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Abstract Booklet

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12 minute presentations (alphabetical order by first name)

Bolded Name (presenting author)

Specialism is not Specialism

Gregg, A., Gemby, A., Mooers, A.

Specialism is the name allocated to species that are restricted to a very limited niche breadth, with increasing niche breadth approaching the typically binary designation of a generalist species. In this study, I examined the relationship between published predictors of "specialism", the axes of specialism they predict in Canadian butterflies, and if the discrete classifications are significant when fit linearly. In butterflies, specialism is most often measured along any of three axes: habitat breadth, temperature breadth, and host plant breadth. Here, we scored 307 Canadian butterfly species along these three axes and asked whether the scores were correlated – i.e., to what extent a species with a narrow or wide habitat breadth had a narrow or wide temperature or hostplant breadth. We find that the three axes show very low pairwise correlations ($R^2 < 7\%$). We then asked if the predictors of these axes of specialism have significant predictive power. We found one combination of moisture affinity predicting habitat niche breadth that had a high pairwise correlation relative to all other combinations ($R^2 = 20.4\%$). However, the other predictors of specialism show very low pairwise correlations with the respective axes of specialism even if significant ($R^2 < 3.4\%$). We conclude the published predictors of specialism do not accurately predict the measures of specialism in Canadian butterflies apart from moisture affinity, and the axes of specialism do not covary. These results highlight the need to consider the definition of specialism in a broader context as the implications of misidentifying a species according to one definition of niche breadth extends into real-world conservation efforts and species' imperilment classifications.

Impact of petroleum products on Pacific oyster physiology and histopathology

Hura, A., Green, T., Kennedy, C., Marlatt, V.

With an expansion of petroleum transport projects planned for colder temperate marine ecosystems including the Pacific west coast of BC, the consequences of an oil spill under realistic environmental conditions need to be understood. Colder temperatures tend to lower the evaporation rate of lighter hydrocarbons, which in turn results in sessile communities being exposed to complex, toxic, and bioavailable petroleum compounds for longer durations. A representative and environmentally-relevant range of exposure concentrations (0%, 25%, 50%, 100% of a water accommodated fraction) and duration (7-d exposure and 28-d recovery period) were used to determine the effects of three petroleum products (marine diesel, crude oil, and diluted bitumen) on the scope for growth (SFG) and histopathology of various

tissues in Pacific oysters (*Crassostrea gigas*). For SFG determinations, algal clearance rate (CR), oyster respiration rate (RR), and absorption efficiency (AE) were measured. The histopathological analysis was performed by measuring the gonadal thickness, digestive tubule, and digestive lumen length. The results from these experiments will be utilized during the development of oil spill models and response strategies, environmental risk assessments, and monitoring plans for managing marine organisms, particularly bivalves, in the event of petroleum spills in the marine environment.

Nanoplastics Modulate PFOA uptake in Pacific Oyster

Farajizadeh, A., Giacomini, M., Goss, G.

Hydrophobic persistent organic pollutants (POPs) such as polyaromatic hydrocarbons (PAHs) and perfluorinated organic acids (PFOAs) are near-ubiquitous in the environment. They are known to negatively affect living organisms even at very low concentrations. Recently, our lab has demonstrated that certain hydrophobic plastics can adsorb some PAHs and potentiate uptake of these PAHs into the freshwater zebrafish embryo. We also hypothesized that the exponential increases in specific surface area of nanoplastics when compared to microplastics could exacerbate this potentiation of uptake. We hypothesized that similar processes may be occurring in seawater species and that uptake would be increased in the presence of smaller sized plastics. In this research, we used radiolabelled ¹⁴C-PFOA to explore the potential for adherence of PFOA to polystyrene nanoplastics. Secondly, we assessed whether the presence of nanoplastics could potentiate the uptake of PFOA into a marine (*Pacific Oyster (Magallana gigas)*) species. We developed a novel radiotracer-based method to track the uptake of PFOA in the presence or absence of either 500 or 20 nm nanoplastics. Our study demonstrates that the presence of nanoplastics can significantly increase the rate of uptake of PFOA and that smaller 20 nm nanoplastics have higher rates of potentiation when compared to 500 nm nano plastics. We also demonstrate that presence of nano plastics significantly increases thio - barbituric acid-reactive substances (TBARS) as a measure of lipid peroxidization (LPO) and that 20 nm nanoplastic invokes greater increases in LPO compared to 500 nm nanoplastics.

Understanding Effects of Urbanization on Aquatic Ecosystems Across Vancouver Island

Mickens, A., de Hass, H., Schenk, K., El-Sabaawi, R.

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 and one on the Southern BC mainland along an urbanization gradient based on the percent of impervious surfaces and population of the areas surrounding the site. We examined several aspects of morphology, but will focus our presentation on head and body size. 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, as well as provide a framework for other researchers to carry out similar studies.

How Risky are reintroductions: assessing contaminant impacts in amphibian reintroduction programs.

Danis, B.E.G., Sardari, P., Anderson, L., Marlatt, V

Amphibian declines are common worldwide with a major contributor being an increase in the volume of accidental and intentional release of numerous contaminants into the environment. This study examined water and sediment samples for various contaminants (metals, pesticides, and 17 β -estradiol) at federally designated Critical Habitat sites for the Northern Leopard Frog (Rocky Mountain Population) - NLF (*Lithobates pipiens*). Pesticides were below detection limits for Canadian Council for Ministers of the Environment (CCME) Water Quality Guidelines (WQGs) and Sediment Quality Guidelines (SQGs), except for glyphosate (detected at all sites ranging from 1.49 μ g/L at Leach Lake (Creston) to 21.4 μ g/L at Brisco (Columbia Marshes)). Glyphosate concentrations in surface water were below acute and chronic CCME WQGs of 800 and 27 000 μ g/L, respectively, for adverse effects on freshwater aquatic organisms. All surface water sites had total and dissolved magnesium concentrations above US EPA guidelines (0.647mg/L), and all sites, except Brisco, had total iron levels exceeding CCME WQG (0.3 mg/L). Total aluminum concentrations at Bummer's Flats North (0.191 mg/L), Kootenay Floodplain, exceeded the CCME WQG (100 mg/L adjusted for a pH of 10.1). Finally, total iron and sulphur concentrations in sediment exceeded CCME SQG values in suspected NLF overwintering locations. Metal contaminants can reduce hatching and survival in developing amphibian embryos. Ultimately, we recommend developing standard environmental contaminant screening programs at sites used for reintroductions to minimize the impacts of contaminants on growth, development, and reproduction, and maximize and support these important conservation efforts.

Interbrood comparisons of mass loss strategies in breeding female European starlings

Hodinka, B.

Patterns of mass loss in breeding birds have historically been interpreted as a proximate response to the peak energetic demands of nestlings during chick-rearing ('reproductive stress' hypothesis). However, it has also been recognized that it could represent a strategy for ameliorating costs of increased activity ('adaptive mass loss' hypothesis). While many predictions of these hypotheses remain difficult to disentangle (e.g., heavier birds lose more mass), we should expect key differences in timing of mass loss. Yet studies to date have relied on overall rates of mass change in a single breeding bout, thus ignoring (1) the critical workload transition (i.e., at hatch) where a 'well-timed' loss of mass preceding peak energetic demands may ameliorate workload costs and (2) how mass loss strategies may differ across breeding attempts as local prey availability declines later in the season for many avian species. Using an automated weighing system to weigh female European starlings (*Sturnus vulgaris*) from the start of incubation through day five chick-rearing, we aimed to uncover temporal mass loss signatures across first and second broods and determine if a 'well-timed' loss of mass confers greater reproductive success. Preliminary results suggest adoption of a mass loss strategy during first broods with a stepwise pattern of mass loss occurring rapidly around hatch (in 1–2 days) relative to the incubation and chick-rearing stages. Conversely, mass loss during second broods showed a linear negative relationship from the beginning of incubation. Future analysis will explore the relationship between timing of mass loss and reproductive success.

Seasonal dynamics of juvenile coho salmon in wetlands

Milner, B.

The importance of freshwater wetlands to juvenile salmon in large river networks is not well known. Juvenile salmon use of wetland habitats depends on the connectivity between rivers and wetlands which can change seasonally. During months of low precipitation and flows, wetlands may become disconnected from other riverine rearing habitats, preventing juvenile salmon from moving in and out of wetlands. These drier conditions can also lead to a reduction in wetland habitat area and water quality, making juvenile salmon more vulnerable to high temperatures and low dissolved oxygen concentrations. We studied three wetland sites in the North Thompson watershed to understand how seasonal variation in wetland connectivity and water quality influence juvenile coho salmon habitat use. Dissolved oxygen, temperature, and water level loggers were deployed to monitor seasonal variation in water quality. Monthly mark-recapture sampling of juvenile coho salmon was used to estimate juvenile coho salmon densities. Wetland connectivity to the main stem was directly influenced by main

stem discharge and physical habitat characteristics. We observed high temperatures and low dissolved oxygen concentrations in our wetland sites. Densities of juvenile coho were low in April and May in all three sites; however, fish were larger, indicating they had recently overwintered. Densities peaked in July and August and decreased in September and October, suggesting young of the year enter the wetlands in late spring and early summer. Our findings indicate that inland wetlands may be important rearing habitat for early life stages of juvenile coho as these habitats are used year-round.

Promoting ocean literacy and inspiring marine conservation through fish sounds

Spriel, B., Davies, H., Cox, K., Looby, A.

