird vocal behaviour over the annual cycle.

Bulk nitrogen fixation rates and optimal temperature range of the globally important diazotroph *Candidatus* Thalassolituus haligoni

Author: Stephanie Duffy
Programme: Combined Honours in Marine Biology & Ocean Sciences
Supervisor(s): Dr. Julie LaRoche, Department of Biology, Dalhousie University

Abstract

The marine nitrogen cycle governs the flow of nitrogen throughout the ocean, providing the essential nutrients needed to sustain the growth of living organisms. The most abundant form of nitrogen found within the ocean is dissolved atmospheric dinitrogen, N2, however this form is unavailable for most organisms. Diazotrophs are a select group of microorganisms that have the ability to convert atmospheric N2 gas into ammonia (NH3), through a process known as biological nitrogen fixation. By using the oxygen sensitive catalyst enzyme, nitrogenase, nitrogen becomes bioavailable for microorganisms to use and incorporate into growth. Diazotrophs can be further separated into two categories: cyanobacterial (CD) and non-cyanobacterial (NCD). NCDs and CDs have a wide diversity, characterized through the *nifH* gene which acts as a phylogenetic marker and proxy for diazotroph detection. The importance of NCDs in global N2 fixation remains to be determined due to few isolated cultures and in-situ demonstrations. *Candidatus* Thalassolituus haligoni is a widely distributed NCD and is representative to a major clade of uncultured NCDs within Oceanospirillales. By using this model organism, a glimpse can be provided into closely related species and potential roles they may have in marine nitrogen fixation. The main objectives of this study were to investigate bulk N2 fixation rates (NFR) in *Cand*. T haligoni when grown under various nitrogen (NO3, NH3 and N2) and oxygen (anoxic and oxic) conditions and to investigate the temperature range and *nifH* transcript abundance of *Cand*. T. haligoni when under the presence of fixed nitrogen (NO3 and NH3) conditions. Our study determined a significant difference between bulk NFR measurements, with N2 conditions being 3 orders of magnitude higher than oxic fixed N conditions. Temperature range (4 °C – 40 °C) results exhibited an optimal temperature (T opt) between 27 °C – 30 °C for NO3 and 30 °C – 35 °C for NH3. The maximum temperature (T max) for fixed N was 35 °C. Collectively our study offers the potential to be at the forefront of marine nitrogen research, providing further insights into this elusive group of NCDs.

Nrxn-1 +/- mice and Delta-S5 - exploring seizure-like activity in four mouse genotypes; effect of genotype, age, and sex.

Author:	Ana Faustova
Programme:	Concentrated Honours in Biology
Supervisor(s):	Richard Brown, Department of Psychology and Neuroscience, Dalhousie University Ian Weaver, Department of Psychology and Neuroscience, Dalhousie University

Abstract

Introduction: Epilepsy is a neurological disorder affecting 1% of the human population, characterized by an onset of seizures. Seizures are spastic limb movements or dissociation caused by a disbalance of neurons involuntarily activating in the brain. Epilepsy is of often comorbid with age-related disorders, like Alzheimer's Disease and neurodevelopmental disorders like Autism Spectrum Disorder (ASD). All of these disorders have many contributing genetic factors, including mutations in the Neurexin-1 gene. The Neurexin (NRXN) family of membrane protein synaptic organizers are thought to have specific functions at the synapse by binding to postsynaptic neuroligins encoded by the gene Nrxn-1. Another protein involved in inhibitory synapse functioning is the post-synaptic membrane protein, MDGA-2. In humans, mutations in the genes encoding these proteins are associated with epilepsy, neurodevelopmental and neurodegenerative disorders.

Model: Our animal research models on the Nrxn1 gene demonstrate neurodevelopmental issues as seen in humans and could be used to show the development of seizures and epilepsy due to age. Specifically, the Nrxn-1 "rescue" model with a DS5 site alteration was made, and shows an upregulation of Nrxn-1, counteracting the Nrxn-1 knockdown phenotype.

Methods: The seizures in our animal models; transgenic Nrxn1(+/-), wildtype Nrxn1(+/+), recovery transgenic Nrxn1(DS5/-) and double recovery Transgenic Nrxn1(DS5/DS5) were recorded and scored using an updated Racine scale.

Results: Our results showed that males and females developed seizures in equal proportions, with onset slightly earlier in males than females. Mice carrying the DS5 recovery gene were more likely to exhibit seizures. No heritability pattern was uncovered after a family analysis.

Further Exploration: Electroencephalogram (EEG) tests will be conducted to determine if and what types of seizures the mice exhibit. A genetics approach will be taken to examine the methylation profile of the Nrxn-1 promoters and expression of MDGA-2 in the brain, as a postsynaptic molecule interacting with Nrxn-1. Our research shows the effect of age on the development and occurrence of epilepsy and helps further understand the underlying causes of it in humans.

Epigenetic Clock: Creating a Molecular Aging Method for Brook Trout (*Salvelinus fontinalis*) with Methylation Data

Author: Clare Frymire
Programme: Concentrated Honours in Marine Biology
Supervisor(s): Daniel Ruzzante, Department of Biology, Dalhousie University
Ellen Weise, Department of Biology, Dalhousie University

Abstract

Knowledge of age is fundamental in population biology because it is required for understanding the characteristics, structuring, and future health of populations. Fish age is a crucial part of fishery management as knowledge of the age of individuals are an integral part of fish stock assessments and aid in the estimate of several life history traits, including growth, mortality, and fecundity of fishes. Despite the important role of aging in conservation, aging methods are time consuming, expensive, fatal for the fish, and prone to error. The current primary aging method for fish involves individually counting rings of accumulated growth on calcareous structures called otoliths, located in the fish's skull. It is crucial to develop alternative aging methods for effective fishery management and the conservation of biodiversity.

