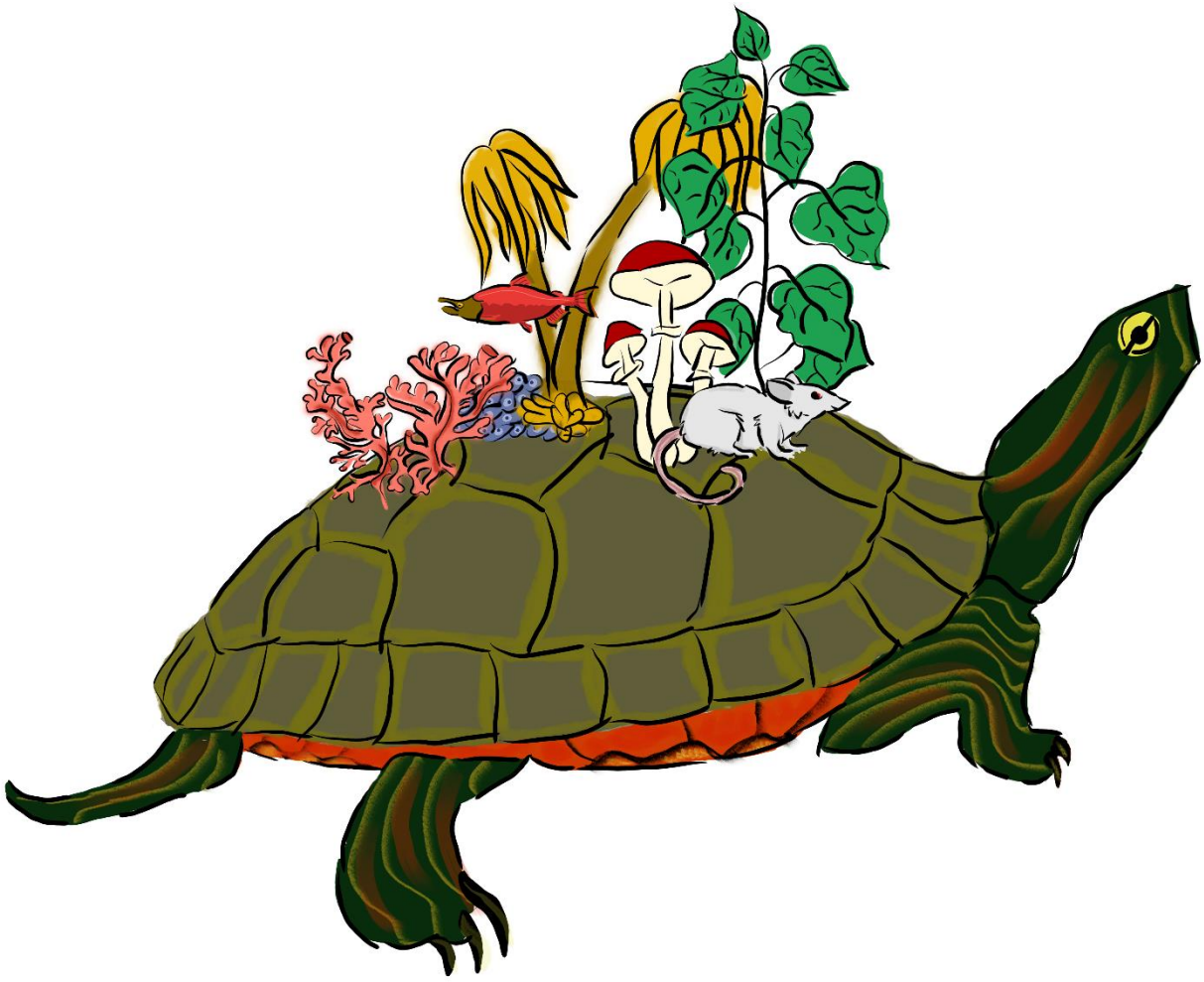
Abstracts

Biology Graduate Symposium

April 11-12, 2023



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Author: Lane, Sarah

Degree Sought: PhD
Supervisors: Dr. Jürgen Ehlting, Dr. Patrick Walter
Category: Forest Biology

From plants to people to Parkinson's: how nutrient stress strategies in plants can treat iron overload disease in humans.

How do we discover new drugs for treating human disease, and how can we make this process more efficient? This project harnesses plant stress responses to find new compounds that are similarly bioactive in human cells. I'm looking for compounds that interact with iron, so I put plants into iron deficiency stress and isolate metabolites they make in response. These extracted metabolites are first characterized with metabolomic techniques and chemical assays, then applied to human cell cultures. Analysis of cells with flow cytometry, microscopy, and other techniques identifies if metabolites have bioactivity. Compounds that interact with iron are needed, as few drugs of this nature are approved for human use. They are important for treating a variety of iron overload diseases, which occur when iron accumulates to toxic levels in different tissues. These drugs can remove the excess iron from the body. I'm testing if my plant extracts have this activity on two cellular iron overload models: iron-treated monocytic-like cells to model secondary iron overload and patient-derived dopaminergic neurons to model neurodegeneration with brain iron accumulation, like Parkinson's disease. I've found that the profile of secondary metabolites changes in response to iron deficiency in poplar, lavender, and western redcedar metabolite extracts, for some in just 7 days, and differently across species. Metabolite extracts do not appear to have cytotoxic effects on monocytic-like cells, but some extracts stimulate differentiation. Extracts from poplar reduce intracellular iron and may lower oxidative stress. Work to identify similar effects in neurons remains ongoing.

Author: Innes, Katie

Degree Sought: MSc
Supervisor: Dr. Francis Juanes
Category: Marine Biology

The overwinter diets of juvenile Chinook salmon in the Strait of Georgia

Declines in Chinook Salmon abundance in recent decades are generally attributed to reduced survival during marine residence. A large portion of Chinook Salmon mortality is believed to occur in the first winter following ocean entry. High mortality rates may be caused by limited feeding in the preceding summer which prevent juvenile Chinook Salmon from building up enough energy reserves to last them throughout the winter months, a period of supposed starvation. However, despite the hypothesized importance of winter in regulating survival, little is known about juvenile Chinook Salmon ecology during this time, including a lack of information on winter diets throughout the Strait of Georgia. We sample juvenile Chinook Salmon by microtrolling (non-lethal hook and line capture) on an on-call basis from October to March in the Strait of Georgia; samples include fish length and weight, scales for genetic stock identification, and stomach contents by gastric lavage. A subset of intact prey from the diets are retained for energy density (ED) determination by the ash-free dry weight to wet weight ratio, a reliable predictor of ED. The overall diets and ED of juvenile Chinook Salmon prey throughout winter are assessed by stock, site, and date, and these values are used in bioenergetic modelling. These results will fill critical knowledge gaps and contribute to testing the hypothesis that nutritional stress in winter is linked to elevated mortality of juvenile Chinook Salmon in the Strait of Georgia.

Author: Anderson, Chris

Degree Sought: MSc
Supervisor: Dr. Robert Chow
Category: Neuroscience, Cell, and Molecular Biology

Post-Transcriptional Regulation of *Vsx1* in the Developing Mouse Retina

Post-transcriptional regulation encompasses various mechanisms that impact mRNA stability and protein translation and helps shape the correct spatial and temporal gene expression levels necessary for proper development. We are studying these mechanisms in the retina, which is an ideal experimental model for central nervous system development due to its simple anatomy, cellular organization, and ease with which it can be manipulated experimentally. Our work is focused on *Vsx1*, a gene that is necessary for the terminal differentiation of a subset of retinal bipolar cells and cone visual signalling. VSX1 protein is first detected in the mouse retina exclusively in newly born bipolar cells between P4 and P5, while its mRNA is first detectable three days earlier at P2. To determine whether the *Vsx1* 3'UTR mediates this apparent post-transcriptional regulation, we developed an *in vivo*, dual reporter assay which utilizes the expression of an mCherry reporter carrying the *Vsx1* 3'UTR and a control GFP reporter for within-cell normalization. We observed *Vsx1* 3'UTR-mediated repression of the mCherry reporter protein in presumptive retinal progenitor cells electroporated at P0. Bioinformatic analysis of the *Vsx1* 3'UTR identified a 206nt conserved region which contains microRNA recognition elements that are known to be expressed in the developing retina. Deletion of this conserved region from the *Vsx1* 3'UTR derepressed mCherry reporter expression suggesting that it mediates *Vsx1* post-transcriptional repression. These findings provide insight into the post-transcriptional regulation of *Vsx1*. The molecular mechanism underlying this regulation and its functional relevance in developing retinal cells is yet to be determined.