Scientists are facing unprecedented difficulty sharing their findings with the public due to increasing public distrust and apathy, especially towards topics focused on anthropogenic impacts. For marine ecologists, one strategy to address this issue is connecting with the public through outreach, with objectives to inspire marine conservation action. We present FishSounds Educate, an educational program that aims to use the topic of marine bioacoustics to encourage future ocean conservation leaders and enhance ocean literacy across Canada. The program derives content from scientific papers, bioacoustic experts, and the website FishSounds.net. Launched in 2021, the website features sound production information for all confirmed soniferous fish species and 239 audio recordings. To introduce our free program, we contacted over 80 teachers, aquariums, and naturalist clubs from September to December 2022. We utilized feedback from educators interested in participating to develop workshops and seminars for elementary- to university-level learners. Between January 1st and February 1st 2023, we visited five classrooms and delivered one university seminar, amounting to over 230 participants thus far. We have 16 additional engagements scheduled up to August 2023, and are continuing to make new connections with educators. We will collaborate with organizations including Let's Talk Science and Ocean Networks Canada to develop continuing labs for their respective programs, ensuring longevity of FishSounds Educate. We also plan to investigate workshop effectiveness through participant surveys. Our goal is for FishSounds Educate to serve as a model for marine ecologists to share their research and inspire future scientists and changemakers.

Ecosystem-level evolutionary response to temperature

Febvre, C., Goldblatt, C., El-Sabaawi, R.

An important macroscopic pattern that emerges when comparing ecosystems across Earth is the latitudinal biodiversity gradient: decreasing biodiversity from the tropics toward higher latitudes. This pattern is also detectable in the fossil record and is more pronounced during times of stronger global temperature gradients, suggesting that

temperature is an important driver of ecosystem diversity. Many biological rates are sensitive to temperature, but unanswered questions remain regarding the effect of temperature on ecosystem-level properties and dynamics. This study investigates ecosystem-level response to temperature by modelling networks of interacting species whose thermal response curves can evolve. The modelling framework allows for assessing the statistics of numerous, randomly generated ecological communities, and investigating the role of thermal response curves and metabolic theory in producing macroecological patterns such as the latitudinal diversity gradient. The results show that community survival probability increases with temperature up to a turning point temperature, above which biological degradation dominates. Speciation opportunities show similar dependence on metabolic rates. In contrast, the abundance and diversity of those ecosystems that do survive converge to similar values across a wide range of temperatures. This work produces a baseline for scaling the effects of temperature on metabolism up to the ecosystem level, disentangling the effects of temperature on community survival probability from community-level diversity and suggesting that the latitudinal diversity gradient could arise from differential community survival rather than from differences in diversity within communities.

Transformative Change towards Indigenous Food Sovereignty in Shellfish Food Systems

Armstrong, C.

Clams and other shellfish are central to coastal First Nations communities for food security, health and nutrition, economy and trade, and culture. Current shellfish management systems in BC have created barriers to a flourishing shellfish food system. This research explores the concept of transformative change towards Indigenous Food Sovereignty (IFS) as a pathway to restore shellfish food systems. The objectives are to (1) synthesize a framework for IFS in shellfish food systems, (2) identify and describe barriers to harvesting shellfish, and (3) explore levers for change to re-establish a thriving shellfish food system that benefits both people and nature. This research employs literature review with a mixed-methods qualitative approach using NVivo 12. Inductive coding is used to develop a framework that categorizes barriers based on pillars and indicators of IFS. Deductive coding is used to explore levers that instigate transformative change in shellfish food systems. The barriers identified are: (1) high levels of shellfish contaminants that pose risks to human health; (2) a lack of monitoring that contributes to long-term closures at shellfish harvest sites; (3) limited access to shellfish harvest sites due to land privatization and coastal development; and (4) loss of Indigenous culture relating to shellfish management practices. The overall recommendation is to establish a specific organization with the mandate to support Indigenous shellfish harvesters. This support could include: regional pollution identification and correction programs, regional phytoplankton monitoring and shellfish

testing, and eco-cultural restoration programs that provide opportunities for cultural resurgence.

Know your enemy: Blacklegged ticks sense and avoid ant-frequented areas

Gooding, C., Gries, R., Pinard, C., Devireddy, A., Gerhard, G.

Blacklegged ticks, *Ixodes scapularis*, are obligatory blood feeders and transmit more disease-causing microbes than any other blood-feeding arthropod. Despite their reputation as blood-feeders, ticks spend most of their lifespan off hosts. Off-host ticks are highly susceptible to predation, particularly by ants, but the mechanisms underlying ant avoidance behavior have not yet been studied. Because foraging ants deposit semiochemicals to communicate with nestmates, and because blacklegged ticks have no defenses against ant predation, we tested the hypothesis that ticks avoid ant-frequented areas by sensing the ants' semiochemical deposits. In two-choice still-air olfactometers, we show that semiochemical deposits of thatching ants, *Formica rufa*, deter adult female blacklegged ticks. The deterrent semiochemicals originate from both the poison gland and Dufour's. Extracts of both glands combined, but not of either gland alone, proved deterrent to ticks.

Local adaptation of trees to forest pests

Luo, D., O'Neill, G. A., Wang, T., Ottc, P. K.

The detection of local adaptation of forest tree species to pests could provide a new opportunity to address forest health concerns, particularly as climate change exacerbates these concerns. Taking advantage of an extensive asset of provenance and progeny field trials, we compiled health assessment records for 14 pests of six native tree species in western North America (1,522,275 records from 446,473 trees at 25 field trials and 195 field test sites) and developed transfer functions (TFs) to 1) investigate the extent of local adaptation to forest pests; 2) identify high-risk climate transfers associated with increased incidence of pest infection; and 3) demonstrate the calculation of safe seed transfer distances to avoid high risk transfers. Transfer distance of mean summer precipitation (MSP), mean coldest month temperature (MCMT), mean annual precipitation (MAP), frost free period (FFP) and mean warmest month temperature (MWMT) were found strongly related to infection from multiple forest pests. Local adaptation was found for forest population resistance to most investigated pests, and safe transfer distance was quantified using the PTFs for most combinations of tree species host-pests. Under the same climate gradients, *Endocronartium harknessii* was positively correlated to *Dendroctonus septosporum*, live crown ratio was negatively affected by both *E. harknessii* and *Dothistroma septosporum* while was positively correlated to *D. Ponderosae* for lodgepole pine (*Pinus contorta* var. *latifolia*). These

findings indicated the feasibility and necessity of including forest health to applying assisted migration to address climate associated health risk.

Biofouling, Environmental Factors, and Gill Health on Atlantic Salmon Farms

Johnson, D., Flaherty, M., Pearce, C., Cowen, L.

Recently, salmon aquaculture companies in British Columbia have experienced losses due to gill and mouth disorders. After examining and ruling out other possible causations, the present hypothesis is that the removal of biofouling communities on salmon nets via power-washing creates suspended particulate matter that impacts fish-gill health. Hydrozoans, with their stinging cells are the most likely problematic species and are known to occur in local biofouling communities. This study examined the development of biofouling communities on nets at two commercial Atlantic salmon (*Salmo salar*) farms on Vancouver Island, with a focus on identification and quantification of the various species. Five 30 x 30-cm fish-net panels were deployed at each of five depths (1, 5, 10, 15, and 20 m), totalling 25 panels per site. These panels were collected bi-weekly, with fresh panels being re-deployed, for approximately six months. Their collection occurred just before commercial net cleaning. Species growing on the nets were identified and quantified, with an emphasis on hydrozoan identification. Key environmental parameters (e.g. temperature, salinity, dissolved oxygen, pH, nitrates, ammonia, phosphates, iron, and silica) were measured daily. The gill health of fish contained within the study pens was monitored weekly for the duration of the study. The relationship between the environmental parameters, the biofouling community, and fish-gill health will be examined by various correlative statistical techniques. Results show seasonal and site patterns and variations in the environmental parameters, composition of the biofouling community, and seasonal trends in individual gill scores of fish sampled. Specific results will be discussed.

Advances in knowledge of seahorse life history from community science

Camins, E., Correia, M., Stanton, L., Vincent, A.

Marine community science presents an important route to gather valuable scientific information, expand capacity for data collection, while also influencing local management and policy, and thus contributing to marine conservation efforts. As seahorses are charismatic and cryptic species, there has been a consistent lack of knowledge and became really good candidates for using community science to overcome this gap in knowledge. Using the community science project iSeahorse, we have assessed all the collected data till April 2022 for 35 seahorse species. And compared the obtained results with the existing IUCN Red List assessments, done between 2014 and 2017, to better understand the potential of iSeahorse in expanding seahorse knowledge. Our results show updated geographic ranges for seven seahorse

species, new habitats described for 24 species, 14 species had observations outside the IUCN Red List depth range, and obtained information of sex ratio for 15 species and of pregnancy seasonality for 11 species. One example of species that benefit from this information is *H. colemani*, for which we obtained proves that it's geographic range is bigger than we thought it was. Moreover, we also obtained some new information of habitat and depth for this species. With these results we demonstrate the power of iSeahorse and community science in general in expanding the knowledge of seahorses, which are widely understudied, and helps us understand the potential contribution of marine community science projects in IUCN Red List assessments.

Can ancient clam gardens buffer the impacts of contemporary heatwaves?

Spencer, E., Britton, A., Thomas, K., Norris, N., DeRoy, B., Slade, E., Green, T., Harley, C. D.G., Salomon, A. K.