The goal of this project is to develop an epigenetic clock to age brook trout (*Salvelinus fontinalis)*, through identifying age associated methylated sites with machine learning. Epigenetic clocks are an alternative aging method that is non-fatal, faster, cheaper, and potentially more precise than aging fish with otoliths. Methylation is a type of epigenetic marking that occurs when a methyl group is added to a DNA base. The brook trout clock is scientifically significant because it is the first salmonid epigenetic clock; a family of fish that has large cultural, economic, and biological significance. Additionally, the epigenetic clock is the first to utilize wild caught, short-lived fish. The epigenetic clock was developed from 27 brook trout whole genome sequences, which were sampled by backpack electrofishing from three streams in the North Mountain region of Nova Scotia. The brook trout in the study site live up to three years, and were aged from scales and otoliths.

The epigenetic clock combines pre-feature-selection of CpG sites with elastic net regression. The clock was able to identify the age of brook trout with an absolute mean error of 0.7 years. The epigenetic clock will help aid in the conservation and fishery management of brook trout, which is especially important as climate change and anthropogenic disturbances threaten fish biodiversity.

Patterns of offspring care in northern bottlenose whales

Author: Claire Girard
Programme: Concentrated Honours in Marine Biology
Supervisor(s): Dr. Hal Whitehead, Department of Biology, Dalhousie University
Sam Walmsley, Department of Biology, Dalhousie University

Abstract

Early life is a critical period for offspring, and care-giver investment varies based on numerous ecological and evolutionary strategies. When non-parents contribute to offspring care, these are considered alloparents. Alloparental care offers a unique lens through which we may understand the evolution of cooperation in social species. This type of effort may be particularly important in environments that offer little shelter, such as marine environments. For deep diving whales, cooperation may be essential to ensuring the safety of young while guardians dive to feed. Northern bottlenose whales (NBW) are a highly social species that form fluid social structures, typically in ephemeral groups of 2-6 individuals. However, it is not yet understood with whom calves and juvenile animals associate. The purpose of this study is to understand care behaviour and its distribution across a population of NBW. The Whitehead lab has compiled photographic and aerial video data of the population of endangered northern bottlenose whales residing in the Gully submarine canyon, a marine protected area located on the Scotian Shelf. This long-term dataset will be used to determine whether sex or age class influence the probability of associating with or providing care to calves and juveniles. In addition, the data will be used to characterize how widespread networks of potential caregivers are for NBW. These findings will shed new light on the functions of social relationships and patterns of cooperation in whale populations.

Epifaunal diversity and assemblage patterns determined by spatial and temporal differences of Halifax's Bedford Basin

Author: Jett Gleason
Programme: Concentrated Honours in Marine Biology
Supervisor(s): Dr. Derek Tittensor, Biology Department, Dalhousie University
Dr. Craig Brown, Oceanography Department, Dalhousie University

Abstract

The Bedford Basin is a highly trafficked harbour surrounding the high-density city of Halifax, NS. Harbour use includes transport, trade, fishing, waste management, and scientific research. The Basin is exposed to freshwater inflow and open ocean interaction, creating a variation of salinity, temperature, and nutrient dynamics. Detailed bathymetry maps describe a range of depth and bottom-type due to natural and anthropogenic processes. This thesis investigates the patterns of species assemblage and diversity within these spatial differences, specifically sediment type. The study area encompasses a 2-kilometer squared section of the Bedford Basin seabed, ranging in depths of 15 to 70 meters. Utilizing high-resolution multibeam echo sounder backscatter data, the seabed was categorized into four distinct sediment types: shallow mud, deep mud, cobble and boulder with mud, and gravel and cobble and boulder. Video footage of the seabed was collected in each substrate using a 4k underwater camera towed across 50 meter transects. Four replicates were made of each substrate, for a total of 16 transects. Still images were taken every 2m for a total of 25 images per transect. Images were then analyzed using BIIGLE to identify species to the lowest taxonomic level. Across each transect, species abundance and diversity were assessed and ANOVA was performed to determine differences among sediment type, followed by a turkey test. Differences in community composition were assessed with PERMANOVA. Patterns amongst community and benthoscape were measured with a Bray-Curtis similarity. Results showed higher levels of diversity and community composition of epifauna in gravel and cobble and boulder substrate. This thesis describes benthic species distribution and assemblage patterns within the Bedford Basin and contributes to the understanding of how oceanographic factors and sediment composition determine benthic community structure.

Spatiotemporal patterns in the production of audible and tonal calls by blue whales (*Balaenoptera musculus*) of the Scotian Shelf

Author: Danielle Guérin
Programme: Concentrated Honours in Marine Biology; Minor in Ocean Sciences
Supervisor(s): Dr. Amanda Babin, Bedford Institute of Oceanography
Dr. Hilary Moors-Murphy, Bedford Institute of Oceanography

Abstract

The blue whale (*Balaenoptera musculus*) is an endangered species found in all oceans. They have distinct vocalizations characterized as either “audible” or “tonal” calls. Audible calls are produced by both sexes that are assumed to be used for feeding and social purposes, whereas tonal calls are only produced by males as a reproductive display. Acoustic analysis of these calls was undertaken in various areas off the coast of Nova Scotia including the Emerald Basin (on-shelf area), sites in and near the Gully Marine Protected Area (slope area), and the Western Scotian Shelf (slope area). The main goal of this study was to determine the relative contribution of audible calls to our current understanding of blue whale occurrence based on tonal calls, as well as to examine spatial (on-shelf vs. slope) and temporal (seasonal and diel) patterns in relative audible and tonal call occurrence. Passive acoustic monitoring was used to conduct this study, whereby moorings mounted with autonomous recorders were deployed at various sites in the areas listed above for six months to over a year. Data were recorded there during select years (2015 and 2018 for Emerald Basin, 2012-2014 for Gully-associated sites, and 2019 for Western Scotian Shelf; representative datasets will be presented). Acoustic data were then processed using a detector classifier system to identify potential blue whale vocalizations. An acoustic analyst validated these detections using spectrogram analysis. To date, in the representative Gully-associated site (slope) audible call occurrence was elevated in the fall, but highest in the summer (72% of days overall, with 39% co-occurring with tonal calls and 32% in the absence of tonal calls). In the Emerald Basin (on-shelf), audible calls had the highest occurrence in the fall (65% of days overall, with 64% co-occurring with tonal calls and 1% occurring in the absence of tonal calls), whereas the occurrence of audible calls in the absence of tonal calls was highest in the winter (8% of days). In the slope area, the high occurrence of audible calls in the absence of tonal calls indicates that blue whales are, as predicted, likely feeding in that area during the summer. In contrast, in the on-shelf area, the higher occurrence of audible calls in the winter indicates that blue whales may be feeding during an unexpected time of year or may be using audible calls for an alternative purpose, such as socializing.