Author: Buzzoni, Daisy

Degree Sought: PhD
Supervisor: Dr. Julia Baum
Category: Marine Biology

Coral symbioses under multiple stressors: Record-breaking heatwave drives co-dominance of symbiont genera and cryptic diversity losses

Climate change-amplified marine heatwaves pose the greatest threat globally to the future of coral reefs. Simultaneously, coral reefs are ubiquitously exposed to some degree of human disturbance, such as fishing or pollution. The Pacific Island of Kiritimati harbours reefs along a gradient of local human disturbance and was the epicentre for the 2015-2016 global coral bleaching event, making Kiritimati a microcosm representative of the coral reef crisis. The algal symbionts hosted by corals often have dramatic consequences for heatwave survival and bleaching resilience. Here we report symbiont metabarcoding from samples taken over 5 years spanning the heatwave (n=1,270) from tagged colonies of 7 coral species across different families and life-history strategies, at sites exposed to varying levels of human disturbance. Variation in the alpha and beta diversity of partners has previously been reported for coral and symbiont species but not yet across a major stress event, such as a heatwave. Upon heatwave recovery, more corals simultaneously hosted symbionts from competing genera than before the heatwave; heatwave exposure and local disturbance interacted antagonistically in this regard. Yet at the community level, widespread partner changes from phylogenetically and functionally more diverse *Cladocopium* spp. to ostensibly thermotolerant *Durusdinium* spp. resulted in significant declines in symbiont metacommunity richness. This natural experiment on a symbiotic model system addresses foundational ecological debates surrounding contrasting effects of disturbance on macro- and micro-organism diversity and effects of local disturbance protection on climate change vulnerability, with clear implications for predicting and managing coral resilience in an increasingly disturbed ocean.

Author: Hayward, Emma

Degree Sought: MSc
Supervisor: Dr. Jürgen Ehlting
Category: Forest Biology

Swiss Needle Cast: does the microbiome matter? A deep dive into the foliar microbiome of Douglas-fir and impacts on disease symptom severity

My research aims to better understand *Nothophaeocryptopus gaeumannii*, causal agent of a disease of Douglas-fir called Swiss-Needle Cast (SNC). This pathogen, which infects the needles of its host, is associated with premature defoliation. Its range encompasses large areas of Western North America, specifically along the BC, Washington, and Oregon coast. Studies have observed a rise in incidence and severity of this disease in the past few decades which has been linked to climatic changes and forestry practices. Breeding populations of Douglas-fir have been observed to have a genetic component to SNC tolerance, enabling selection of SNC resilient genotypes for reforestation. However, fungal load is not correlated with disease symptom severity in these populations suggesting a more complex relationship between pathogen, host, and disease severity. This begs the question whether there are other organisms involved in this interaction – specifically other fungi. Working with researchers at the BC Ministry of Forests and the Canadian Forest Services I have been using microbiological techniques and metagenomics to characterize the foliar microbiome of a stand of SNC infected Douglas-fir located in a high incidence area near Jordan River, BC. My data so far suggests a great diversity of fungal species that comprise this niche within the Douglas-fir needles and an investigation into their relationship with *N. gaeumannii* and SNC symptom severity is being explored. For this, community composition will be associated with disease phenotype data collected for this stand of trees (*i.e.*, incidence of fungal fruiting bodies in their needles and degree of needle loss).

Author: Piirtola, Eerik-Mikael

Degree Sought: PhD
Supervisor: Dr. C. Peter Constabel
Category: Forest Biology

Poplar leaf bud resin metabolomics – seasonal patterns of leaf bud resin chemistry

As part of their adaptation to Northern latitudes, poplar trees are known to secrete resinous exudate from their leaf buds. The hydrophobic resin protects the leaf buds and developing leaves from insect herbivory and frost. Due to its rich flavonoid composition, poplar resins have been widely used in traditional medicine for their antimicrobial properties. The aim of this study is to identify seasonal patterns in the chemical composition of *Populus trichocarpa* leaf bud resin during the development and growth of the leaf buds.

To study the seasonal patterns of the leaf bud resin chemistry, we analyzed the secreted resin extracted from the surface of the leaf buds, as well as the whole leaf bud extracts in samples collected monthly over a one year growing period. The focus of this study is on dihydrochalcones, which are a characteristic group of phenylpropanoids in *P. trichocarpa* leaf bud resin. We used ultra-high performance chromatography (UPLC) coupled with mass spectrometry (MS) for targeted quantification of dihydrochalcones, and high-resolution mass spectrometry (HRMS) for nontargeted metabolomics to identify changes in the total metabolites in the leaf bud extracts.

We identified dynamic patterns in the dihydrochalcone accumulation in both sample sets, showing an increase in the quantity of dihydrochalcones in the dormant leaf bud resin compared to leaf buds in the early stages of bud development. These results indicate that the chemical composition of leaf bud resin changes during different stages of leaf bud development, and that seasonal patterns may impact the secretion of the surface resin.

Author: Chundekkad, Pavitra

Degree Sought: MSc
Supervisor: Dr. Gautam Awatramani
Category: Neuroscience, Cell, and Molecular Biology

Inhibitory components of the orientation selective circuit in direction-selective ganglion cells

In the mammalian retina, ON-OFF direction selective ganglion cells (DSGCs) have also been found to be orientation selective (OS). The preferred orientation of these cells have been observed to be orthogonal to their preferred direction of motion. Asymmetric GABAergic inhibition from starburst amacrine cells (SACs) and symmetric glutamatergic excitation from bipolar cells (BCs) together contribute to the regulation of these circuits.

Cells which have their preferred direction along the dorso-ventral axis of the retina, are strongly inhibited by the SACs along the same axis, thereby causing them to respond to an orientation along the anterior-posterior axis. Also, previous studies have shown that BCs are tuned to respond preferentially to vertically oriented stimuli. Therefore, in the presence of inhibitory blockers, it is observed that all DSGCs respond to only vertically oriented stimuli when stimulated at the centre and in the distal surround. Since not much is known about the distal inputs to the DSGCs, this study will focus on gaining more insight into the arrangement of inhibitory inputs from distal stimulation in the ON-OFF DSGCs. This will help further the understanding of the complex retinal circuits that work together to ultimately produce the complex phenomenon of vision.

Author: Gaffney, Leigh

Degree Sought: PhD
Supervisor: Dr. Francis Juanes
Category: Marine Biology

Abnormal otoliths: Causes and consequences of vateritic otoliths in hatchery-reared Coho Salmon

Although Coho Salmon are of cultural, ecological, and economic importance throughout their range, anthropogenic activities have led to widespread declines in natural populations. To mitigate such declines, federal, provincial, and private organizations have undertaken large-scale hatchery-rearing of juvenile Coho Salmon. Unfortunately, once released into the wild, hatchery-reared Coho Salmon juveniles survive at generally low rates compared to wild-origin juveniles, such that hatcheries have proven much less effective than initially hoped.

Recently, differences have been observed between the sagittal otoliths of hatchery-reared and wild-origin Coho Salmon. Sagittal otoliths are essential sensory structures that enable fish to hear and maintain balance. Sagittal otoliths are normally composed of aragonite, a polymorph of calcium carbonate, but otoliths with inclusions of vaterite, an abnormal polymorph, also occur. Although vateritic otoliths have been shown to occur in less than 10% of wild-origin Coho Salmon, they are extremely common in hatchery facilities, affecting 60-80% of hatchery-reared Coho Salmon. Vaterite deposition reduces otolith function and causes hearing impairment in salmon; potentially leading to compromised marine survival rates and restoration efficiencies. Despite long-standing evidence of the occurrence of vateritic otoliths, the causes, and consequences of vaterite formation is largely unknown.