Societies around the world are grappling with the challenge of maintaining productive food systems that are resilient to contemporary and future disturbances. One example of Indigenous management systems are clam gardens, intertidal rock-walled terraces made by people that can quadruple clam biomass. Experimental evidence suggests that clams have higher growth rates in clam gardens than in non-walled beaches due to moderated temperatures and enriched sediment carbonate associated with crushed shells. We hypothesize that clam gardens may reduce the effects of extreme climatic events, like the 2021 heat dome in the Pacific Northwest by moderating the clams' internal body temperature and reducing energetically costly heat shock responses (HSR). In collaboration with nine Coast Salish Nations and the Gulf Islands National Parks Reserve, we simulated a heatwave in situ to evaluate if, and to what extent, clam gardens and their carbonate-rich sediment can buffer the effects of heatwaves on sediment temperature and the clams' HSR. Compared to the non-walled beach, we detected lower subsurface sediment temperatures at the clam garden, matching summertime trends observed elsewhere on the coast. We used qPCR to test for differential heat shock protein expression amongst experimentally transplanted clams. This study may reveal the physiological mechanism that supports higher growth rates of clams in clam gardens and improve our understanding of how clam gardens can serve as climate change adaptation strategies for coastal Indigenous Nations.

Evolutionary isolation of Canadian terrestrial vertebrate species

Kominek, E., Cornies, O., McCurdy-Adams, H., Mooers, A. Ø.

Conservation prioritization has become increasingly important as a practical response to on-going biodiversity loss and limited resources. One tool, evolutionary distinctiveness (ED) is based on a measure of evolutionary isolation and has merit for identifying taxa with few close relatives. Here we present the first-ever national-level ED

scores for all Canadian tetrapods. We updated and pruned global dated phylogenies of all terrestrial vertebrates (amphibians, squamates, turtles, mammals, and birds) down to native Canadian species and calculated Canadian ED scores for each and compared them to their global ED rankings. Whereas the average species age of a terrestrial vertebrate globally is four million years, Canadian species join the Canadian phylogeny on average 6 million years ago. Canada's terrestrial ectotherm vertebrates (amphibians and reptiles) represent most of Canada's most evolutionary isolated species and many score higher nationally than globally in their ED scores. These taxa are also the most imperilled in Canada and so species with populations assessed as at risk by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) represent, on average, more than expected evolutionary history. Interestingly, several exotic species also have very high national ED scores. To the extent that evolutionary isolation captures aspects of local and national biodiversity worth preserving, our lists may provide useful input to conservation agencies engaging in conservation prioritization exercises.

Hare population cycles impact lynx genetic diversity and gene flow

Hersh, E., Whitton, J., Gorrell, J., Harrower, W.

The iconic Canada lynx – snowshoe hare population cycle is a key predator-prey process regulating biodiversity in the boreal forest of North America. As snowshoe hare populations rise and fall over 10-year periods, populations of lynx follow suit. Past genetic work has indicated that lynx populations are nearly panmictic at the continental scale. However, some lynx disperse vast distances as hare populations decline, suggesting that population structure and diversity may vary during different phases of the cycle. We used thousands of genome-wide markers to analyze lynx diversity, relatedness, and population structure across phases of the most recent cycle in the northwest boreal region. We identified a significant proportion of close relatives (~10%) across different localities, indicating recent long-distance dispersal events. All sampled lynx belonged to a single genetic cluster regardless of cycle phase, which is likely a result of increased dispersal and gene flow during cycle declines. Finally, we found that diversity increased over the course of the cycle, which may be driven by bottleneck-induced inbreeding at the beginning of the cycle and subsequent recovery as the population grows. These results highlight the cycle as an important mechanism influencing lynx dispersal and genomic patterns of structure and diversity.

Social/environmental tradeoffs of green burial as land conservation tool

Gawron, G.

The modern green burial movement counters the toxicity of conventional burial practices by eschewing chemical cremation, non-biodegradable caskets, and vaults.

Since, by law, burial ground in Canada must be protected and maintained in perpetuity, green burial offers a unique opportunity for well-protected and well-funded natural restoration and conservation projects. However, the current literature on "conservation burial" focuses exclusively on its financial and logistical benefits, without taking into account its human dimensions. This research consists of site visits to four natural burial grounds and semi-structured interviews with green cemeterians on Vancouver Island, the Gulf Islands and the Lower Mainland. Over the course of these case studies, the issue of trade-offs made on (and in) the green burial ground to meet the triple bottom line of ecologically sound, affordable, and meaningful burial emerged as the central problem faced by green burial practitioners. Analyzing this data with respect to B.C. policies governing cemeteries and the certification requirements set forth by the Green Burial Society of Canada reveals a gap between the theory and practice of conservation burial. This failure to meet the triple bottom line most frequently takes the form of conflicts of interest arising from the sensitivity of memorialization work set against the strictures of ecological stewardship. Ultimately, this research shows that as green burial grows in popularity, a deeper understanding of the emotional and social needs met by cemeteries is necessary to realistically plan the ecological future of burial land.

Reversed Sexual Dimorphism and Resource Partitioning in black oystercatchers

Roodenrijs, H., Green, D.

Reversed sexual dimorphism, where the female is larger than the male, has evolved across multiple avian taxa. Several hypotheses exist on why this evolved, but one testable hypothesis focuses on resource partitioning, where dimorphism in bill length can reduce intersexual competition. In many shorebird species, females have significantly longer bills than males which often leads to differences in diet between the sexes. Black oystercatchers (*Haematopus bachmani*) are a shorebird species where bills of females are, on average, 9% longer than males. We used stable isotopes to investigate whether black oystercatchers partition resources by quantifying diet proportions across British Columbia, Canada and Alaska, USA. Despite this large dimorphism, we found no evidence of resource partitioning between the sexes, suggesting that a mechanism other than resource partitioning drives reversed sexual dimorphism in this species.

Exploration of intraspecific variation in fish stoichiometry within a watershed

de Haas, H., Mickens, A., Schenk, K., El-Sabaawi, R.

The elemental composition of organisms can affect the way they interact with their environment through differential resource acquisition and excretion. Ecological stoichiometry is a framework used to predict the impact an organism has on its environment by examining organismal, diet, and excretory stoichiometry. Most research

focuses on interspecific variability in organismal stoichiometry, however, intraspecific variability is poorly understood. Studying intraspecific variability in elemental composition can help us better understand the extent, potential drivers, and ecological consequences of such variability. To study variability in elemental composition, *Gasterosteus aculeatus* (threespine stickleback) were collected from 8 sites along the Cowichan River drainage basin. This system allows us to explore intraspecific variation in elemental composition in relation to environmental (pH, dissolved oxygen, turbidity, conductivity) and organismal factors (armour cover, sex, body size). Elemental composition was quantified by determining the % Phosphorus (P) in the entire body and within boney armour structures. The drivers and extent of variation in bone mineral density (%P bone) are not well understood; *G. aculeatus* is the ideal candidate for exploring this variability as their armour structures are made of bone, which is the largest pool of P within vertebrates. We assessed the extent of variation in both whole body %P and bone mineral density and examined the influence of environment and armour traits on organismal stoichiometry. By examining organismal stoichiometry across habitats, we can better understand what role the environment plays in trait evolution, tease apart the drivers of intraspecific variation, and make predictions on the ecological consequences.

Unveiling reciprocal contributions between fishers and seabirds in the Patagonian hake fishery

Ojeda, J., Morello, F., Suazo, C. G., Ban, N. C.

Fishing activities are often characterized by how marine life benefits people (ecosystem services between fishers and commercial species). Alternatively, Indigenous scholars and ethical thinkers emphasize the need to encompass other ways of relationship, such as nature-people reciprocity. The reciprocal contributions concept is a conceptual tool to explore these reciprocal relationships in social-ecological systems. This work explores the reciprocal contributions between artisanal hake fishers and seabirds in Patagonia, Chile. We used an ethnographic approach to conduct semi-structured interviews with hake fishers as well as participant observations on fishing operations to understand the fishers' relationships with seabirds. From a seabird's ecological perspective, we evaluated food provision from fishers to seabirds by consumption of offal based on stomach, liver, and gonad items. We offered offal items at random to determine feeding preferences. We discovered four attributes based on fisher perceptions: seabirds are indicators of productive areas, seabirds provide companionship in fishing activities, albatrosses contribute to scenic beauty, and seabirds help to clean the sea. We observed that seabird assemblage consumed the liver 99% of the time, while they consumed less stomach (31.8%). Southern giant petrels (61.4%) and black-browed albatrosses (28.6%) consumed more liver, while kelp gulls (60.6%) ate more stomach. The liver is composed of 51.6% fat, essential for

top-level marine predators such as southern giant petrels. In conclusion, characterizing reciprocal contributions between fishers and seabirds can broaden and improve fishing assessments.

The persistence of a selfish X chromosome in a common woodland fly

Radford, J., Perlman, S.

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, there are many avenues to pursue with regards to 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.

Eyes on the Reef: Using remote timelapse cameras to reveal the hidden habits of marine megafauna in a newly designated UNESCO Biosphere Reserve

Zerr, K., Baum, J., Hilbourne, S., Stevens, G.

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 typus*). 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.

Selection for genes underlying Bergmann's Rule

Carbeck, K., Arcese, P., Lovette, I., Pruett, C., Winker, K., Walsh, J.