Relating acceleration data of Atlantic cod (*Gadus morhua*) and European lobster (*Homarus gammarus*) to their behaviour

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Supervisor(s): Dr. Robert Lennox, Department of Biology, Dalhousie University

Abstract

Movement ecology is an important field that focuses on how an organism interacts and moves throughout its environment. In movement ecology, different organisms can be tagged with tools such as accelerometers in order to infer their movement. Accelerometers are a common tool used to track variables such as acceleration across defined time intervals. Sensor data gathered from accelerometers can represent specific behaviours but requires calibration between the device and observations of the animals to understand values derived from animals in the wild. To provide a calibration between sensor-derived acceleration and behaviour, acceleration data from transmitters and footage of Atlantic cod (*Gadus morhua*) and the European lobster (*Homarus gammarus*) were gathered from animals tagged in an aquarium in Norway. The accelerometers measured the average acceleration at 12.5 Hz across 27s intervals, which detected acceleration up to 3.645m/s². Three behaviours were identified on film; the three behaviours identified for the Atlantic cod consisted of resting, swimming, and burst swimming, which were mainly categorized based on caudal fin movement. Minimal use of the caudal fin was associated with resting behaviour, swimming with intermittent use of the caudal fin, and bursting with high frequent use of the caudal fin across the 27s interval. Random forest was used as a classification method to estimate the animals' behaviour from their acceleration. This study aims to be able to apply the results of this study on the acceleration data of wild-tagged Atlantic cod and European lobster to predict their behaviour without visual aid.

Regeneration of *Aponogeton madagascariensis* through callus tissue

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Abstract

The lace plant, *Aponogeton madagascariensis* is an aquatic monocot native to Madagascar. The leaves have unique perforations formed through programmed cell death (PCD). The predictability of the formation of these perforations, the thin leaves ideal for live cell imaging, and the established sterile culture system for plant propagation make the lace plant an excellent model for studying PCD.

The lace plant is currently propagated in a sterile culture system through subdividing corms. Since flowering and seed production are challenging to induce in lab conditions, an additional method for the propagation of the lace plant would be beneficial to maintain a source of plant material. Whole plant regeneration through callus tissue is a possible alternative method to propagate lace plants.

Callus tissue is an undifferentiated mass of cells possessing totipotency. Callus can be induced from any section of plant material using a combination of plant growth regulators (PGRs), such as auxin and cytokinin, and subsequently be used to regenerate the entire plant. Regeneration through callus tissue is a commonly used technique in plant biology, however, there is no universal method as the protocols needed to induce callus formation vary significantly among species. In addition to the concentration of PGRs, additional factors such as light levels, temperature, medium, explant material, as well as the accumulation of phenolic compounds affect the formation of callus tissue.

The main objective of this research is to develop an efficient protocol for callus induction and whole-plant regeneration in the lace plant. First, the best explant material and hormone concentration will be optimized for callus induction. Second, the best hormone concentration for regenerating whole plants via callus will be determined.

Plants were propagated in a sterile culture system. Explants such as immature leaves, mature leaves, corm tissues, and roots were selected. The explants were then tested on various concentrations of PGRs to determine the most efficient protocol for callus induction. Promising callus formation was found on protocols with lower concentrations of PGRs, however excessive phenolic accumulation led to explant and callus death. A protocol to reduce phenolic accumulation during callus induction was also developed. Ongoing research focuses on maintaining the callus and regenerating the lace plant.

Age distribution of *Lophelia pertusa* colonial scleractinian cold-water coral fragments from the NE Scotian margin

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Supervisor(s): Dr. Owen Sherwood, Department of Earth and Environmental Science, Dalhousie University

Abstract

The Lophelia Coral Conservation Area (LCCA) is a protected area on the Scotian Shelf known to contain living *Lophelia pertusa,* a deep-sea coral species of ecological significance. While there is currently only a small volume of living coral at the site, extensive past coral growth is indicated by the large quantity of unconsolidated *Lophelia* rubble found there. However, the time period during which this growth occurred, as well as the current rate of coral growth at the site, is unknown. Six fragments of coral rubble collected from within the LCCA were investigated with radiocarbon analysis to gain a better understanding of their age. Probability distributions were generated from these data, and photogrammetry was used to investigate the modern rate of calcification at the site. The coral fragments varied widely in age, with the oldest specimen dating to the 1st Century CE and youngest specimens to the 16th Century CE. Notably, none of the specimens were dated to the modern period, a finding which was supported by a probability distribution. These results suggest long-term and sustained growth of *Lophelia* within the LCCA across at least 15 centuries. As well, the mortality of these specimens appears to predate modern fisheries in the area, implying that their deaths were not caused by anthropogenic means, but by some other natural force. Paleoclimactic shifts, such as the long-term cooling trend in the Scotia-Maine region, may be implicated.