This study aims to investigate which hatchery-rearing conditions and practices cause vateritic otoliths to form in Coho Salmon juveniles and whether vateritic otoliths influence the marine survival rates of hatchery-reared Coho Salmon. This research has the potential to increase the generally poor success rates of Coho Salmon restoration efforts and improve the welfare of hatchery-reared salmon worldwide.

Author: Mokariasl, Niloufar

Degree Sought: PhD
Supervisor: Dr. John Taylor
Category: Neuroscience, Cell, and Molecular Biology

Expression levels and expression domains of melanopsins (a subfamily of non-visual opsins) during sablefish (*Anoplopoma fimbria*) development

A diversity of biological processes, such as reproduction, the sleep-wake cycle, gene expression, body temperature, immune function, cell division, and development are impacted by light, the earth's most reliable signal. In metazoans, G protein-coupled receptors called opsins mediate light sensitivity. Visual opsins (those expressed in the rod and cone cells of vertebrate eyes) are far outnumbered by non-visual opsins, yet very little is known about the functions of these presumably light sensitive proteins. Melanopsins, encoded by four genes, are vertebrate non-visual opsins expressed in melanophores, retinal ganglion cells, and the brain. Most fish have four or five melanopsins. My research focused on sablefish (*A. fimbria*) because of its unique life history and availability, from unfertilized egg to adulthood, from a local aquaculture facility. I have been using qPCR and immunohistochemistry to characterize melanopsin expression in sablefish during development. The qPCR data indicate that the expression of melanopsin genes begins seven days after fertilization when fish are kept in complete darkness and reaches its peak when larvae are exposed to light at age 47 days. Using immunolabeling, I discovered Opn4m proteins in cells of the developing retina and in the radial glia cells. Radial glia are neuroprogenitor cells; thus, these new data suggest that opsins and light may play a role in brain development in fish.

Author: Gray, Sierra

Degree Sought: MSc
Supervisors: Dr. Amanda Bates, Dr. Christopher M. Pearce
Category: Marine Biology

Juvenile Pacific oysters in a changing ocean: teasing out the impacts of co-occurring climate stressors and the potential benefits of climate bio-mitigation (IMTA)

Climate change, driven by increasing anthropogenic greenhouse gas emissions, is leading to increases in global atmospheric and oceanic temperatures with coinciding rises in oceanic carbon dioxide (pCO_2), which is driving ocean acidification (OA). Certain marine animals, including various bivalves (*e.g.* oysters, mussels, clams), are negatively impacted by heat and OA in isolation, but the combined effects of elevated temperature and pCO_2 can reveal different effects which are non-additive, including biological compensation mechanisms. Here we experimentally tested for independent (one stressor) and co-occurring (two stressors) climate exposure effects exposure and quantified biological, physiological, and genomic responses of juvenile Pacific oysters (*Crassostrea gigas*). Two factors (pCO_2 and temperature) and two levels (average summer level and maximum summer level) were included in a fully crossed design including six replicate tanks per treatment and 20–24 oysters per tank. Oysters were sampled at bimonthly/monthly intervals over 16 weeks to examine shell biometrics, condition index and gene expression looking at physiological stressors. Condition index analysis showed an inflection point around week 6; indicating higher temperatures affected oyster responses regardless of pCO_2 level, further analysis is needed. We are following up this initial experiment with a second experiment investigating potential benefits of integrated multi-trophic aquaculture (IMTA) by holding juvenile Pacific oysters with California sea cucumbers (*Apostichopus californicus*) and sugar kelp (*Saccharina sp*.). Our results combining condition index, gene expression, and carbonate chemistry in response to multiple stressors advances our predictions for climate change ecology and sustainable aquaculture systems in mono-culture and integrated multi-trophic aquaculture production systems.

Author: Zerr, Kaitlyn

Degree Sought: MSc
Supervisors: Dr. Julia Baum, Dr. Guy Stevens
Category: Marine Biology

Eyes on the Reef: Using remote time-lapse cameras to reveal the hidden habits of elasmobranchs in a newly designated UNESCO Biosphere Reserve

Overexploitation of oceanic sharks and rays (elasmobranchs) due to the high value of their fins and gill plates has led to significant declines in many populations over recent decades. Identification and protection of biodiversity hotspots for threatened elasmobranch species is urgently required. Many pelagic species focus their activities near remote islands or seamounts, which promote localized upwelling of nutrient rich waters and support high levels of biodiversity. In the Indian Ocean, Fuvahmulah Atoll, known as 'the Galapagos of the Maldives,' is a recently designated UNESCO Biosphere Reserve in the Maldives. At this isolated, single island atoll, diver sightings of several endangered species outnumber those from other regions in the Maldives including: oceanic manta rays (*Mobula birostris*), scalloped hammerhead sharks (*Sphyrna lewini*), pelagic thresher sharks (*Alopias pelagicus*), and whale sharks (*Rhincodon typas*). Considering the Maldives offers national protection to sharks and rays, Fuvahmulah Atoll may be a globally important site for these endangered species. However, to date, no scientific studies have documented the visitation or diversity of elasmobranchs experienced at this site. We deployed remote time-lapse cameras at three locations around the island to record elasmobranch visitation throughout all daylight hours from March to August 2022. By investigating the relative abundance and diversity of species across and between sites, as well as influencing factors, this project will highlight the importance of the Atoll for endangered species and will contribute critical knowledge to inform new marine management plans and policies to protect Fuvahmulah's globally significant biodiversity.

Author: Black, Morgan

Degree Sought: PhD
Supervisors: Drs. Francis Juanes, Sarah Dudas
Category: Marine Biology

Do ancient indigenous clam gardens alter the diet of a benthic, generalist predator?

Humans have been modifying, and extracting resources from, coastal habitats for millennia. Often, especially in post-industrial time, this has been to the detriment of other species. First Nations' clam gardens have stood for thousands of years and are a habitat modification of the intertidal zone, designed to promote and manage preferred marine food species. We explored the effect of this aquaculture method on a commonly occurring, non-target fish species, *Oligocottus maculosus*. We compared the foraging behaviour of individuals collected on clam gardens and nearby reference sites. We hypothesize that individuals residing on clam gardens consume a greater diversity of prey items and demonstrate broader isotopic niche space.

Author: deRosenroll, Geoff

Degree Sought: PhD
Supervisor: Dr. Gautam Awatramani
Category: Neuroscience, Cell, and Molecular Biology

Locally-tuned cholinergic signals contribute to high-fidelity direction coding in the retina

In the murine retina, starburst amacrine cells (starbursts) drive direction selectivity in downstream direction-selective ganglion cells (DSGCs) using mixed GABAergic (inhibitory) and cholinergic (excitatory) synapses. While the role of GABA inhibition in the suppression of spiking activity in the null direction is well established, cholinergic transmission may occur over relatively broader spatial scales, making it more difficult to pinpoint its precise role in shaping direction selectivity. Using a detailed computational model based on the known circuit wiring, we demonstrate that promoting 'paracrine' (volumetric diffusion beyond the confines of synaptic clefts) modes of ACh transmission that render local input non-directional, leads to significant decreases in direction selectivity. We show that the loss of direction selectivity arises primarily due to disruptions of the relative timing of excitation (E) and inhibition (I) occurring on a fine spatiotemporal scale, rather than significant alterations in the global E/I ratio. These model predictions were confirmed in a series of electrophysiological and imaging experiments in which we perturbed acetylcholine (ACh) signaling using an ACh esterase inhibitor, which rendered local dendritic signals non-directional. Together, results from this study reveal the importance of precise subcellular E/I interactions, which are invisible in electrophysiological somatic recordings that are classically used to study neural computations.

Author: Heimrich, Annika

Degree Sought: PhD
Supervisors: Dr. Francis Juanes, Dr. William Halliday
Category: Marine Biology

A changing Arctic soundscape: How bearded seals (*Erignathus barbatus*) cope vocally

The Arctic is experiencing the highest rate of warming globally due to climate change, predicted to lead to an ice-free Arctic Ocean by mid-century. Historically, the Arctic Ocean has had quieter levels of ambient sounds than other marine areas, due to the dampening effect of sea ice. However, as sea ice is declining, sounds caused by wind, waves and melting sea ice are transported easier into the water column, resulting in an elevation of underwater sound levels.