Ecogeographic rules denote spatial patterns in phenotype and environment that may reflect local adaptation as well as a species' capacity to adapt to change. We compared 79 genomes from 9 song sparrow (*Melospiza melodia*) subspecies that vary ~300% in body mass (17 - 50 g) to identify genes underlying Bergmann's Rule, which posits that spatial correlations of body mass and temperature reflect historic selection and local adaptation in endotherms. Comparing large- and smaller-bodied northern subspecies revealed nine candidate genes in three genomic regions associated with body mass. Further comparisons to the five smallest subspecies endemic to California revealed nine SNPs in candidate regions of four genes (*GARNL3*, *RALGPS1*, *ANGPTL2*, and *COL15A1*) associated with body mass and varying as predicted by Bergmann's Rule. Our results strongly support the hypothesis that co-variation in environment, body mass and genotype reflect historical selection, local adaptation, and a capacity for contemporary evolution in this highly diverse species.

Using satellite remote sensing to characterize the spatio-temporal resilience of kelp forests in the Broughton Archipelago, BC, Canada

Man, L., Barbosa, R. V., Neufeld, C., Gendall, L., Wachmann, A., Wadhams, A., Johnson, J., Alfred, J., Webber, J., Okey, T.A., Costa, M.

Kelp forests are highly productive coastal ecosystems found on 25% of the world's coastlines. In British Columbia, these habitats are dominated by giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystis luetkeana*), which act as three-dimensional foundation species that foster high levels of biodiversity, and support finfish production including juvenile salmon. Kelp abundance and health depend on a variety of environmental variables such as sea-surface temperature, hard substrate availability and also on biotic variables like the abundance of kelp grazers and keystone species. Here, we evaluate changes in kelp distribution in the Broughton Archipelago to 1) determine areas with specific trends such as persistence, decline, or variation and 2) evaluate the drivers of kelp change. The Broughton Archipelago is located at the interface of the Johnstone Strait and the Queen Charlotte Strait, and it experiences

strong oceanographic variation between exposed coastlines and sheltered inlets. There is increased interest in the condition of kelp within the region after the formation of the Broughton Aquaculture Transition Initiative (BATI) of the 'Namgis, Mamalilikulla, and the Kwikwasuitinuxw/Haxwa'mis First Nations, which this study contributes to. To achieve our objectives, we performed a preliminary analysis of kelp persistence within the region from satellite imagery and historical British Admiralty nautical charts created between 1858-1956 to select potential field work sites. The selected sites display variable levels of change, with some showing persistence throughout the years, some showing some level of change, and some showing kelp loss. Fieldwork was conducted in July 2022 at the selected sites (n=32). At the field sites, a combination of remotely operated vehicle (ROV) underwater transects, drop quadrats, drone flights, and water profiles were conducted to capture in-situ data such as seawater temperature, salinity, in-water light availability, kelp condition, seafloor substrate, understory kelp types and the abundance of kelp grazers in the region. The data showed that larger and denser kelp beds were observed in areas with higher current exposure, and that smaller fringing kelp beds were found in more sheltered areas such as inlets; areas with lower salinity showed sparse kelp beds or no kelp at all. The results of this study are fundamental for the conservation of kelp forests and marine spatial planning in the Broughton Archipelago.

Power Analysis in Occupancy Models of Acoustic Data from Haida Gwaii

Leston, L.

Autonomous recording units (ARUs) are increasingly used to monitor wildlife with multiple recordings per site per field season. We investigated the minimum necessary number of sites and/or recordings per site within and across seasons to detect: 1) significant effects upon occupancy; and 2) detection and significant trends in occupancy over time. We used actual and simulated occupancy data of 20 bird species from 572 ARU recordings collected by Parks Canada (1 Apr - 15 Aug) at 91 stations in the Haida Gwaii Archipelago, British Columbia, Canada. We used occupancy models to estimate environmental effects on detection probability and probabilities of occupancy and detection for each species. We then estimated: 1) power to detect a change in occupancy between two sets of sites (as in different years); and 2) power to detect effects of predictors on initial occupancy, detection, colonization, and extinction at sites across 5-year (50% trend), 7-year (30% trend), and 10-year (10% trend) periods. Power to detect occupancy differences increased nonlinearly with both occupancy and detection probability of each species and with number of sites and/or temporal replicates per site per season for each species. Power was sufficient (0.80) to detect 50% and 30% differences in occupancy in 7 and 5 species, respectively. To obtain more sites for analysis and monitoring programs, ARUs can be moved within seasons to multiple locations within a cluster. With one week at each location in the summer, it will be possible to obtain tens or dozens of temporal replicates per location.

The contribution of Red Alder to forest stand nitrogen budgets

Nehring, L.

Red Alder (*Alnus rubra*) is a native coastal hardwood in British Columbia that has a symbiotic relationship with the nitrogen-fixing actinomycete, *Frankia*. This research uses $\delta^{15}\text{N}$ signatures in soils, wood and litter to assess the contribution of nitrogen-fixing Red Alder to the components of stand nitrogen budgets. In this study, a subset of B.C. Ministry of Forests' long-term Experimental Project 1121.01 at Holt Creek was used as the site contains Douglas-fir and Red Alder stands in five proportions (Red Alder: Douglas-fir proportions: 100/0, 50/50, 25/75, 11/89, 0/100). Increment cores were taken along with soil and litter samples and analyzed for essential mineral elements and $\delta^{15}\text{N}$. I hypothesized that Red Alder would enhance soil nitrogen stocks and elevate $\delta^{15}\text{N}$ signatures and that these changes would be observable in the $\delta^{15}\text{N}$ signature of the tree rings of both species. Forest floor soil under Red Alder in the 100/0 plot was significantly deeper and enriched in total nitrogen, and $\delta^{15}\text{N}$ was elevated. The litter of the two species did not differ in $\delta^{15}\text{N}$. The forest floor nitrogen enrichment effect was visible in the tree rings of Douglas-fir in the 50/50 stand, confirming that the impact of fixed nitrogen can be observed in non-fixing species. This research provides insight into the long-term effects of nitrogen fixation by Red Alder and its influence on pure and mixed-stand nitrogen budgets. This ultimately can be used to inform both forestry and reclamation practices that seek to use Red Alder.

How boat noise alters behaviour and vocalizations in plainfin midshipman fish

Woods, Mackenzie B., Halliday, W. D., Balshine, S., Juanes, F.

Anthropogenic noise has drastically changed natural soundscapes, negatively affecting 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.

Intraspecific variation and osteology of the Rocky Mountain sculpin

Dueck, M.

Cottus, a genus of freshwater sculpins, presents a taxonomic challenge due to inconsistent morphological features within and between taxa. Found in only three Canadian watersheds, the Rocky Mountain sculpin (*Cottus* sp. RMS), is a source of taxonomic confusion. *Cottus* sp. RMS has previously been misidentified as *C. bairdii*, and *C. confusus*, along with other sculpin species, but is now considered a distinct taxon awaiting formal taxonomic description. The objective of this study is to assess intraspecific variation of external morphology and osteology of *Cottus* sp. RMS from the three Canadian watersheds it inhabits. Previous work has identified that the populations of *Cottus* sp. RMS found in each of these watersheds is a distinguishable unit with genetic and morphometric differences. I collected measurements and counts from specimens of *Cottus* sp. RMS from Lee Creek (n = 55), Milk (n = 46), Flathead (n = 8), and St. Mary (n = 91) rivers to assess intraspecific variation in this species. Select specimens have been cleared and counterstained for cartilage and bone to describe and compare the osteology of individuals from different rivers. An understanding of the intraspecific variation within a species of *Cottus* will be informative for addressing taxonomic confusion and establishing natural classifications within the genus.

Snails of Theseus: Highly Derived Shell of Hydrothermal Vent Gastropod

Quindazzi, M., Tunnicliffe, V.

Human activities leading to the increase of atmospheric carbon dioxide levels are causing ocean acidification. The acidification of the oceans is of concern especially to organisms that rely on calcium carbonate structures, such as most members of Gastropoda. Hydrothermal vent organisms are useful proxies for studying the effects of extreme acidification, since pH levels are generally below predicted values for 2100. Since the first discovery of life at hydrothermal vents less than 50 years ago, highly derived animals have been found with unique adaptations to their extreme environments. The members of the genus *Alviniconcha* are one such example. These snails live in diffuse vent flow conditions where temperatures can reach 40°C and the pH drops below 6.0. To cope with their acidic environment, the *Alviniconcha* have evolved a shell repair mechanism involving alternating layers of organic matrix and calcium phosphate crystal. This repair mechanism has no counterpart and represents a highly derived characteristic in the face of a chronically acidic environment.

Assessing effects of acclimation temperature on thermal tolerance of stream-type juvenile Chinook salmon under ecologically relevant temperature ranges

Butler, N.A., Eliason, E.J., Lotto, A.G., Hinch, S.J.

Fish were acclimated for two weeks at temperatures spanning present and expected future summer levels (15°C, 18°C, 20°C, 24°C). Using fish from each acclimation temperature, we measured: 1) endurance swimming (Eswim), where swimming fish were exposed to increasing speeds at each temperature, 2) critical thermal maxima (stationary) (CTmax stat) where water was heated (0.3°C/min) in a stationary tank, and 3) critical thermal maxima (swimming) (CTmax swim) where water was heated (1°C/30min) while fish swimming at a fixed speed. Fish acclimated to higher temperatures generally exhibited higher thermal tolerance, based on CTmax stat and CTmax swim trials, though fry exhibited a greater sensitivity to increased temperatures. However, swim performance impairment was greater at the 24°C acclimation treatment for both CTmax swim and Eswim trials in parr and fry, indicating an upper thermal limit with differing responses between life stages.

Are glass animals important to the global silicon cycle?

Melville, O., Varela, D.