Aerial insect populations in the Halifax Backlands and their availability to the Common Nighthawk (*Chordeiles minor*)

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Dr. Cindy Staicer, Department of Biology, Dalhousie University

Abstract

Insects are experiencing rapid and dramatic global declines due to human activities, such as agricultural intensification, urbanization and pollution. The drastic loss of insects significantly impairs ecosystems by diminishing the delivery of essential services, including pollination, herbivory and waste decomposition. Reductions in insect biomass decrease the amount of energy moved through food webs, threatening organisms at higher trophic levels with endangerment or extinction. Aerial insectivores are animals that capture aerial insect prey in flight and are particularly vulnerable to insect declines. The Common Nighthawk (*Chordeiles minor*) is a migratory, ground-nesting nightjar and is listed as a Species at Risk in Canada. As an aerial insectivore, insect decline is hypothesized to be the leading threat to this species. Recent observations of nighthawks frequenting the Halifax Backlands, an urban wilderness area located south of Halifax, suggest this area may be an important refuge for this species in Nova Scotia. The Halifax Backlands feature a post-fire landscape with open rock faces, low vegetation and numerous wetlands, making it the ideal breeding and foraging grounds for the Common Nighthawk. To investigate aerial insect abundance in the area, Malaise intercept traps and insect light traps were deployed at 21 sites across the Backlands in the summer of 2024. Insect samples were sorted into orders, counted and grouped by size before samples were dried at 60˚C for 24 hours. Dried insect groups were weighed to 0.001g precision to obtain dry biomass values. The abundance and dry biomass of insects >5 mm in length will be analyzed to examine the relative prey availability for nighthawks at each site. Insect prey data will be compared with nighthawk detections recorded by Autonomous Recording Units (ARUs) used concurrently with insect traps in the summer of 2024. Results of this study will help to identify important nighthawk foraging areas and improve knowledge of insect communities in the Halifax Backlands.

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Nanobubble technology: a method to increase the growth rate of Atlantic salmon (*Salmo salar*) and reduce biofouling in recirculating aquaculture system (RAS)

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Abstract

The increasing human population has required increased global aquaculture production, including Atlantic salmon (*Salmo salar*), the fourth highest produced finfish. Finfish are traditionally cultured in net pens in the open ocean, but it is moving towards the land-based recirculating aquaculture system (RAS), which is considered more environmentally friendly, as it does not interact with the marine environment. However, RAS is relatively new and requires careful attention to water chemistry in order for fish to survive. Dissolved oxygen (DO) is a critical limiting factor. The lack of DO in the water can lead to decreased fish growth or even mortality of fish in the system. Another factor is biofouling, which is the buildup of bacteria in the system, and can increase energy usage and labour by hindering the movement of water flow within water supply pipes. Nanobubble (NB) technology has the potential to mitigate those problems. NBs are nanoscale (>1,000 µm) bubbles that can remain stable in liquid for a few months. They can achieve efficient mass gas transfer into liquid, remove the particles settled on the surface, and prevent the settlement of particles on the surface. The objective of this study is to determine whether NB oxygen can positively influence Atlantic salmon growth and water quality in RAS. Atlantic salmon post-smolts (n=144) were measured initially for fork length and weights, and then divided equally among six tanks, which were further divided into two groups (n=3) with lab #1 for control using ordinary oxygen and lab #2 for experimental using NB oxygen. Fish were fed with a commercial diet until satiation, and the amount of feed consumed for each lab was recorded. A subsample of fish was measured halfway through the experiment. At the end of the trial (8 weeks), fish were measured again. The condition factor, feed conversion ratio, and specific growth rate were calculated. Water quality parameters (oxygen, ammonia, nitrite, and nitrate) were also collected. Bio balls were weighed and placed in the sumps of each RAS to observe the effect of NB on biofouling. This work can potentially be applied to commercial RAS to improve oxygen efficiency and salmon growth and reduce biofouling.

Spatial ecology of the Common Nighthawk (*Chordeiles minor*) in the Halifax Backlands

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Abstract

Located in southern Halifax, NS, the Halifax Backlands is an urban wilderness that is home to a diversity of species and ecosystems, including the Common Nighthawk (*Chordeiles minor*). The Common Nighthawk is a migratory bird species that is widely distributed across North America during its breeding season, and is classified as Special Concern under Canada's Species at Risk Act. Between 1970 and 2018, nighthawk populations declined by 68% in Canada, likely due to breeding habitat loss and declines in aerial insect prey. Currently, there is limited research on how habitat characteristics and prey abundance influence the spatial distribution of nighthawks in Atlantic Canada. This study aimed to determine the spatial distribution of nighthawk foraging and nesting areas within the Halifax Backlands, as well as investigate the influence of environmental characteristics on these distributions. Furthermore, the study also aimed to examine seasonal and diurnal trends in nighthawk activity. Between May and September of 2024, nighthawks were sampled in the Halifax Backlands using Autonomous Recording Units (ARUs) and visual surveys. To detect vocal and non-vocal indicators of nighthawk activity, auditory recordings captured by ARUs were analyzed using BirdNET. Auditory detections were plotted to visualize seasonal and diurnal trends in activity. Using location data collected during visual surveys, kernel density analysis was performed to determine the spatial distribution of nesting and foraging areas. The importance of habitat characteristics and insect prey abundance on nighthawk spatial distribution was analyzed using a generalized linear mixed model (GLMM). Results of the study are important for improving understanding of the spatial ecology of Common Nighthawks in Atlantic Canada, and can inform future monitoring and conservation strategies in the Halifax Backlands.

Enhancing phytoplankton production of the essential omega-3 fatty acid eicosapentaenoic acid (EPA) by tryptophan fertilization

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Abstract

Consumption of omega-3 fatty acids is necessary for human health, development, and disease prevention. However, long-chain omega-3s, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are primarily sourced from unsustainable fish oils, with an inconsistent quality from (over)harvested wild fish stocks. Omega-3s accumulated in fish are produced by phytoplankton, so they could be obtained directly by cultivating phytoplankton. However, cost-effective mass production of phytoplankton is limited by the cost of providing light and nutrients. Phytoplankton biomass production can be enhanced with plant hormones. The amino acid tryptophan is the biosynthetic precursor for a plant hormone, indole-3-acetic acid, shown to improve phytoplankton growth rates and yields. In culture, omega-3 yield rates depend on growth rates and cell quotas that vary by growth phase (stationary vs exponential), and growth medium (inorganic mineral medium vs organic-amended medium). This study compares EPA yield rates of two phytoplankton, *Cylindrotheca closterium* and *Nannochloropsis oculata*, in an inorganic mineral medium vs a tryptophan-amended medium, in exponential vs stationary phases.