Since the marine soundscape is a steadily changing environment and considered a crucial habitat feature for marine animals, latter ones must overcome the large variation in sound levels caused by both natural and anthropogenic sources for effective communication.

Male bearded seals both advertise courtship and defend territories particularly during their mating season (April-June) using acoustic communication and thus likely have a mechanism to compensate for natural variations in underwater sound levels.

Acoustic data were recorded near Sachs Harbour in the Northwest Territories, over a one-year period, and analyzed focusing on the potential relationship between bearded seal vocal characteristics and natural variations in underwater sound levels.

Underwater sound levels were strongly driven by wind speed, sea ice concentration and bearded seal vocalizations. Regressions models revealed varying temporal patterns in seal vocal characteristics in response to changing underwater sound levels. This study presents the first measurements of bearded seal vocal behaviour in response to their naturally shaped soundscape within Canadian waters, and therefore can be used as baseline for future studies.

Author: Ellis, Sarah

Degree Sought: MSc
Supervisor: Dr. Rana El-Sabaawi
Category: Ecology and Evolution

Does preservation alter bone phosphorous concentrations?

Bone is phosphorous-rich and highly variable. Aquatic organisms can be phosphorous-limited and are often reliant on nutrient recycling of phosphorous through vertebrate metabolic wastes and carcass decomposition. Threespine stickleback (*Gasterosteus aculeatus*) have bony armour that can evolve quickly, perhaps altering their contributions to phosphorous recycling. Current research uses nutrient content of organisms to predict nutrient flow through ecosystems; yet it is unclear how preserving specimens prior to analysis affects recovery of their elemental composition. This study facilitates future nutrient research by comparing the effects of common preservation methods on stoichiometric data. We conducted two field seasons, collecting and preserving stickleback in ethanol and by freezing over short-term (between 2 days and 3 months) and long-term (17 months) time periods. We also analyzed fish on collection day to compare preserved and freshly-caught fish. After preservation, for each fish we tested percent phosphorous of the plate and girdle (external bony armour structures) as well as their whole-bodies (ground tissue of the eviscerated fish body, including remaining bones). Results show that ethanol preservation increases percent phosphorous of the whole-body tissue over time compared to preservation by freezing. In contrast, the bony armour did not vary significantly with preservation, indicating that inter-study comparisons of bone phosphorous are viable. This understanding of the interaction between preservation and nutrient recovery is key to unlocking a rich archive of historical fish specimens, allowing broader comparisons across studies and timeframes, and enabling a deeper understanding of nutrient recycling in aquatic ecosystems.

Author: Rimmer, Talen

Degree Sought: MSc
Supervisor: Dr. Francis Juanes
Category: Marine Biology

'Kelp-ful AI': assessing the effects of seaweed farms on nearshore biodiversity using computer vision-assisted video analysis

Seaweed aquaculture has rapidly expanded in British Columbia in the last decade due to its low-intensity cultivation method and its potential to offer ecosystem benefits similar to kelp forests. However, despite growing interest in the industry, there is limited research that explores how kelp farms impact underwater ecosystems, particularly ecologically and economically important species like forage fish. In this study, we analyze underwater video data recorded over the course of one year at two kelp farms and their adjacent reference sites (located at Barkley and Clayoquot Sound), using a combination of manual annotation and computer vision techniques to quantify biodiversity and abundance of nearshore fish and invertebrate taxa.

Videos were recorded for a period of five minutes every daylight hour from February 2022 – March 2023 using programmable underwater video cameras, for a total of ~4300 hours of data. A subset (~720 hours) of the videos were manually annotated to develop and train supervised computer vision methods to detect common fish and invertebrate species at the highest possible taxonomic level. This will be coupled with a novel unsupervised anomaly detection filter, which will flag and process uncommon species with the goal of yielding a more comprehensive analysis of the fish biodiversity from the video data set. Data analysis for this study is in progress, but preliminary results indicate that seaweed farm presence may impact the abundance of some nearshore fish species, though biodiversity varies broadly across sites and seasons.

Author: Lawton, Maggie

Degree Sought: PhD
Supervisor: Dr. Ryan Gawryluk
Category: Neuroscience, Cell, and Molecular Biology

Characterizing the diversity of microbial eukaryotes in oxygen minimum zones

Oxygen minimum zones (OMZs) are oceanic regions with low dissolved oxygen levels. Despite being inhospitable to aerobic organisms like fish, they contain diverse microbial communities that mediate gas and nutrient cycling. They are therefore critical components of oceanic ecosystems and biogeochemical cycles. Anthropogenic climate change has led to these regions' expansion, altering their communities' function and composition. While the prokaryotic component of these environments has been extensively studied, the eukaryotic component has not. A common model system for studying OMZs is the Saanich Inlet, a seasonally anoxic fjord in Vancouver Island, British Columbia. This project investigates the eukaryotic diversity within the Saanich Inlet over seasonal and temporal variations in dissolved oxygen, with a particular focus on identifying novel species and metabolisms. A combination of molecular techniques were developed, tested, and refined to allow for an accurate and thorough investigation. Environmental metabarcoding was used to estimate overall species presence and diversity, while also providing a baseline reference for further techniques. Single-cell sequencing is currently underway to obtain genomes and transcriptomes from previously understudied anaerobic taxa, both in culture and from the environment. This genomic data will allow us to describe the anaerobic metabolic strategies of the studied organisms, and help enrich the eukaryotic tree of life. Overall, this investigation will improve our understanding of protists, anaerobic metabolism, and OMZs, as well as the effects of climate change.

Author: Livingston, Michael

Degree Sought: PhD
Supervisor: Dr. Diana Varela
Category: Marine Biology

Estimating marine carbon gel concentrations from multivariate regression models

Transparent exopolymer particles (TEP) form a gelatinous matrix within the upper surface of the world's oceans and are important for the efficiency of the biological carbon pump. While TEP can facilitate organic matter aggregation in the surface oceans, the TEP matrix is also less dense than seawater, and can accumulate near the surface. Owing to their low density, high TEP concentrations can reduce the sinking potential of organic aggregates and can even induce upward flux. Due to the characteristics of TEP, and their ubiquity in the global ocean, it is critical to understand how changes in ocean conditions, such as warming and a shoaling of the mixed layer, influence TEP concentrations. Here we show that the primary drivers of TEP concentrations in the Subarctic Northeast Pacific include phytoplankton biomass (as proxied by chlorophyll *a*), productivity, temperature, and nutrient concentrations. Furthermore, TEP concentrations can be estimated from multivariate linear regression (MLR) models using proxies for its primary drivers as predictor variables. The MLR models yielded accurate results when tested on new data sets along Line P, with an error of ~10-15 ¨g XG eq L^{-1} in TEP estimations. The MLRs were applied to a database of oceanographic measurements collected along the Line P transect in the Northeast Pacific Ocean and archived by the Department of Fisheries and Oceans Canada. The results from these models provide a deeper understanding of surface distribution and changes in TEP concentrations in the Northeast Pacific Ocean from 1998 - 2018.

Author: May, Emily

Degree Sought: PhD
Supervisor: Dr. Rana El-Sabaawi
Category: Ecology and Evolution

How bone affects vertebrate elemental demand and release

Understanding how animals recycle nutrients is critically important, as animals take up, transform, release, and transport critical nutrients. Ecological stoichiometry (ES) is commonly used to evaluate animal-mediated nutrient recycling. However, empirical data on vertebrates rarely supports ES predictions, both because elemental demand and release do not appear tightly linked to body elemental content and because vertebrates often break the assumption of stoichiometric homeostasis (i.e. that body elemental content remains within bounds as environmental supply fluctuates). Bone, a phosphorus (P)-rich tissue, likely plays a significant role. We systematically reviewed zoological and medical literature to evaluate (1) how bone physiology impacts vertebrate elemental demand and release, (2) how bone causes stoichiometric flexibility, and (3) how bone density varies across both bone types and species. We found that not only does bone change body elemental content, but it also functions directly in mineral homeostasis, complicating how P content affects demand in vertebrates. Additionally, bone (1) can increase or decrease in density depending on environmental conditions, changing body P content, and (2) can substitute elements within its mineral structure, changing its stoichiometry. These two factors, along with bone's unique role in female reproductive biology, make bone a key trait for understanding stoichiometry. We present our systematic review alongside original data to characterize bone's overall impact and to provide predictions that can be tested by future researchers.