Silicon is a fundamental element to biogeochemical cycles, ultimately linked to carbon cycling via biological uptake. However, the silicon cycle is not fully constrained due to unknown fluxes and biological reservoirs. Siliceous Rhizaria are a group of zooplankton which create their skeletons with dissolved silicon (dSi) and are found in all ocean basins, representing an understudied component in the silicon cycle. The marine silicon cycle is dominated by photosynthetic diatom production; however diatoms only inhabit lit surface oceans where nutrients are also available. Rhizaria, on the other hand, have been found to flourish in oligotrophic areas, as well as in deep parts of the ocean with no access to light. In this project I am investigating the community composition of siliceous Rhizaria and their silicon uptake rate using ^{32}Si as a tracer in the Northeast Pacific Ocean. The project aims to help constrain biological contributions to the global silicon cycle by examining this understudied group. The results indicate that siliceous Rhizaria are found in low abundances in the Northeast Pacific, with differing composition as sites move further from the coast. Rhizaria silicon uptake was found to be variable among taxa, suggesting potential important contribution from certain groups to overall silicon cycling in marine environment.

Fraser estuary Chinook and dietary differences between populations

Roper, P., Scott, D., MacDuffee, M., Hinch, S. G.

Diet affects early growth and impacts the overall success of salmon individuals, but several factors may influence the type of prey consumed and energetic reserves of individuals before out-migrating to the ocean. The Fraser River is the largest producer of Pacific salmon in Canada with millions of juveniles out-migrating each spring. Estuaries are crucial stopover areas for juvenile Chinook salmon (*Oncorhynchus tshawytscha*) who can reside in this habitat for over a month. In the Fraser estuary, eelgrass (*Zostera marina*) habitat provides diverse prey, refuge from predators, and is a transition zone to acclimate to saline conditions for out-migrating juvenile Chinook. Early diet and size of juvenile Chinook varies between wild and hatchery production types and can result in differences in prey choices during residency in eelgrass habitat. To gain a comprehensive understanding of wild and hatchery juvenile Chinook diet in eelgrass habitat, we analyzed stomach contents and stable isotopes values from the tissue of individuals captured in eelgrass habitat on Roberts Bank. Stable isotope signatures found in the tissue of juvenile Chinook differed by population, wild Chinook salmon had relatively wider dietary ellipses, and hatchery Chinook signatures were reminiscent of food from their hatcheries. Wild Chinook transitioned to piscivory and had fuller stomach compared to hatchery Chinook. We will discuss how an individual's size and prey selection are connected and the importance of diet in this life-stage.

Audit of Remediated Culvert Barriers in the Fraser River Watershed

Zubick, P., Sherker, Z., Lapointe, N., Hinch, S.

Pacific salmon habitat has been targeted for culvert barrier remediation projects due to broad declines in their populations across their range, attributed in part to habitat fragmentation. Small-scale barriers like culverts fragment more linear stream habitat than dams and are a major issue for Pacific Salmon. In British Columbia, there are over 200,000 barrier culverts that restrict fish passage. Two techniques are used to restore fish passage at barrier culverts (retrofit or replacement), and best practices to restore fish passage have been developed. However, it is unknown whether culvert restorations continue to meet best practices or if fish passage changes through time. To address this knowledge gap, we performed a post-treatment audit on culvert barrier restorations in British Columbia. We hypothesized that the technique applied will affect how a restoration meets best practices and that fish passage will be impacted if not met. Furthermore, we expected retrofit sites to meet best practices less frequently as they will not have addressed the original cause of barrier development. At each site, we collected data on the restoration structure and habitat. We assessed these data against current best practices for culverts and performed a fish passage assessment. We found that the conditions at all sites do not fully meet best practices and that 56% of sites are

fish-passage barriers. These results show that the techniques used to restore fish passage at culverts are prone to failure, and that post-restoration monitoring should be prioritized to ensure fish passage is maintained.

How is local phylogenetic diversity changing globally?

Fernandez-Fournier, P., Carroll, T., Dornelas, M., Mooers, A. Ø.

Ecosystems are witnessing drastic changes in biodiversity worldwide. However, it is still unclear whether changes in phylogenetic diversity, another facet of biodiversity, reflect observed changes in taxonomic diversity. Using a database of compiled assemblage time-series from all around the world, we estimated changes in phylogenetic diversity in marine fish, birds, mammals and plants. We estimated how phylogenetic diversity has changed compared to taxonomic diversity and whether there were diverging patterns across taxonomic groups. We found that most taxonomic and phylogenetic diversity metrics did not significantly change through time. Importantly, we found that the average relatedness among co-occurring species has decreased in fish and birds and increased in mammal assemblages, whereas we found no pattern in plant assemblages. Our findings support the growing body of literature suggesting that assemblages are changing in composition but not richness and that these changes significantly alter the evolutionary makeup of assemblages at the local scale. We emphasize the need for examining the evolutionary identity of species during temporal turnover and for assessing the anthropogenic drivers of those changes. We also encourage a framework of incorporating multiple biodiversity facets for all future studies of local biodiversity change.

A Landscape Archaeological Approach to Chimpanzee Accumulative Stone Throwing

Nakano, R.

In Boé National Park in Guinea-Bissau, wild Western chimpanzees (*Pan troglodytes verus*) have been observed engaging in a potentially cultural behaviour: accumulative stone throwing (AST). Individuals habitually throw rocks at particular trees, making AST a unique instance of non-foraging stone tool use. Although previous research suggests that AST has a communicative function and is influenced by the trees' acoustic properties, it is unclear what factors impact individual site selection. I identify patterns in the spatial proximity of certain resources, landscape features, and chimpanzee and human space-use to AST sites by mapping their distribution using QGIS. These include indirect chimpanzee observations, tree, rock and water sources, and signs of human activity. The study area encompasses approximately 100 km², with data from spatially explicit observations collected during reconnaissance surveys by previous research teams in 2014 and 2017. At the time of data collection, there were a

total of 56 AST sites with 14 actively used by chimpanzees. The presence or absence of AST sites is modeled in R using binomial generalized linear models to determine the influence of resource availability and landscape features on the likelihood of AST site presence. Site selection is influenced by the proximity of important food tree species and AST sites are more likely to arise in areas with high chimpanzee activity. Improved understanding of primate behaviour can inform inferences relevant for hominin evolution and the development of behavioural flexibility and provide support for the maintenance of biological and cultural diversity in endangered chimpanzee populations.

Addressing Climate Anxiety through Participatory Art

Guzman Skotnitsky, S.

As inheritors of the climate crisis, young people in particular are struggling with higher rates than ever of climate anxiety and other forms of eco-distress triggered by the increased intensity and frequency of climate change impacts. As a young person and climate justice advocate, I know from lived experience how these emotions can lead to immobilization, depression, and burnout. Having explored the impacts of movement toxicity and burnout on activist retention through my undergraduate thesis, I have come to understand that relationship building and mental wellbeing are critical to the success of the climate justice movement. Youth are a large driving force of this movement worldwide, which is why it's essential we support them to sustain their action for the long haul. Scholars have found that art and storytelling can be powerful tools for healing, resilience-building and fostering community among people who share common mental health struggles. My Master's research asks, how then can art and storytelling be used to help young people grapple with these difficult eco-emotions, envision better futures and generate active hope? This presentation will cover 1) unique challenges but also the strengths of youth living through the climate crisis, 2) the value of arts-based approaches in research methods and mental health services, and 3) practical resources on climate change and mental health.

Rare Species Recovery in an Urban Greenspace through Community Stewardship

Gibson, C., Henderson, S.

Our 'Rare Species Recovery in an Urban Greenspace through Community Stewardship' project aims to conserve and protect Yellow Montane Violet (*Viola praemorsa*) and the Garry Oak meadow habitat on Christmas Hill overall, helping to preserve one parcel of a Canadian crisis ecoregion. The Christmas Hill ecosystem includes diverse assemblages of some of the region's rarest plant communities, including deep-soil Douglas fir and Garry oak woodland, rock outcrop, and vernal pond communities. Despite having the greatest diversity of land plants in coastal BC, 25 plant, six invertebrate, and six vertebrate species are currently considered at risk in this

habitat. Christmas Hill is home to approximately 250 plant species and eight plant species at risk. This work is linked to larger ecosystem benefits of watershed management and conserving some of the last remaining 3% of Garry Oak meadow in Canada. Following a habitat-wide recovery approach, this project will also benefit Garry oaks and various other species including Banded Cord-Moss, White-Top Aster, Tall Woolly-Heads, and other sensitive species on site, such as Common Nighthawks, Olive-sided Flycatchers, Barn Swallows, and Purple Martins. Our work proposed here is not only urgent provincially and regionally in terms of its tangible outcomes, but also with respect to training local stewards. Given our urban location, the Nature Sanctuary affords an accessible opportunity to welcome learners on site. As we face ever-growing urban human densities, we must convey to our community how to conserve habitat and prevent the loss of additional species.

Elements of conservation messages that sustain whale watchers pro-environmental behaviours

Board, S.