Phytoplankton omega-3 production rates were assessed using a combination of bio-optical monitoring and growth modeling. Omega-3 yield rates were calculated from cell quotas measured with gas chromatography following transesterification. In tryptophan dose-response screening, there was no significant increase in growth rate for either species. The biomass yield for *C. closterium* was significantly higher in 2.5 mM tryptophan than in control cultures ($P < 0.0001$). The EPA production rate and yield for both species await analysis. At scale, tryptophan fertilization could reduce the cost of producing high-value omega-3s used for both human food supplements and animal feed. These sustainable omega-3s will relieve the pressure on weakened wild fish stocks. Developing sustainable omega-3s could help achieve the UN Sustainable Development Goals 12 (responsible consumption and production) and 14 (life underwater).

Quantifying species richness and variability among Nova Scotia eelgrass meadows using baited remote underwater video (BRUV)

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Dr. Kristina Boerder, Department of Biology, Dalhousie University

Abstract

Eelgrass (*Zostera marina*), is an important marine species that forms extensive meadows in shallow coastal waters of Atlantic Canada. These meadows support enhanced biodiversity, acting as breeding and nursery grounds for many other marine species, and additionally, provide several ecosystem services that protect the surrounding marine environment. Despite their significance, global declines due to climate change and anthropogenic impacts have placed seagrasses alongside coral reefs and tropical rainforests as some of the most threatened ecosystems worldwide. Although increased conservation efforts have led to some restoration success, many areas lack long-term monitoring programs that are crucial for understanding regional seagrass trends. In Atlantic Canada, few studies have explored how regional habitat variation influences the community composition of eelgrass meadows, and understanding these dynamics can aid in improved conservation efforts. To investigate these regional differences, field surveys were performed on three eelgrass meadows (Owls Head Provincial Park, Rose Bay, and Shad Bay) across Nova Scotia's Eastern Shore. Baited Remote Underwater Video (BRUV) systems were deployed at each site to quantify species richness, and conservative estimates of species abundance using the metric MaxN. Transect and quadrat surveys were performed by snorkelers to estimate eelgrass density for each site, followed by drone assessments to determine meadow extent. Regional habitat variation was observed in both meadow structure and associated species assemblages. Owls Head Provincial Park showed the highest estimates for eelgrass density, meadow extent, and species richness, while species abundance varied across different species and sites. These findings are essential for informing more localized and targeted conservation strategies for Nova Scotia eelgrass meadows.

Reconstructing seasonal changes in surface particulate organic matter using carbon isotopes of amino acids

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Abstract

The marine biological carbon pump is responsible for fixing and sequestering approximately ten petagrams of carbon per year. How climate change will affect the biological carbon pump is currently unknown. The Northwest Atlantic Ocean of Nova Scotia is undergoing some of the most rapid warming of any ocean region on Earth. Many oceanographic observations have only occurred in the past 100 years, meaning that historical climate and carbon sequestration trends are poorly understood. To fulfill this knowledge gap, better paleo-proxy is needed. Recently, compound-specific isotope analysis of carbon-13 in amino acids (δ13C-AA) has been shown to differentiate among phylogenetic groups, including terrestrial plants, bacteria, fungi and within groups of algae. Amino acids comprise the largest characterizable molecular fraction of organic material and are abundant in detrital material, making Amino acids a good candidate for compound-specific analysis. These δ13C-AA fingerprints are well preserved in organic archives in the deep sea, thus opening up the possibility of tracking long-term changes in carbon sources over climate-relevant timescales. How carbon sources using δ13C-AA for near coastal systems change seasonally is not well studied. This study hypothesizes that the seasonal transition from large-cell, diatom-based production in spring to small-cell, flagellate-based production in summer is reflected in δ13C-AA signatures of seawater filtrates. The objectives of this study were the following: to sample local coastal water for δ13C bi-weekly following a spring-to-fall seasonal cycle, compare the values of δ13C-AA to the bulk δ13C values and compare the found δ13C values to those in the literature to validate carbon source composition. To do so, water samples were collected periodically at Oakland Road Park; before analysis, samples underwent wet chemistry and derivatization, and δ13C-AA data were collected using Gas chromatography isotope ratio mass spectrometry and bulk δ13C values were collected via Elemental Analyser Isotope Ratio Mass Spectrometry. Preliminary results from the spring 2024 plankton bloom show compound-specific isotope analysis can differentiate between major taxonomic groups using previously published studies and suggest an increase of carbon input from terrestrial sources in May compared to April.

The use of UV-LED in drinking water treatment as a response to climate-driven increases in natural organic matter

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Abstract

Our current methods of drinking water treatment are unsustainable in our ever-changing climate. As climate change has progressed, the source water for facilities in the Halifax Regional Municipality (HRM) has experienced an increase in natural organic matter (NOM) concentration. In response to this increase, this study aims to compare various methods of water filtration to reduce the levels of NOM prior to disinfection. The primary technique of focus is the use of UV-LED preceding the final step of water treatment, chlorination. Clearwell water was combined with various levels of hydrogen peroxide and run through a custom-made AquiSense UV-LED flow cell at several different UV power levels and flow rates to eliminate NOM. The output water was then tested for standard water quality parameters including dissolved organic carbon (DOC), fluorescence excitation-emission matrix analysis, UV254 and UV275 absorbance. If the experiment is successful, the results will show decreased DOC, UV254, and UV275 in comparison to the clearwell water from the treatment plant. So far, we are seeing decreases in UV275 absorbance as great as 0.015 cm^{-1} and decreases in UV254 absorbance as great as 0.014 cm^{-1}. This study is still in the preliminary stages, but early results are promising. This technique could revolutionize drinking water treatment, as it already has with wastewater treatment. This research is vital to prevent further increases in disinfection byproducts that occur as a result of residual NOM reacting with the chlorine added in the final step of treatment. Ongoing experiments will provide data replication and results under alternate conditions, leading us to conclude the best use of this technology in the HRM and beyond.