Author: Davies, Hailey

Degree Sought: PhD
Supervisors: Dr. Francis Juanes, Dr. Dana Haggarty
Category: Marine Biology

Barotrauma injuries in Pacific rockfish species around Entrance Island, British Columbia

Rockfishes (*Sebastes* spp.) are a highly diverse group, with at least 41 species found off the British Columbia (BC) coast. These fish have a physoclistous swim bladder (no connection to the esophagus) which limits them to gradual adjustments in buoyancy. Consequently, rockfishes often suffer from barotrauma injuries when forced to the surface during capture due to expansion of gas in the swim bladder. Inshore rockfishes are targeted by many groups and industrial fishing has led to devastating declines in most populations. Despite conservation measures in BC, there has been little evidence of population recovery. We collected field data to quantify species differences in barotrauma symptoms using hook-and-line methods to capture rockfishes (9 species, n = 353) on a reef surrounding Entrance Island, BC in 2020 and 2021. Each rockfish was assessed for six external barotrauma symptoms: esophageal eversion, pop eye, tight abdomen, bulging membrane, membrane emphysema, and ocular emphysema. We found that there were differences in the type and severity of barotrauma between species. Yelloweye (*Sebastes ruberrimus*) and Canary (*Sebastes pinniger*) rockfishes experienced the most severe symptoms including esophageal eversion more frequently than other species, while Quillback (*Sebastes maliger*) experienced less severe injuries, and Yellowtail (*Sebastes flavidus*) only suffered mild barotrauma. Drivers of these differences could include physiological, life history, or behavioural characteristics (e.g., benthic versus pelagic schooling behaviours). These results add to the existing literature on rockfish barotrauma symptoms, including data deficient species in BC.

Author: Wright-LaGreca, Marissa

Degree Sought: MSc
Supervisors: Dr. Amanda Bates, Dr. Timothy Green
Category: Marine Biology

Using probiotics to improve Pacific oyster (*Crassostrea gigas*) survival against pathogenic bacteria

As filter-feeders, oysters serve ecological roles by cleaning seawater but this also, in turn, exposes them to a variety of marine microbiota, some of them opportunistic pathogens. Of particular concern are pathogenic *Vibrio* bacteria, which have been linked to mass bivalve mortality in the summer months. Amid other environmental stressors, such as ocean warming and acidification, *Vibrio* infection often occurs when the oyster's immune defenses are stretched beyond their limit. Probiotics, or beneficial bacterial supplements, may improve microbiome composition and immune response towards pathogenic bacteria. A potential probiotic is *Roseobacter*, a diverse marine bacterial group, that are important and persistent symbiotes across oyster life-stages and have been shown to inhibit *Vibrio spp.* growth *in vitro*.

My research project utilizes a *Roseobacter* probiotic to improve the Pacific oyster's (*Crassostrea gigas*) immune defenses against pathogenic bacteria. This project manipulated early microbiome formation by supplementing a candidate probiotic to *C. gigas* in the first 24 hours of life, resulting in significant improvement in long-term disease resilience. This information has a practical use in aquaculture and conservation, as well as furthering our knowledge of invertebrate immune defenses and its bearing on host-pathogen interactions.

Author: Csordas, Matt

Degree Sought: PhD
Supervisor: Dr. Julia Baum
Category: Marine Biology

Assessing the distribution and vulnerability of a critical nearshore ecosystem: Evaluating the drivers of current and future kelp distributions in British Columbia

Kelp forests are a key component of the temperate nearshore where they are considered the most vulnerable ecosystem to the effects of climate change, with climate change associated declines already occurring around the world. In the coastal waters of British Columbia (BC) kelp forests sustain nearshore biodiversity and productivity by provisioning habitat and food to a variety of ecologically, culturally, and commercially important species. There is also a growing interest in kelp as a form of blue carbon (i.e. carbon sequestration and storage), and conserving these ecosystems, therefore, could have both biodiversity and climate solution benefits. Despite this, we have a poor understanding of the current distributions and trajectories of kelp species throughout BC. Supported by the BC Parks Living Lab program, in the summer of 2022, we performed benthic video transects using an underwater remote operated vehicle (ROV) to assess kelp distributions within and around BC Parks near Vancouver Island. Combining data from these surveys with occurrence records from the DFO benthic habitat mapping dataset we created an occurrence dataset for canopy forming and understory kelp species throughout BC. Combining the resulting dataset with spatially associated environmental variables (500m scale), we are training species distribution models (SDMs) to predict where kelp species are likely to occur in BC. This will allow us to identify areas of high biodiversity and blue carbon potential and assess which factors are driving these patterns on a BC-wide scale.

Author: McPolin, Marie Claire

Degree Sought: MSc
Supervisors: Dr. Barbara Hawkins, Dr. Marty Kranabetter
Category: Forest Biology

Ectomycorrhizal fungal endemism and rainforest nutrition in Pacific Northeast

Considerable research exists on how niche processes and spatial trade-offs structure the species richness observed in ectomycorrhizal fungal (EMF) communities, but little attention has been paid to how this might relate to the high levels of endemism reported in these communities. As endemism is typically associated with habitat specialization, I anticipated that EMF species endemic to the distinct high available nitrogen (N), low available phosphorous (P) soils of the Pacific Northeastern (PNE) temperate rainforests would display greater macronutrient concentration, indicative of superior nutrient exploitation. I measured both the sporocarp nutrition and the root tip abundance of EMF species on a mature forest (CWHVm zone) of Sitka spruce and western hemlock and determined fungal endemism using the UNITE database. Endemic species, (~ 50% of species found on root tips), had significantly higher sporocarp N, K and Mg concentrations than cosmopolitan species, but comparable P levels. Endemics were more likely to occur on western hemlock (a coastally restricted genus) plots than Sitka spruce (a circumpolar genus) plots and became more frequent on root tips as inorganic P levels in the soil decreased. Endemics showed moderate but non-random dispersion across the phylogeny; The Inocybaceae family was predominantly endemic, while Cortinariaceae was largely cosmopolitan, highlighting some phylogenetic niche conservatism in certain lineages, but not as an overall pattern. I conclude that endemic EMF account for a significant portion of fungi most well adapted to PNE coastal soils, have preference for coastally restricted *Tsuga*, and are expected to provide superior N nutrition to their tree hosts.

Author: Lancaster, Darienne

Degree Sought: PhD
Supervisors: Dr. Francis Juanes, Dr. Dana Haggarty
Category: Marine Biology

Investigating non-destructive acoustic methods for monitoring vulnerable rocky reef fish

Rocky reef fish like Quillback (*Sebastes maliger*), and Yelloweye Rockfish (*S. ruberrimus*) are important to British Columbia's ecology and fishing interests, but multiple species are currently listed as threatened or species of special concern by the Committee on the Status of Endangered Wildlife in Canada. Increased monitoring of populations has been recommended to effectively protect reef fish. However, traditional surveys use lethal hook and line sampling which can be destructive to vulnerable marine species or time consuming visual surveys. New acoustic monitoring techniques may have the ability to solve some of these assessment challenges. My research will test new acoustic methods for monitoring rocky reef fish. This study will push the boundaries of marine bioacoustics and investigate the feasibility of replacing or improving existing fish assessment techniques with new acoustic methods. My project has four primary objectives: 1) Investigate rocky reef fish calls for species and size specific characteristics using a passive acoustic localization array; 2) Investigate environmental and behavioural influences to rocky reef fish call rates; 3) Use passive acoustic monitoring to estimate rocky reef fish abundance; and 4) Develop mobile active acoustic methods for monitoring rocky reef fish in high slope and high rugosity environments. My research will help make Canada a world leader in non-destructive fish monitoring by testing new acoustic assessment methods. These new techniques will improve assessment efficiency and lower research survey costs which will help inform conservation and management actions.