Whale watching has been described as a form of eco tourism where the sustainability of the industry is in balance with the sustainability of the species being viewed. Through an inductive lens this research study aimed to find out what elements of conservation messaging associated with, and delivered during whale watching experiences in the Salish Sea Bioregion sustained the pro-environmental attitudes and behaviours of adult whale watching participants longitudinally. Twenty-five naturalistic observations that focused on the crew/naturalists of two Victoria based whale watching companies were conducted. The conservation messaging given to passengers was recorded through field notes. Following the observed wildlife viewing, adult whale watching passengers were invited to complete a survey regarding their experience and learning. The results of 123 completed surveys showed that the majority participants' pro-environmental attitudes significantly increased due to the whale watching experience. An increase in pro-environmental behavioral intentions was also found. Eight semi-structured interviews were conducted between 24 and 54 days after the interviewees whale watching experience. The interviews were thematically coded, and showed a pro-environmental behaviour change in the result of increased awareness and effort in regard to implementing previous pro-environmental behaviours. The elements that lead to this change were the stories of individual whales as well as the impact of witnessing whale/cetacean behaviours as they occur naturally and the emotional connection these create. The recommendation is therefore for the already established onboard interpretation to increase this connection by focusing on the affective domain of passengers.

Megafires' and the recovery of culturally significant plants

Dickson-Hoyle, S., Stuxwtéws; Skeetchestn Natural Resources Corporation; Eatherton, A., Daniels, L. D.

The increasing frequency and severity of megafires throughout western North America poses a significant threat to ecosystems and biodiversity. Concurrently, there is a growing shift in fire management towards the restoration of fire-adapted ecosystems, including the restoration of historical fire regimes and Indigenous fire stewardship. However, there is relatively little attention to the impacts of fire on understory plant communities, which are a major contributor to forest biodiversity and of important cultural value to Indigenous peoples. To address this gap, we initiated a four-year collaborative monitoring project with Stuxwtéws (a Secwépemc Nation community) to examine understory plant community recovery following a large, mixed-severity wildfire that burned in the dry mixed conifer forests of southern British Columbia in 2017. We established 66 stratified-random plots, stratified by forest ecosystem type and fire severity class. We assessed ground fire effects to calculate Composite Burn Index (CBI) as a metric of fire severity, as well as understory species composition and abundance. Four-years post-wildfire we recorded 196 species (155 native, 33 exotic, 8 unidentified); 98 of these species have a documented and ongoing use by Secwépemc people. Regression modelling identified both understory and overstory CBI as significant drivers of species richness and diversity, with contrasting effects on native, exotic and culturally significant species. Community composition analysis further highlights the distinct responses of plant groups across fire severity and ecological gradients. These results, and implications for post-wildfire restoration, will be discussed, alongside recommendations for restoring culturally significant plants through the use of prescribed and cultural fire.

Camera traps: pushing the limits of their use

Young, S.

Camera traps are powerful tools used worldwide to monitor biodiversity. From snow leopards in the mountains of Asia to the greening of the Arctic, these cost-efficient cameras can gather detailed information on species' spatial distributions, densities, and phenology. To do so, cameras are set up differently based on the research goal. Across the world, 95% of cameras monitor wildlife through motion-triggered images. Out of the remaining 5%, most cameras exclusively track plant phenology through timelapse imagery, and a few are used to track both plants and wildlife through motion-triggered and timelapse images. As COVID-19 put on hold all international travels, my data collection to monitor plant phenology was suddenly restricted to motion-triggered images meant to capture wildlife. This prompted the question of how a camera trap set up exclusively for wildlife can monitor plant changes across a landscape. With a dataset

ranging from 2016 to 2022 from a field site in Kyrgyzstan, I am investigating if cameras set up to monitor snow leopards can be additionally used to track plant phenology. Moreover, defining the number of images necessary to monitor various plant parameters (i.e. phenology, composition, abundance) will allow research teams focusing on plant biology and biogeography to utilize 95% of camera trapping data accumulating worldwide currently only being used for wildlife monitoring.

Energetic and genomic responses of oysters to a changing ocean

Gray, S., Pearce, C., Mackenzie, C., Montgomery, E., Walker, C., Raap, M., Gurney-Smith, H., Bates, A.

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 (pCO₂), 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 pCO₂ can impart different effects that are non-additive and may be subject to biological compensation mechanisms. Here we experimentally tested for independent (one stressor) and co-occurring (two stressors) climate exposure effects on juvenile Pacific oysters (*Crassostrea gigas*) and quantified their biological, physiological, and genomic responses. Two factors (pCO₂ 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. Condition indices showed an inflection point at around week 6, indicating that higher temperatures affected the oysters regardless of pCO₂ level. Other data are currently being analyzed. We are following up this initial experiment with a second one, investigating potential benefits of integrated multi-trophic aquaculture (IMTA) in mitigating high pCO₂ by holding juvenile Pacific oysters with California sea cucumbers (*Apostichopus californicus*) and sugar kelp (*Saccharina latissima*). Our results combining condition index, gene expression, and carbonate chemistry in response to multiple stressors advances our predictions for climate change impacts on sustainable aquaculture systems, including both mono-culture and IMTA systems.

Response of boreal songbird communities to linear features of varying width

Kalukapuge, T., Leston, L., Bayne, E.

Alberta's boreal forest is heavily dissected by linear features such as seismic lines, pipelines, powerlines, and roads. Linear features vary substantially in width. Although the impacts of linear features on songbird communities have been reported, there is considerable ambiguity on how different linear feature widths and thresholds

influence bird communities in the boreal forest. We tested the hypothesis that bird community composition change as a function of linear feature width. We sampled on-footprint and edge bird communities using autonomous recording units (ARUs) across over 300 different linear feature sites including seismic lines, pipelines, and transmission lines in north and northeastern Alberta. Our initial findings suggest that the width of linear features has a notable influence on the songbird communities as communities present in narrow, intermediate and wide linear features show distinct community compositions and narrow linear features tend to support a high abundance of mature forest species like Ovenbirds. Understanding the impacts of linear feature width on boreal songbird communities will provide valuable information for provincial bird models used for regulatory decision making, rather than treating all linear features as being the same width.

ATP signaling in sneezing sponges and the evolution of coordination

Ho, V., Goss, G. G., Leys, S. P.

Sponges (phylum Porifera), one of the earliest diverging metazoan lineages, lack a nervous system, yet they are able to sense and respond to their environment with coordinated contractions that expel water from the whole body. Contractions can be triggered by neuroactive molecules such as glutamate. Purinergic signaling often works together with glutamatergic signaling in the nervous systems of many animals, leading us to ask whether ATP also works with glutamate to coordinate contractions in sponges. Genes for glutamate receptors, as well as for ATP-activated purinergic P2X receptors, are found in several sponge transcriptomes & genomes. Using pharmacological approaches on the freshwater sponge *Ephydatia muelleri* - an emerging model system that can be easily cultured in the lab - we show that ATP triggers the expansion of excurrent canals, but prevents them from returning to their initial resting state. When incubated with apyrase, an enzyme that hydrolyzes ATP, sponges can undergo complete contractions when ATP is added, however when glutamate is added instead, the excurrent canals become constricted. Blocking purinoceptors with PPADS prevents glutamate-triggered contractions entirely. These data suggest an essential role of ATP in coordinating contractions, and that ATP and glutamate work in a balanced feedback loop to regulate sponge behaviour. Furthermore, our phylogenetic analysis of protein sequence alignments show that P2X receptors are highly conserved in metazoa and beyond. Our findings contribute new knowledge in understanding the physiology of sponges, and provide new insight into the evolutionary origins of the nervous system.

The impact of climate change on endangered conifer tree species

Xu, W.

Climate change results in the habitat loss of many conifer tree species and jeopardizes species biodiversity and forest ecological functions. Delineating suitable habitats for tree species via climate niche model (CNM) is widely used to predict the impact of climate change and develop conservation and management strategies. However, the robustness of CNM is broadly debated as it usually does not consider soil and competition factors. Here we developed a new approach to combine soil variables with CNM and evaluate interspecific competition potential in the niche overlapping areas. We used an endangered conifer species - *Chamaecyparis formosensis* (red cypress) - as a case study to predict the impact of climate change. We developed a novel approach to integrate the climate niche model and soil niche model predictions and considered interspecific competition to predict the impacts of climate change on tree species. Our results show that the suitable habitat for red cypress would decrease significantly in the future with an additional threat from the competition of an oak tree species. Our approach and results may represent significant implications in making conservation strategies and evaluating the impacts of climate change, and providing the direction of the refinement of the ecological niche model.

Effectiveness monitoring for culvert and floodgate remediations to improve salmon migrations

Sherker, Z., Zubick, P., Hinch, S.

Pacific salmon are currently barred from thousands of kilometers of spawning and rearing habitat in British Columbia by ill-fitting culvert barriers and improperly functioning floodgates. Culverts were initially installed to rapidly transport water past instream infrastructures (e.g. road crossings), but over time have degraded to form one of the most numerous barriers to fish movement globally. Floodgates can remain closed for weeks to months at a time, blocking access to thousands of kilometers of invaluable floodplain habitat. Failed culverts and floodgates have culminated into an intricate, and poorly quantified, network of barriers to fish in B.C., with the strongest impact being felt by obligatory migrators such as potadromous and anadromous salmonids. Tens of millions of dollars have been spent to remediate barrier sites and reopen otherwise viable stream and floodplain habitats, though little effectiveness monitoring has been done. To evaluate the efficacy of various culvert remediation strategies, we assessed fish passage at 30 culvert remediation sites that employed an array of barrier mitigation techniques (e.g. installation of baffles, rock weirs, fishways, culvert removal and replacement with open bottom structures) by comparing fish community structure and abundance upstream and downstream 10-15 years post-remediation. We have also been using radio telemetry to monitor juvenile salmon passage into overwintering

habitats upstream of floodgates on the lower Fraser River to improve passage through an innovative self-regulating floodgate. This research will provide critical effectiveness monitoring to inform future barrier remediations efforts and ensure maximal benefits to salmon populations.