High-resolution mapping of Pacific white skate (*Bathyraja spinosissima*) nursery habitats at a Galápagos hydrothermal vent field

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Abstract

Pacific white skate (*Bathyraja spinosissima*) nurseries were recently discovered at a Galápagos hydrothermal vent field. At these nurseries, skate eggs of various forms (e.g. brown, yellow-green, white) appear to be clustered together in proximity to active hydrothermal vents. It was hypothesized that the skates were purposely laying their eggs around active vents because the expelled heat increases the surrounding water temperature which was thought to speed up their 4-year incubation period; however, the specific environmental drivers that influence these skate egg distributions remain unconfirmed. Our study aims to determine environmental predictors of *B. spinosissima* nurseries at a Galápagos hydrothermal vent field and explore the relationship between skate egg presence with seafloor morphology, and distance and direction from active vents. From 3 remotely operated vehicle dives, high-resolution video footage collected on a research mission aboard the Schmidt Ocean Institute vessel, the RV Falkor Too, was analysed and annotated using the software BIIGLE. Leveraging high-resolution seafloor mapping data from the Sentry survey, we processed bathymetry and backscatter, and derived seafloor morphology (e.g. slope, benthic positioning index, curvature). Georeferenced skate egg locations from the video footage were imported into ArcGIS Pro and overlaid on the environmental predictor layers. Our random forest habitat suitability model reveals that the main environmental predictors for skate egg presence were distance from active vents, bathymetry, and broad-scale benthic positioning index. In addition, the skate eggs were generally found southeast from active vents. Our findings provide the first quantitative evidence of *B. spinosissima* laying their eggs in close proximity to active vents and using seafloor geomorphology to target steep scarps on which to lay their eggs at a Galápagos hydrothermal vent field. These results further contribute our ecological understanding of *B. spinosissima*.

Biogeography of Atlantic salmon (*Salmo salar*) in the Cape Breton highlands

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Abstract

Atlantic salmon (*Salmo salar*) populations have experienced significant declines in recent decades. In Canada, conservation efforts are divided into 16 designatable units (DUs) to address unique regional challenges among genetically distinct populations. The Cape Breton Highlands are a particularly understudied region in Atlantic Canada, characterized by limited assessments and outdated distribution data. The Cape Breton Highlands are divided into two DUs; the Eastern Cape Breton (ECB) and Gulf of St. Lawrence, in which salmon are listed as "endangered" and "special concern," respectively. This study aimed to update the distribution and abundance of Atlantic salmon in the Cape Breton Highlands describing the community composition of lesser-known systems and identifying environmental variables that influence salmon presence. Electrofishing surveys conducted across 24 rivers in the ECB and Gulf of St. Lawrence DUs targeted lesser-known systems with potential to support small salmon populations. Each of these systems were described by species assemblage, and environmental metrics (e.g. temperature, pH) were recorded to identify habitat predictors associated with the presence of Atlantic salmon. Species assemblages were analyzed using non-metric multidimensional scaling (NMDS) to compare community composition between DUs which revealed no significant difference between management units. A generalized linear model (GLM) assessed salmon abundance between the two DUs, indicating that salmon populations are more robust within the Gulf of St. Lawrence DU. A second GLM was applied to identify environmental predictors of habitat suitability, incorporating in-situ measurements alongside GIS-derived landscape metrics. The model revealed that river gradient had the strongest negative effect on salmon abundance, while temperature and pH exhibited comparatively smaller effects. Ongoing monitoring and reassessment of salmon is critical for an up-to-date perspective on the status of the species. These data will provide usable insights for environmental managers by offering accurate data on the present status of salmon populations in the Cape Breton Highlands.

Identification of Galápagos sperm whale (*Physeter macrocephalus*) vocal clans in 2022-2023 using a novel automated coda detection software

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Programme: Concentrated Honours in Marine Biology (Co-Op); Environment, Sustainability & Society Minor

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Ana Eguiguren, PhD Candidate, Department of Biology Dalhousie University

Abstract

Sperm whales (*Physeter macrocephalus*) have complex social structures that give rise to sophisticated communication networks. A primary type of social vocalization they produce are called codas, which are repeated short bursts of sounds that are socially learned and produced mainly by females during social interactions near the surface. Based on their patterning, codas can be categorized into types, which are used to identify vocal clans: large groups of associated individuals that share acoustic repertoires. Understanding these clans is crucial for studying the species' behavioural ecology, population biology, and culture, which, in turn, inform conservation methods. Traditionally, vocal clan identification has involved manual analysis of acoustic recordings by researchers, a labourious and time-consuming process. During this project, the first ever automated coda analysis software – innovated by marine technology researchers from the University of Haifa, Israel - was tested and used to analyze acoustic recordings of Galápagos sperm whales, collected over two field seasons in 2022 and 2023, to ultimately identify the vocal clans present during these surveys. First, the efficiency of the automated software at detecting codas was compared to that of a manual auditing technique, that uses the software Audacity®. The efficiency of the automated detector was optimized by adjusting its auditory parameters and constraints. Following this testing, the 2022-2023 recordings were analyzed by the detector, and the output files were manually annotated for codas, using the software "CodaSorter". Preliminary results suggest that the automated detector can surpass manual auditing in efficiency when constraints are applied to both the software's auditory factors and to the coda detection threshold. These optimizations have shown to maximize the precision at which the software outputs files with codas, ultimately reducing human labour and time, which are the primary drawbacks to manual auditing methods. Next steps for this project include identifying the vocal clans present in this dataset, using the identify call method (IDCall), which analyzes files with annotated codas for distinct patterns and categorizes them hierarchically based on coda type. This work advances our understanding of Galápagos sperm whale population biology and social structure, while also exploring the potential of novel technologies and methods for analyzing their vocalizations.