Author: Hirabayashi, Kaede

Degree Sought: MSc
Supervisor: Dr. Gregory Owens
Category: Ecology and Evolution

Lingonberry genomics and evolution

Lingonberry (*Vaccinium vitis-idaea*) is a dwarf shrub that grows widely in the circumpolar region. The species has two recognized subspecies (ssp.) defined by their origin: European ssp. *vitis-idaea* and North American ssp. *minus*. The two subspecies are morphologically different, with the former growing relatively taller with longer/wider leaves and bigger fruits than the latter. The berries have recently been studied as medicinal crops for their potential anti-cancer, antioxidant, and anti-inflammatory properties. The exploration of cultivars with agroeconomic benefits to initiate larger-scale lingonberry commercial production has therefore been a growing area of research. Despite extensive chemical analysis, there exists a knowledge gap in essential biological features such as adaptation to various habitats. Moreover, the borderline between the two subspecies is undefined, leaving behind numerous observations in the wild with unclassified subspecies. The goal of my project is to create the genomic resource for lingonberry, which is currently lacking, and further elucidate the species history using the genomic data.

To achieve this, I first sequenced and assembled the genomes of both European and North American lingonberries and further annotated the genomes with genes. Using genome alignment and population modelling, I explored the evolutionary history and population dynamics of the species. Preliminary results have shown that neither of the subspecies has undergone a dramatic shift in population size, and the subspecies has started diverging approximately 800,000 years ago. Follow-up studies with population-level sampling and sequencing would be able to link genetic features with the species' biological features.

Author: Crawford, Rebecca

Degree Sought: MSc
Supervisor: Dr. Ryan Gawryluk, Dr. Diana Varela
Category: Marine Biology

Community structure of eukaryotic phytoplankton across Arctic and Subarctic Oceans

In recent years, shifts in environmental conditions in Arctic and Subarctic oceans have brought increased attention to the biodiversity of these regions. Environmental changes in the Bering and Chukchi seas are especially concerning, as they are among the most productive regions in the world's oceans, and their fisheries are crucial to supporting people on a local and global scale. To predict the impact that climate change will have on these oceanic regions, it is crucial to study biodiversity at the base of the food web, namely eukaryotic phytoplankton. To this end, we have sequenced the V4 hypervariable region of the 18S rRNA gene and the full 18S rRNA gene from water samples collected in Cambridge Bay, the Chukchi and Bering Seas, and the Northeast Pacific Ocean. These datasets cover a suite of samples that were collected in 2021 and 2022 across depth and season to investigate spatial and temporal trends in phytoplankton community structure in arctic and subarctic oceans. In addition to all DNA samples collected, oceanographic measurements were taken such as temperature, salinity, and nutrient concentrations. These parameters are used to explore how phytoplankton biodiversity varies with environmental trends. Samples preserved for microscopy were collected as well for morphological identification of taxa to address biases that may exist in the molecular data from amplicon sequencing. Preliminary data show that temperature is a strong predictor of phytoplankton community composition in the Pacific arctic, having serious implications for the future of these communities under warming conditions.

Author: Clark, Lindsay

Degree Sought: MSc
Supervisors: Dr. Amanda Bates, Dr. Cherisse Du Preez
Category: Marine Biology

Monitoring cold-water corals and sponges in changing ocean conditions: A case study in the Northeast Pacific Ocean Oxygen Minimum Zone

Understanding the mechanisms which constrain the distribution patterns of vulnerable marine species underpin ocean change predictions and guide informed Marine Protected Area (MPA) management and monitoring strategies. The Canadian Pacific contains some of the lowest oxygen levels in the global ocean where a mid-water oxygen minimum zone (OMZ) is losing oxygen rapidly (15% in the last 60 years) and is transected by a dense collection of seamounts which support abundant long-lived habitat-forming cold-water corals and sponges (CWCS). The MPAs within this region aim to maintain and restore habitat-forming CWCS given a backdrop of rapid ocean change. Seven long-term monitoring sites (LTMS) were established on Dellwood Seamount in 2018 at depths identified as vulnerable to further oxygen depletion. 3D reconstructions of these LTMS were created to characterize abiotic and biotic factors and establish abundance and condition baselines for future monitoring. Three years later five of these LTMS were revisited, enabling the first CWCS time-series in the MPAs. Contrary to our expectations, we found evidence of changes in the abundance and condition of CWCS within the relatively short interval. Based on 3-D mosaic image analysis, we observed decreases in the number of coral branches, increases in the amount of visible dead tissue on sponges, and an overall decline in the total number of individuals per LTMS. Our findings highlight the importance of (1) ecological studies to identify drivers of biodiversity change, and (2) annual monitoring to monitor MPA effectiveness and facilitate strategic management in Canadian Pacific MPAs to support CWCS conservation objectives.

Author: Mickens, Ashley

Degree Sought: MSc
Supervisor: Dr. Rana El-Sabaawi
Category: Ecology and Evolution

Understanding effects of urbanization on aquatic ecosystems on Vancouver Island

Urbanization is increasingly altering the landscapes surrounding cities. Anthropogenic impacts associated with urbanization, such as increased nutrients, habitat degradation and loss, and the introduction of invasive species significantly alter the health and function of aquatic ecosystems. While many studies have looked at the relationship between increasing urbanization and water quality, fewer have looked at how urbanization alters traits (morphology and phenotype) of aquatic organisms. In this study, we chose to examine the morphology of a species found commonly across North America, the threespine stickleback, in relation to varying degrees of urbanization. During summer 2022, we surveyed 19 freshwater locations on Vancouver Island along an urbanization gradient based on the percent of impervious surfaces, such as roads, sidewalks and roofs, as well as population of the areas surrounding the site. For the analysis, we examined several aspects of stickleback morphology, such as head and body size, body depth, gape width, jaw length and dorsal spine length. We make preliminary conclusions about how urbanization may impact the health of aquatic ecosystems. While this survey is a snapshot of the conditions at each site, we can use these results to make recommendations to urban planners and resource managers for where to focus conservation efforts, and to provide a potential framework for other researchers to carry out similar studies.

Author: Wyatt, Shea

Degree Sought: PhD
Supervisor: Dr. Diana Varela
Category: Marine Biology

Effects of ocean acidification on the growth and physiology of diatoms during an induced phytoplankton bloom in the Bering Sea

Diatoms, a type of silicifying phytoplankton, are responsible for about 20% of Earth's primary production, regulate the marine silicon cycle, form the base of efficient food webs, and are a driving component of the biological carbon pump. Despite their biogeochemical and ecological importance, little is known about the effects of ocean acidification on diatoms. We performed pH manipulation experiments by inducing a phytoplankton bloom in the Bering Sea, growing a diatom-dominated natural phytoplankton assemblage under current and future projected CO_2 concentrations. These experiments investigated the effects of decreased pH at high pCO_2 on the growth rate, chlorophyll-*a* biomass, and ratios of particulate carbon, nitrogen, and silica in the bloom assemblage. The physiological processes of C, N, and Si uptake were measured directly from the incorporation of stable (^{13}C and ^{15}N) and radioactive (^{32}Si) isotopes. Using the fluorescent dye PDMPO we determined the diatom taxa responsible for the majority of silica production within the assemblages, and assessed taxonomic shifts as the bloom progressed using 18S rRNA and microscope taxonomy. Results from this study suggest that diatoms in the Bering Sea are tolerant of more acidic conditions during the rapid growth phase of a bloom. This will help us to better understand whether these crucial phytoplankton will continue to succeed in rapidly changing Arctic marine environments.

Author: Qualley, Jessica

Degree Sought: MSc
Supervisor: Dr. Francis Juanes
Category: Marine Biology

Otolith stable isotopes differentiate migration patterns of Pacific Herring

Migratory life histories of Pacific Herring (*Clupea pallasii*) in the Strait of Georgia (SoG) are not well understood. Most adults (age-2+) migrate between spring spawning grounds in the SoG and summer foraging grounds on West Coast Vancouver Island. However, some adult herring are observed in the SoG year-round, suggesting an alternative resident life history. While resident herring likely constitute a small component of the aggregate stock, they may be disproportionately important to the SoG ecosystem and important predators, like Pacific Salmon. My research aims to develop an otolith elemental "tag" to differentiate resident from migratory individuals. Teleost fish grow paired, calcium carbonate structures called otoliths that aid in sound detection and gauging position in the water column. As the fish grows, otoliths accrete material like rings in a tree where elements from the surrounding seawater are incorporated as a lifetime record of the various aquatic habitats occupied by that individual. Otolith stable isotopes of $\delta^{13}C$ and $\delta^{18}O$ are known to reflect different aspects of the life history of a fish and distinct otolith stable isotope signatures have been found between migratory and resident SoG herring. Further development of an otolith stable isotope tag will have both ecological and fisheries management applications. Such a tag can be used to study the causes of different migration types in the SoG herring population, their role in the marine food web, and the vulnerability of these components to fisheries.