3 minute presentations (alphabetical order by first name)

Impacts of marine heatwaves and hypoxia on commercial shellfish species

Bickell, A., Pearce, C., Mackenzie, C., Bates, A.

The proposed project will examine the impacts of singular and coinciding acute stressor events on shellfish species of commercial and First Nations importance. Specifically, the project will investigate the effects of marine heatwaves and hypoxia on stress response (gene expression) and survival of Pacific oysters (*Crassostrea gigas*) and Pacific razor clams (*Siliqua patula*). A combination of laboratory experiments simulating heatwaves and hypoxic events and summer field trials during high temperatures and hypoxic conditions will provide opportunities to investigate species-specific stress responses under both controlled-lab and natural conditions. The Haida First Nation are interested in examining potential climate-change impacts on razor clam survival, particularly as recruitment levels have been low in the last few years. The Council of the Haida Nation (CHN) will be directly involved in the project, carrying out field trials with razor clams, and offering traditional knowledge on native shellfisheries. The project will develop and test a suite of genetic biomarkers that may be applied to future monitoring efforts and pilot test a potential method for mitigation of thermal/hypoxia stressors. This will support the research priorities of identifying climate change impacts and vulnerabilities, creating mitigation tools, and informing management decisions related to adapting fisheries, oceans, and coastal infrastructure. These outputs, along with project data regarding stress response and survival under stressor conditions, will also contribute to the development of comprehensive vulnerability assessments for both species and thus enable environmental and aquaculture managers and to prepare for and respond to the impacts of climate change.

Benthic contaminant transfer in bald eagles through plainfin midshipman predation

Linton, A.

Benthic marine organisms are rarely introduced into terrestrial food-webs. To assess the transfer of contaminants from the benthose to terrestrial environments, our study will investigate the predation of plainfin midshipman (*Porichthys notatus* Girard) by bald eagles (*Haliaeetus leucocephalus*) at Crescent Beach, British Columbia. Bald eagles are known to congregate and feed on temporary, dependable food sources^{1,2,3}. And, the plainfin midshipman becomes readily available during the summer as it migrates from 300m depth to spawn in the intertidal zone^{1,2,4,5}. As observed in summer 2022, bald eagles predate on *P. notatus* at a rate of one fish every 40 minutes primarily as the tide recedes and tide pools begin to form within the eel grass. Furthermore, previous studies suggest that some marine ecosystems, have high amounts of harmful substances that bioaccumulate in top predators, like bald eagles. For example, Elliott et al. (2009)⁶ confirmed that polychlorinated biphenyls (PCBs) occur at higher levels in bald eagle nestling blood when the birds have marine diets. Through contaminant, isotopic and nutritional analysis of fish tissue samples and eagle nestling feathers, we will determine the unique properties of these benthic marine organisms and their potential transfer to upper trophic level terrestrial predators and their offspring. My research aims to quantify the degree and frequency of predation interactions between bald eagles and *P. notatus* as a potential source of contaminant transfer at Crescent Beach, British Columbia, and our results will advance our understanding of the ecological interplay between benthic marine systems and terrestrial food-webs.

Efficacy of Drones for Beaver Surveys in the Yukon

Smith, A.

Beavers (*Castor canadensis*) play an important role in ecosystems as engineers, predators, and prey, as well as hold traditional and economic values to local peoples. A beaver's ability to manipulate the environment around them can be both beneficial or detrimental to the local flora and fauna by creating habitats that can increase or decrease abundance of plants, amphibians, fish, and waterfowl. Understanding spatial and temporal scale of beaver populations in fish-bearing creeks can help with local management decisions in wildlife conservation and land use planning. Beaver surveys are often costly and time consuming, which can limit the size of the study area and number of surveys conducted. Unmanned aerial vehicles (UAVs), also known as drones, are a cost effective tool that can be used for wildlife monitoring, but there is little known about their efficacy for beaver based surveys. In this study we analyzed drone imagery from five different creeks with known beaver populations in southern Yukon. From this imagery we ran tests of precisions and observer bias of individuals' abilities to detect and classify dams, lodges, and caches. These tests were then compared against ground surveys for aerial vs ground beaver feature detectability on two of the five

creeks. Dam density was also calculated on all creeks to determine beaver abundance in the area. Understanding the uses and limitations of drones for beaver surveys will aid in the application of continuous and future monitoring of beaver populations in the Yukon.

Signatures of change in the North Pacific Ocean

Kieran, C., Price, M., Hertz, E., Richards, M., Reynolds, J.

Large scale climate events, anthropogenic pressures, and increasingly unpredictable ocean conditions are drastically altering marine food web structures and driving major changes in the biodiversity and productivity of ocean ecosystems. To develop effective marine conservation strategies, it is necessary to understand the long-term patterns and consequences of these changes. Isotope analysis of high-level consumer tissues is a powerful tool for investigating long-term ecosystem dynamics: the isotope composition of a consumer's tissues is controlled by that organism's diet, distribution, and by variation in baseline phytoplankton and nutrient dynamics at the time of tissue growth. My research uses isotope analysis of fisheries-collected salmon scales from the Skeena Watershed to investigate the marine ecosystem dynamics of sockeye salmon (*Onchorynchus nerka*) throughout the last century (1913 – 2021). I investigate relationships between carbon ($\delta_{13}C$), nitrogen ($\delta_{15}N$), and sulphur ($\delta_{34}S$) isotope variation and changes in climate and environment, and use correlations between isotopes and environmental variables to estimate marine foraging locations. This research provides insights into the ecosystem dynamics of sockeye salmon, a high-level marine consumer with major ecological, socio-economic, and cultural importance, and develops our understanding of changing ecosystem conditions in the North Pacific Ocean.

Rock the boat: an investigation into the effects of vessel noise on rockfish communication

Hart, C.

Rockfish are an essential part of the Salish Sea's ecosystem, but their populations have been declining due to overfishing. Rockfish Conservation Areas (RCA's) were established to prohibit the catch or by-catch of rockfish. However, increasing human activity in the Salish Sea from commercial shipping, ferry traffic, and recreational boating has led to acoustic pollution that affects the soundscape of the Salish Sea. To understand the impact of anthropogenic noise on underwater ecosystems and their inhabitants, it was crucial to study how it affects rockfish. This research aimed to investigate whether rockfish changed their vocalizations in response to anthropogenic noise pollution, providing valuable insights into the effect of acoustic pollution on rockfish abundance and behaviors. My research analyzes rockfish

vocalizations in two locations within the Salish Sea, Fernie Island, and Spring Bay, cross-comparing them with specific vessel bandwidth frequencies. The approach involved manually annotating rockfish vocalizations and concurrent vessel disturbances using Raven Pro. A series of statistical tests were programmed using R to test the hypotheses. The study findings will significantly contribute to the development of future management strategies for rockfish, with a focus on the impact of anthropogenic underwater noise. Ultimately, this research aims to enhance our understanding of the potential effects of vessel noise on marine life, particularly rockfish, and pave the way for more effective conservation and management measures.

Partial Migration in Black Oystercatchers Breeding in Alaska

Rankin, C., Green, D.

Partial migration, where some individuals in a population migrate and some do not, has been observed across a wide range of taxonomic groups. However, the causes for intraspecific differences in migration strategies and their persistence remains unclear. From 2019-2021 we deployed geolocators (n=40) and GPS tracking devices (n=33) on Black Oystercatchers (*Haematopus bachmani*) at four sites in the Gulf of Alaska to determine their migratory behaviour and evaluate the body size, arrival time and diet specialization hypotheses for partial migration. Increased structural body size observed in females is predicted to be better adapted for remaining in Alaska year-round. Territorial males who remain in Alaska have the earliest access to the high-quality territories. Temporal shifts in prey assemblages may influence migration decisions and we are using carbon and nitrogen stable isotopes to assess the proportion of grazing and filter-feeding invertebrates in the diet of individual oystercatchers. To date we have determined the migratory strategies of 23 birds. Black Oystercatchers moved between 0-1600 kilometers from their breeding grounds, with 13 remaining in the Gulf of Alaska and 10 migrating to British Columbia during the non-breeding season. Preliminary analyses suggest that neither sex or body size affect whether birds migrate or the distance travelled. However, after controlling for structural body size, and counter to expectation heavier birds were more likely to migrate and travel further than lighter birds. Further analyses will determine whether territory quality or dietary specialization across sites influence migration.

Zooplankton biomass and nutritional quality in the Canadian Offshore Pacific

Labbé, D., Sastri, A., Stevens, C., DuPreez, C., Dower, J.

As key prey items for many species of fish, marine mammals and seabirds, zooplankton represent a critical link between primary producers and higher trophic levels in marine foodwebs. For this reason, understanding the distribution and energetic

value of zooplankton is critical to quantifying marine food web processes. As part of the planning for a newly announced marine protected area off Canada's west coast, Fisheries & Oceans Canada (DFO) conducted oceanographic surveys across the Canadian Offshore Pacific Bioregion (OPB), primarily around underwater volcanoes known as seamounts, in 2017, 2019, 2021, and 2022. During these surveys, size-fractionated zooplankton samples were collected using "bongo" nets to study zooplankton as a food source within this region. Traditionally, bongo net samples have been used primarily for quantifying zooplankton taxonomy and total biomass. However, other approaches can be used to provide additional information on the energy content and nutritional quality of zooplankton, including energy proxies (e.g., total lipids and total proteins) and ash-free dry weight, which can be used to estimate energy content. Our data suggest that the energy content of zooplankton fluctuates across years and between regions, likely due to shifts in community composition. In addition, the energy content of zooplankton differs between size fractions, possibly affecting the flow of energy in these ecosystems. I will show how these various energy proxies vary across the Canadian OPB and discuss the implications of the observed trends in zooplankton communities for local conservation efforts of seamount ecosystems.