Observing combined effects of ocean acidification and marine heatwaves on larval development of *Placopecten magellanicus*

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Abstract

Both ocean acidification and increasing rates of marine heatwaves can be detrimental to the success of marine species. As climate change increases the intensity of ocean acidification and the frequency of marine heatwaves, these effects will become more severe. One of the species with potential to be impacted by these phenomena is the Atlantic Sea Scallop (*Placopecten magellanicus)*, which is of particular concern due to its importance to Atlantic Canadian fisheries and ecology. By exposing embryos to a range of pH and temperature treatments in combination and observing patterns of development, predictions can be made on how these changes in environmental conditions may affect sea scallops. To observe this, known concentrations of gametes from wild caught scallops were mixed in seawater of pH 7.0 – 7.8, then exposed to a water bath simulating either ambient surface temperature or marine heatwave conditions. Samples from each combination were preserved at 4, 8, 12 and 24 hours post fertilization. Samples were imaged with microscope cameras and developmental stages seen in each were labelled by visual comparison to staged figures of early scallop development. Statistical analysis of the mean development rates between each treatment will reveal if there are significantly different patterns of development when fertilization and early development take place under acidified and heatwave conditions and allow for more accurate scientific advising on fisheries management for this valuable species.

Effects of substrate grain size composition on the ex-situ growth of eelgrass (*Zostera marina*)

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Supervisor(s): Heike Lotze, Department of Biology, Dalhousie University
Kristina Boerder, Department of Biology, Dalhousie University

Abstract

Seagrasses are a group of marine flowering plants found in shallow coastal waters all around the world. Seagrasses can aggregate to form extensive aquatic meadows, which provide food, habitat and nursing grounds for numerous marine species. In addition, they provide natural coastal protection against wave erosion and sequester carbon, mitigating climate change. *Zostera marina*, also known as "eelgrass", is the most widely distributed species of seagrass in Canada and are the only species present in Nova Scotia. Over the past decades, *Z. marina* has been heavily affected by anthropogenic activities. As such, there is an increasing need for conservation and restoration efforts. Numerous restoration strategies involve harvesting whole plants or seeds from donor sites for transplantation in other sites. Newer techniques employ the use of land-based aquaculture facilities for growing and propagating eelgrass prior to transplantation, thus reducing stress on donor sites. Such strategies would benefit from optimizing the conditions in which the eelgrass is grown to maximize yields. While the effects of light exposure, nutrient availability and temperature have already been studied, little research has been conducted on the effects of sediment grain size on the growth of eelgrass. Previous field studies determined that eelgrass grows better in fine natural sediments, however such results may not apply in controlled laboratory environments. To address this issue, I monitored the *ex-situ* growth of *Z. marina* shoots in three artificial sediments of various average grain sizes over a period of 19 weeks. Leaf growth, leaf sprouts, shoot sprouts, plant death were monitored throughout the experiment. Average biomass was measured at the end of the experiment. Preliminary results have shown that sediment grain size composition within the studied range has no effect on the growth of Z. marina in a laboratory environment. These results could imply that sediment grain size may not be a significant factor in eelgrass aquaculture, making the process simpler than originally thought. Therefore, the results of this study can be used to conceive more effective strategies for eelgrass restoration in Atlantic Canada.

Design, construction, and function of a genetic circuit that regulates gene transcription in response to a pair of mutually exclusive induction events

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Abstract

Synthetic biologists reimagine molecular processes essential to life by engineering systems of interacting biomacromolecules. This bottom-up approach uses genetic and protein machinery found in nature to establish new controls over gene transcription. These engineered systems can be organized into genetic circuits to mimic logical operations in living cells. Accordingly, genetic circuits may provide innovative solutions to medical and environmental problems. For example, to address the emergence of antimicrobial resistance, new antibiotics must be developed. Antibiotics incorporating D-amino acids represent a promising class of therapeutics. However, enantiospecific production of D-amino acids is limited by a lack of chemical and biocatalytic strategies. What is urgently required are new enzymes engineered to produce D-amino acids. This is challenging because conventional protein engineering strategies lack the throughput and capability to simultaneously interrogate and distinguish between the production of D- and L-amino acids.

To mitigate this shortcoming, genetic circuitry can be proposed as a platform for protein engineering. A prototype genetic circuit was designed that controls transcription in response to two input signals, isopropyl β-D-1-thiogalactopyranoside (IPTG) and D-fructose. This prototype, referred to as an "exclusive or" (XOR) logic gate, enables transcription when only one inducer is present. This prototype could be developed into a selection platform for identifying enzymes that produce the desired amino acid enantiomer. This project involves the design and construction of a prototype genetic circuit delivered to an *E. coli* host on a single plasmid. This plasmid expresses a system of repressor proteins that are selectively recruited to protomers in a network that mediates XOR function. The promoter sequences and their counterpart repressors are synthesized using various molecular biology techniques such as PCR, restriction-digestion, and ligation. The assembled plasmid is introduced into *E. coli* by transformation. The function of prototype genetic circuits will be evaluated by monitoring the expression of a green fluorescence reporter protein. Specifically, transformed *E. coli* will be grown in media containing: (1) IPTG and D-fructose, (2) IPTG, (3) D-fructose, and (4) no inducer molecule. *E. coli* colonies transformed with functional XOR genetic circuits are expected to express the reporter gene when only IPTG or D-fructose are present.

Using environmental DNA (eDNA) concentration to quantify abundance of American eels (*Anguilla rostrata*)

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Abstract

The American Eel (*Anguilla rostrata*) species is in decline. This is due to many factors such as habitat loss, migratory barriers, pollution, and, most notably, the overharvesting of juvenile eels, also known as elvers. American Eel elvers are highly valued for their use in aquaculture, and, in recent years, the lucrative business of elver harvesting has led to intense exploitation of the species. In Canada, the American Eel was assessed as threatened in 2012. An important knowledge gap is lack of information about the abundance of elvers in streams and rivers across the range. The use of environmental DNA (eDNA) as a monitoring tool has become increasingly popular due to its non-invasive nature, high sensitivity, and wide applicability. This study aims to assess the relationship between eDNA concentration and abundance of American Eel elvers under controlled conditions in aquaria. The correlation between elver density and eDNA concentration will be evaluated by determining the limit of detection (LOD) and the limit of quantification (LOQ) in addition to calculating eDNA shedding and decay rates within the tanks. This study will also compare estimates of eDNA concentration obtained by two methods of quantification, quantitative PCR and digital droplet PCR. Results from this study will contribute to development of a novel sampling tool for the American Eel where time, cost, and logistical concerns have prevented monitoring using traditional methods. The use of eDNA as a monitoring tool has the potential to enable assessment of distribution and abundance during elver migration and could thus inform conservation efforts for this species.