Author: Rajendran, Ahalya

Degree Sought: PhD
Supervisor: Dr. Peter Constabel
Category: Forest Biology

In-vivo and in-vitro characterization of poplar serine carboxypeptidase-like acyltransferase enzyme (SCPL-18) in salicinoid biosynthesis

Salicinoids are salicyl alcohol-based phenolic phytochemicals unique to poplars and willows which function as herbivore defense chemicals. My research aim is to identify and characterize novel enzymes such as serine carboxypeptidase-like acyltransferase (SCPL -18) involved in salicinoid biosynthetic pathways. SCPLs often catalyze the acylation of secondary metabolites using glucose esters as the acyl donor. SCPL are vacuolar proteins which are predicted to possess N-terminal signal peptides. A critical step in SCPL acylation is the formation of glucose esters by Uridine diphosphate glucosyltransferase (UGT) activity. Here, we analyzed transgenic CRISPR/Cas9 generated SCPL-18 knockout plants. Targeted metabolomic analysis showed an overaccumulation of cinnamic acid glucoside and putative hydroxycinnamic acid glucosides. Non-targeted metabolomic analyses revealed lack of trans-cinnamoyl salicortin. Both targeted and non-targeted data revealed that transfer of cinnamoyl group may be required to synthesize cinnamoyl salicortin. UGT84A17 plays an important role in glycosylating cinnamic acid to cinnamoyl glucose which acts as an acyl donor for SCPL-18 to acylate salicortin in forming cinnamoyl salicortin. We cloned and biochemically characterized UGT84A17 in order to achieve production of cinnamoyl glucose in enzyme assays. In-vitro assays of SCPL-18 will be tested using synthesized cinnamoyl glucose as an acyl donor and salicortin as an acyl acceptor. Our in vitro and in vivo results would confirm that SCPL-18 is required for the formation of cinnamoyl salicortin. Transient expression of target gene (SCPL-18) fused with green fluorescence protein would demonstrate localization to the vacuole. Transient co-expression of salicortin biosynthetic genes along with SCPL-18 and UGT84A17 performed in agro-infiltrated *Nicotiana benthamiana* might stimulate the formation of cinnamoyl salicortin. Overall, this study will provide new insights for understanding biosynthesis and ecological importance of salicinoids.

Author: Quindazzi, Micah

Degree Sought: PhD
Supervisor: Dr. Francis Juanes
Category: Ecology and Evolution

Otolith mineralogy affects otolith shape asymmetry

Many aspects of natural and hatchery origin salmonid genetics, physiology, behaviour, anatomy and life histories have been compared due to the concerns about what effects domestication and hatchery rearing conditions have on fitness. Genetic and environmental stressors associated with hatchery rearing could cause greater developmental instability (DI), and therefore a higher degree of fluctuating asymmetry (FA) in various bilaterally paired characters, such as otoliths. Nonetheless, to appropriately infer the effects of DI on otolith asymmetry, otolith mineralogy must be accounted for. Vateritic otoliths differ substantially from aragonitic otoliths in terms of mass and shape and can artificially inflate any measurement of FA if not properly accounted for. In this study, measurements of otolith asymmetry between hatchery and natural origin Coho salmon (*Oncorhynchus kisutch*) from three different river systems were compared to assess the overall differences in asymmetry when the calcium carbonate polymorph accounted for 59.3% of otoliths from hatchery origin *O. kisutch* was vateritic compared to 11.7% of otoliths from natural origin *O. kisutch*. Otolith mineralogy, rather than origin, was the most significant factor influencing the differences in asymmetry for each shape metric. When only aragonitic otoliths were compared, there was no difference in absolute asymmetry between hatchery and natural origin *O. kisutch*. The authors recommend other researchers to assess otolith mineralogy when conducting studies regarding otolith morphometrics and otolith FA.

Author: Woods, Mackenzie

Degree Sought: MSc
Supervisors: Dr. Francis Juanes, Dr. Sigal Balshine
Category: Marine Biology

How boat noise alters behaviour and vocalizations in plainfin midshipman fish

Anthropogenic noise has drastically changed natural soundscapes, negatively effecting marine life in many ways. As noise pollution in coastal environments continues to grow, it is imperative to understand how it may be negatively impacting marine life. In the field, we tested whether noise from a real motorboat would alter the vocalizations or parental care behaviours of nesting plainfin midshipman fish (*Porichthys notatus*), a soniferous toadfish that breeds in the intertidal zone and uses its vocalizations for courtship and defence. We found evidence that midshipman fish decrease their vocalizations when exposed to boat noise. Preliminary data show that boat noise may also lead to fewer parental care behaviours and increased vigilance. This study helps elucidate how boat noise affects vocalizations and behaviour in midshipman fish in their natural habitat, highlighting the potential negative effects that noise can have on an ecologically important intertidal species.

Author: Radford, Julie

Degree Sought: MSc
Supervisor: Dr. Steve Perlman
Category: Ecology and Evolution

The role of male age and female mate choice in the persistence of a selfish X chromosome in a common woodland fly

Most genes follow Mendelian inheritance, that is, most alleles have a 50/50 chance of being passed onto the next generation. However, genomic "parasites" called selfish genes overcome this by biasing their own transmission, despite any negative impact that this may have on their hosts. Selfish X chromosomes that interfere with the production of Y-chromosome-bearing sperm are a striking example of a selfish gene. Left unchecked, this would lead to a highly female-biased sex ratio and even possible extinction, and a major question is to understand what prevents this from occurring. My project investigates how a selfish X chromosome in a woodland fly *Drosophila testacea* has persisted for hundreds of thousands of years. The selfish gene "drive" system in *D. testacea* is ancient yet it was discovered relatively recently; thus, it is a great model to explore fitness factors that influence the behaviour of the selfish X chromosome. I examined the role of male age and female mate choice in the maintenance of selfish X chromosomes. Investigating factors that influence selfish X chromosome persistence over evolutionary time is essential to having a complete understanding of the complexity and implications of gene drive.

Author: Ravi Chander, Prathyusha

Degree Sought: MSc
Supervisor: Dr. Gautam Awatramani
Category: Neuroscience

Orientation selectivity across the population of ON-OFF direction-selective ganglion cells in the mouse retina

In the mammalian retina, orientation and direction-selective information are generally thought to be relayed to higher visual centers via distinct ganglion cell types. Contrary to this notion, I report that classic ON-OFF direction-selective ganglion cells (DSGCs) that are known to encode the four cardinal directions, also encode the orientation of static stimuli. The DSGC's preferred orientations are always orthogonal to its preferred-null axis defined by moving stimuli. To evaluate the synaptic mechanisms underlying orientation selectivity, I used a combination of electrophysiological, optogenetic, and gene knock-out techniques to assess the functional properties of all four types of ON-OFF DSGCs. Interestingly, cumulative results from multiple approaches revealed that the glutamate input to all four types of DSGCs was tuned along the vertical axis. This relies on signals to a specific presynaptic source (the bipolar cell type 5A; BC5A), which appear to be electrically coupled to vertically oriented processes of wide-field amacrine cells. By contrast, the GABAergic inhibition mediated largely by starburst amacrine cells was tuned either along the horizontal or vertical axis, consistent with their well-defined asymmetric wiring pattern, Thus, distinct combinations of inhibition and excitation underlie orientation selectivity in the nasal/temporal and dorsal/ventral coding DSGC populations, only the latter critically relying on the starbursts. Together, my work provides novel insights into how feature selectivity emerges in the hierarchical networks in the retina.

Author: Sykes, Nathan

Degree Sought: MSc
Supervisor: Dr. Greg Owens
Category: Ecology and Evolution

Differential genetic diversity within a co-occurring clade of B.C. rockfish

Pacific rockfish (genus *Sebastes*) are highly speciose and variable in their distribution along the B.C. coast. These fishes are subject to commercial and recreational fishing throughout their range, but the health of their populations is difficult to characterize from aboard a ship. In order to ensure the sustainability of these fisheries, managers at governmental agencies must first assess standing genetic diversity and differentiation between populations of rockfish, to identify and protect those which harbour unique genetic variation. With the help of collaborators at DFO and NOAA, we collected and sequenced rockfish samples from the Bering Strait to Southern California, including a variety of locales within B.C. By performing a comprehensive suite of genetic analyses, we thoroughly capture the extent of genomic variation within and between species of inshore rockfishes. We find that despite the phylogenetic proximity of these co-occurring fishes, overall genetic diversity and isolation-by-distance are species-dependent and highly variable. Our preliminary findings suggest that interspecific differences in dispersal and demographic history require deeper investigation.

Author: Melville, Olivia

Degree Sought: MSc
Supervisor: Dr. Diana Varela
Category: Marine Biology

How do tiny glass animals impact the silicon cycle in the Pacific Ocean?

Silicon is the second most abundant element in the Earth crust and is fundamental to marine biogeochemistry, ultimately linked to carbon cycling via biological uptake. Photosynthetic diatom production strongly controls the silicon cycle in the euphotic zone of all oceans. However, the impact of other planktonic siliceous organisms on marine silicon cycling is presently poorly known, and therefore the silicon cycle is not fully constrained in ocean waters. Siliceous Rhizaria, an understudied group of zooplankton, create silica skeletons and have been found from surface to deep waters in most ocean basins. I will present abundance and community composition results from two seasons and three regions in the Northeast Pacific Ocean, as well as results from silicon uptake experiments, using ^{32}Si as a tracer in the Northeast Pacific Ocean. Siliceous Rhizaria were found in low abundance at all sites and had highest abundance in the winter. The composition changed from winter to summer and among sites. Rates of silicon uptake in Rhizaria were variable among taxa, demonstrating that certain Rhizaria groups have a larger impact than others to overall silicon cycling in NE Pacific waters. Ultimately, the goal of this work is to contribute to our understanding of the marine silicon cycle by comparing siliceous biomass and silicon uptake in diatoms and the poorly known siliceous Rhizaria.

Author: Maucieri, Dominique

Degree Sought: PhD
Supervisor: Dr. Amanda Bates
Category: Marine Biology

Impacts of habitat loss and temperature increases on temperate marine invertebrate communities

Climate change is causing large-scale shifts in ecosystems due to events like marine heatwaves. Additionally, the loss of habitat-forming species such as kelp forests is leading to changes in the invertebrate communities that rely on these habitats. Along Pacific Northwest coasts kelp forests offer a model system to examine the interactions between temperature changes and loss of habitat, as these forests are detectable, common, under threat, and have been surveyed for decades. This study examines how changes in temperature and surface canopy kelp cover influence (i) how alpha and beta diversity change temporally and spatially and (ii) the amount of resistance a community has. We predict that the greatest change in diversity occurs when sites are experiencing high temperatures and habitat losses. We further expect that the sessile invertebrates will be unable to escape extreme conditions and herbivores will lose their food sources, therefore showing sustained shifts in populations. We find that kelp cover is the main predictor of marine invertebrate species richness, while diversity measures that incorporate species abundance are also affected by ocean warming. Overall, the highest number of significant state shifts in species density occurred during the 2014-2016 “Blob” event and did not differ between functional groups. We detect state shifts in species density occurring almost every year with large-scale ocean events driving a doubling of the number of state shifts in species density. Results highlight the importance of surface canopy-forming kelps as foundational species to support the maintenance of invertebrate diversity through major heat stress events.

Author: Abazari, Foad

Degree Sought: MSc
Supervisor: Dr. Raad Nashmi
Category: Neuroscience, Cell, and Molecular Biology

Characterization of α7 and α4β2 nicotinic cholinergic responses in L1 of cortex

The medial prefrontal cortex (mPFC) is a brain region that is responsible for a variety of cognitive functions including attention, working memory, sensory processing and goal directed learning. Cholinergic neurons, which release acetylcholine (ACh), are known to enhance attention and their pathophysiology is associated with nervous system disorders such as Alzheimer's disease, schizophrenia and epilepsy. Nicotinic acetylcholine receptors (nAChRs) are activated by the cholinergic system and modulate neuronal excitability. Therefore, understanding nAChR mediated synaptic neurotransmission in detail will allow us to understand how the functional activities of neurons are precisely controlled. Using whole cell recordings of mouse layer 1 neurons of the mPFC, my preliminary results have shown that optogenetic stimulation of ACh release resulted in two distinct nAChR mediated currents, each with distinct kinetics and pharmacological profiles. One component of the nicotinic receptor current had a rapid rise (~3-5ms) and decay kinetics (~15-20ms). This nAChR current component was sensitive to inhibition by the α7 nAChR inhibitor MLA. The second nAChR current was more persistent and long lasting (~500 ms) and was selectively inhibited by the α4β2 nAChR antagonist DHβE. I will further characterize these two distinct nicotinic currents. Specifically, using the calcium chelator EGTA-AM I will test the hypothesis that the α4β2 nAChR current is produced by asynchronous release of ACh in which the presynaptic calcium source is loosely coupled to the calcium sensor, while α7 nAChR current is produced by synchronous release of ACh in which the presynaptic calcium source is tightly coupled to the calcium sensor.

Author: Murchy, Kelsie

Degree Sought: PhD
Supervisor: Dr. Francis Juanes
Category: Marine Biology

Sound production by three species of Pacific salmon recorded from captive spawning migrants

Sound production has been reported in 15 species of Salmonids, but there is little research on Pacific salmon (*Oncorhynchus* spp.) sound production. Wild Chinook salmon (*O. tshawytscha*), pink salmon (*O. gorbuscha*) and coho salmon (*O. kisutch*) were diverted from a natural spawning migration in the Big Qualicum River and temporarily held captive in the adjacent Big Qualicum Hatchery located on Vancouver Island, British Columbia, Canada during the 2017 fall migration. Underwater sounds were collected continuously over four weeks and examined for salmon sounds, in holding ponds containing Chinook only, coho only, or mixed pink and Chinook salmon. Chinook and coho salmon were documented to produce air movement sounds and sounds produced in a series similar to sounds documented in other salmonids. Although pink salmon were not recorded separately from Chinook, comparison with Chinook only recordings suggest they produce different sounds, including a more prevalent air movement sound type. Our results indicated Pacific salmon produced a variety of sounds and lay the groundwork for potential acoustic monitoring of salmon populations.

Author: Young, Penelope

Degree Sought: MSc
Supervisor: Dr. Raad Nashmi
Category: Neuroscience

Investigating the role of the lateral nigrostriatal pathway in voluntary movement

Midbrain dopamine neuron (DAN) signalling is critical for voluntary movement, however, the mechanism behind its function has confounded scientists for decades. Heterogeneity of DANs across the medial-lateral axis is likely a contributing factor, in addition to the overlap of DAN signalling in multiple aspects of behaviour, including novelty encoding. In this study we used optogenetics to phasically stimulate a subregion of DANs in a transgenic mouse model. We found that phasic stimulation promoted exploratory behaviour in a novelty-dependant manner.

Author: Ens, Nicholas

Degree Sought: PhD
Supervisors: Dr. John Dower, Dr. Stéphane Gauthier
Category: Marine Biology

Characterization of mesopelagic communities in the eastern Gulf of Alaska in winter

Low prey availability during winter months has been posited as a limiting factor of salmon biomass in the Pacific Ocean. As such, appreciable efforts have been made to identify what prey species salmon are consuming during their oceanic phase, in what abundance, and where these prey are distributed. Sampling for salmon prey has historically been limited to discrete fishing events with poor spatial resolution over large sampling areas. This has resulted in poor estimates of where these prey are concentrated and in what abundance they are present. I joined the Canadian Coast Guard Ship Sir John Franklin in 2022 on a winter expedition into the open eastern north Pacific to resolve the prey fields available to salmon at this time. Using continuous multi-frequency echosounder data and discrete depth-stratified net sampling of the mesozooplankton and micronektonic community I plan on characterizing the ecosystems present in this chaotic environment. In this presentation I will discuss the methodologies used on this expedition, some preliminary results, and intended next directions for analyses.

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