Time-tension line cutters: a possible tool to reduce whale entanglements in deepwater fisheries

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Abstract

Entanglement in the vertical lines of fixed fishing gear is one of the most concerning threats to the critically endangered North Atlantic Right Whale (NARW) (*Eubalaena glacialis*). Low breaking strength (LBS) components are a promising mitigation effort in some fisheries; however, previous research has shown that they may pose a safety concern for deepwater fisheries. Use of LBS components in deepwater fisheries could result in gear loss and safety concerns for harvesters. Time-tension line cutters (TTLCs) offer a possible solution. The technology could replace LBS components in deepwater fishing gear, to allow for safer gear retrieval for harvesters. Once inserted onto vertical buoy lines, the TTLC will not cut the line unless a specified tension is reached for a period longer than it would take harvesters to haul in their gear. Alternatively, if the tension remains high enough for a certain amount of time, such as an entangled whale, the device will cut the rope, and the whale should then be freed. Building upon previous research, this thesis explores three questions: (1) Do factory provided TTLC units require a "work in" period? (2) Does the amount of tension affect the time to cut? Finally, (3) does water temperature affect the time to cut? Controlled laboratory experiments were conducted at the Fisheries and Marine Institute of Memorial University in St. John's, NL, from October to December 2024. The time to cut of ten TTLC units was tested across multiple tensions and temperatures using a tensile test machine. Preliminary results indicate that some units do require a "work in" period, although this is not the case for all units. The time to cut appears dependent on tension, with increasing tension potentially reducing the time to cut. Finally, the time to cut appears dependent on water temperature, with decreasing temperature potentially increasing the time to cut. Using empirical data, survival analysis will be used to assess the impact of these factors on the TTLC's performance. The results of this study will inform the best practices of TTLC deployment in deepwater fisheries to ensure the safety of harvesters and optimize the reduction of NARW entanglement.

Caught on camera: Exploring fish and invertebrate populations in Nova Scotian kelp beds using baited remote underwater video systems (BRUVS)

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Abstract

The Eastern Shore Islands (ESI), the largest archipelago in eastern North America, offer a wide diversity of habitat types and coastal features. The region is home to some of Nova Scotia's last remaining healthy kelp beds, which support diverse and abundant fish and macroinvertebrate populations. The ESI are designated as an Area of Interest (AOI) and are slated to become one of Canada's next Marine Protected Areas (MPA). Despite providing critical habitat for a wide variety of resident and migratory species, research examining differences in species assemblage across habitat types in this region remains limited.

To address this knowledge gap, we aimed to investigate variations in species assemblage between two islands within the ESI – Long Island (LI) and Tuffin Island (TI). We also aimed to assess variations in species assemblage across three site types at each island - High Kelp Coverage (HC), Low Kelp Coverage (LC), and Deep (DP) – and identify notable temporal trends in species activity or abundance at these sites.

To accomplish this, we deployed 23 BRUVS for 24-h across all six sites and conducted 16 SCUBA transect surveys at HC and LC sites at each island to document fish and macroinvertebrate abundance. A total of 24 species were observed across both methods, with significant differences in species assemblage found between DP sites and HC/LC sites, while no significant differences were found between the two islands. Notable diurnal patterns were observed in some species, such as Cunner (*Tautogolabrus adspersus*), Winter Flounder (*Pseudopleuronectes* spp.), and Jonah crab (*Cancer borealis*), which were mostly observed during daylight hours. Species observed with BRUVS and SCUBA differed slightly, highlighting some methodological differences between the two techniques.

Our findings highlight the importance of habitat type in shaping marine animal communities, with kelp-dominant habitats supporting distinct assemblages compared to deeper sites. The observed uniformity in habitat use across both islands underscores the need to protect larger geographic areas within the ESI. Temporal patterns observed for multiple species also provide insight into the complex nature of habitat usage by Nova Scotia's marine animals. This research will help inform conservation strategies and policy decisions as the ESI continues its journey toward MPA designation.

Migratory behaviors and route choices of Atlantic salmon migrating through the Norwegian Sandsfjord toward the Suldalslågen river system

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Abstract

Migration is the movement distribution of individuals or populations in terrestrial and marine ecosystems, driven by environmental, physical, and chemical factors. However, human impacts on migration are influencing the crucial variables of distribution pattern, migratory timing, and navigational choices that maintain the ecological success of migratory species. Therefore, knowledge regarding these variables will aid in understanding salmon behaviour to approach conservation and management strategies. In fjord ecosystems, salmon must navigate narrow channels over the course of their outward and return migration. However, there have been limited publications on behavioural analysis to determine the factors that establish the navigational choices of the salmon through these channels. This study analyzes a Norwegian population of anadromous and iteroparous Atlantic salmon that migrate between the Arctic Ocean and their spawning ground in the Suldalslågen river system. This population is subjected to the prospect of marine infilling resulting in an obstruction to one (Starumbergsundet) of three swim-ways (Skorpa, Midtsund, and Starumbergsundet) for the transiting population of salmon in the fjord on account of the adjacent islands Kjølvikskorpa and Berakvamsskorpa. Understanding migratory behaviours and the variables that determine the route choices of the population are crucial to establishing the suitability of the construction on the Starumbergsundet swim-way based on conservation standards to minimize the stress added to the population. To determine how salmon use the three channels, acoustic transmitters were surgically inserted into 80 individual salmon, caught in traditional trap nets (Kilenot) located in the Bay of Hebnes, approximately 15 km from the mouth of their spawning site near the village of Sand. Receiver arrays were positioned throughout the fjord and around the islands to track the spatial and temporal movements of the individuals. Their movements were observed for one year; however, analysis of the data was emphasized during the months of June 2023 to October 2023 during the migration towards the river for spawning. Overall, this research will conclude migratory behaviours and navigational choices of the salmon population from the data to observe the quantitative abundance of individuals that use each swim-way in the fjord.