Salinity tolerance in juvenile Chinook salmon in the Fraser River estuary

Scott, D.

This study examined the development of salinity tolerance in early migrating ocean type Chinook salmon captured in the Lower Fraser River and estuary. As part of a larger research program, juvenile Chinook salmon have been captured in the Fraser River estuary across three (2019 - 2021) out migration seasons, and gill biopsy samples have been retained from a subset of captured individuals to potentially examine physiological preparedness and health by applying recently developed gene expression biomarker techniques. While previous studies of fish health have typically been limited to inferring physiological status from behavioural response, mortality, and through the measurement of stress hormone response, we take a more in depth look at fish condition by applying biomarkers to detect salinity stress and even signals of mortality. Recently developed biomarkers for juvenile Chinook salmon directly measure signals associated with smolting which allow us to better detect physiological status from physiologically prepared for increased salinity to stressed and or potentially moribund individuals. Through applying these biomarkers our study will allow us to determine if fish which rear in the estuary longer are in a physiologically adapted condition and remaining in the estuary to accrue a growth benefit or if they are remaining because they are not tolerant of saline waters and must remain until they reach a certain size and or age at which they develop salinity tolerance.

Strengthening Hāiʻzaqv ocean governance through gavials and taxvai

Lawson, D.

Clam gardens have been identified as a priority for research, restoration, and revitalization by the Haí_zaqv Integrated Resource Management Department. Our hereditary chiefs have _áxva__i to specific areas, and in turn an inherent responsibility to respect and take care of these areas. Due to colonization, forced amalgamation, residential schools, etc. the Haí_zaqv have nearly lost their knowledge of clam gardens (Wickham et al. 2022). As new agreements such as the Fisheries Reconciliation Resource Agreement (FRRA) the Haí_zaqv are looking to expand management practices (Alexander et al. 2019; Atlas et al. 2022), to other species and ecosystems as a whole to protect their resources from further exploitation, overfishing, and climate change. Sea level rise, marine heatwaves, harmful algal blooms, and ocean acidification are all intensifying, climate-related variables that could negatively influence the productivity of ancestral clam gardens even if restored. By returning to traditional forms of reciprocal relationships in specific places (Kelly and Nicholson 2022) with a view to future climate disturbances, the Haí_zaqv can make wise decisions about clam gardens based on specific place-based needs, ancestral _ví_ás, Indigenous knowledge, and western science. By Simon Fraser University (SFU) partnering with the Haí_zaqv, we can focus on social-ecological needs and sub-tribal specific (Kobluk et al. 2021) _ví_ás. Methodologies carved out by the relationship between Haí_zaqv and SFU (Kobluk et al. 2021) in previous research projects will be built upon and made to fit the Haí_zaqv laws and ways of knowing and science (Kovach 2021).

Investigating post-release mortality of coho salmon in a marine recreational fishery

Lunzmann-Cooke, E., Johnston, S., Hendriks, B., Porter, A., Welch, D., Rechisky, E., Hinch, S.

Although many recreationally caught Pacific salmon are harvested, a substantial number of salmon are released after capture. Released fish are often assumed to survive; however, actual catch-and-release mortality rates are largely unknown for Pacific salmon. As a result, published mortality rates may underestimate reality, complicating the ability to develop biologically meaningful management measures for wild salmon populations. This study examines the capture and handling factors influencing post-release mortality of coho salmon (*Oncorhynchus kisutch*) in a marine recreational fishery in British Columbia (BC), Canada. Adult coho were angled in the marine environment near Port Renfrew, BC, affixed with acoustic transmitters, and tracked using an existing network of acoustic receivers located at multiple locations frequented by coho along their return migration to their natal spawning streams. We found odds of mortality to the first point of detection (median = 3.2 days after release) increased with injuries such as scale loss, eye damage, and bleeding. We also found a negative relationship between travel rate and scale loss. Quantifying post-release

mortality rates and understanding how capture and handling factors influence behaviour and mortality will provide information vital to developing management tools and fishing best practices to increase survival of wild fish.

Intraspecific variation of clutch size in ladybeetles

Desjardin, G., Williams, T.

Individual quality (variable and correlated with fitness) is determined by phenotypic (eg. Body size) or life-history traits (eg. fecundity). Although many studies have focused on phenology and fecundity, few studies have researched the causes and consequences of intraspecific variation of egg size. Fewer studies have considered the impact of warming temperatures due to climate change on ectotherms and their future fecundity. Climate predictions suggest insects are more sensitive to warming temperatures. Exploring individual quality in *Harmonia axyridis*, the Asian ladybird beetle, a globally introduced predatory generalist, allows us to study a system without post-hatching care. We hypothesize that a) *H. axyridis* egg size will decrease under high temperatures as individual females will allocate more resources to larger clutch size and fewer resources to individual egg size (maximizing female fitness), but b) smaller egg size will not come at a cost in terms of offspring fitness because larvae from smaller eggs will have higher viability at higher temperatures. Our findings for individual egg size variability will provide base knowledge that can project population trends under warming temperatures. Further, it will contribute to a better understanding of the trade-offs and the mechanisms behind egg size variation within a species.

The cone mosaic of young sablefish: an evolutionary perspective

Dove, G., Novales Flamarique, I.

Vertebrate vision begins with light entering the eye and being absorbed by photoreceptors in the retina. Photoreceptors are of two types: rods, which operate in low light environments, and cones, which operate in bright light conditions. The cone photoreceptors of fishes are often arranged in regular lattice-like formations called mosaics. These mosaics are believed to enhance multiple visual functions such as colour discrimination, spatial resolution and motion detection, which may be necessary for particular ecological tasks such as target recognition, predation and predator evasion under different light regimes. In fishes that develop indirectly, i.e., where the larval phenotype is substantially different from the adult, the cone mosaic appears to transition from hexagonal in the larva, where a single cone is surrounded by six neighbours, to a square where four double cones (each composed of two single cones apposed together) surround each single cone. The evolutionary origins of these two mosaic types (hexagonal and square) are unknown. Here, I report on the cone mosaic of larva and juvenile stages of the sablefish and show that this fish undergoes the

hexagonal to square mosaic transition that has been reported in other groundfishes, like the flatfishes. The hexagonal mosaic appears to be an innovation for high resolution vision that may facilitate detection of microzooplankton by fishes. A search of the literature indicates that the hexagonal mosaic appeared independently in ray-finned fishes and tetrapods but not in coelacanths and lung-fish indicating a variety of high resolution visual functions common to terrestrial and aquatic environments.

Modelling Indigenous led stewardship of sea otters, shellfish and people

Kobluk, H., Tinker, T., Wilson, K. B., Okamoto, D., Silver, J., Salomon, A.

Despite millennia of co-existence (and evidence of management) prior to the onset of colonization and the maritime fur trade - Coastal First Nations are currently left out of sea otter management in Canada. With conservation policy preventing traditional use, some communities have experienced a total loss of access to subsistence shellfish due to sea otter predation. In my research, I propose to investigate how Indigenous led stewardship of sea otters and shellfish may alter social-ecological outcomes, such as food sovereignty at local and regional scales. Working in collaboration with First Nation governments and knowledge holders, we are in the process of creating a spatially-explicit social-ecological model built on ecological data (sea otter demographic models and food web models) and Indigenous and local knowledge. Using this model we can test how different management scenarios meet objectives identified by First Nations leaders (such as food sovereignty and sea otter population health for instance). Ultimately, this work aims to be useful for our collaborators and inform their governance. Yet through this process our work challenges existing management paradigms by putting people back into ecosystems and attempts to uphold Indigenous knowledge and multiple worldviews in the scientific process to inform more just governance of our coasts.

Habitat loss for migratory shorebirds with future sea level rise

Magel, J., Wilson, S., Martin, T.

Climate change is one of the most pervasive threats to the persistence of coastal marine biodiversity, and climate change-associated sea level rise (SLR) poses serious risks to nearshore ecosystems. Tidal flats, which serve as critical habitat for migratory shorebirds along the world's major flyways, are particularly at risk. The Fraser River estuary (FRE) in British Columbia is a key stopover site on the Pacific Flyway and an area of global significance for over 1 million shorebirds, which use the area's tidal flats

to refuel during spring and fall migration. However, the potential impact of future SLR on intertidal habitat in this area is largely unknown. Here, we modelled changes in tidal flat extent in three areas of the FRE (Sturgeon Bank, Roberts Bank, Boundary Bay) from 2020 to 2100 under six possible scenarios of future SLR, using an 'inundation model' approach in ArcGIS. Estimated losses of tidal flat habitat by 2100 ranged from ~8% (17.88 km²) to ~28% (53.91 km²) of current extent, depending on the SLR scenario. Under all examined scenarios, over half of the projected losses (8.93–32.45 km²) occurred at Roberts Bank—a hotspot for migrating Western Sandpiper—suggesting that habitat loss in critical areas of the estuary may disproportionately affect certain shorebird species. The substantial loss of tidal flat habitat in key areas of the FRE will likely impair the ability of this site to continue to host large numbers of migratory shorebirds, with serious implications for the stability of the intercontinental Pacific Flyway.

Barrow's Goldeneye refine migratory phenology in response to environmental conditions

Kemp, J.

Timing of seasonal bird migrations is broadly determined by internal biological clocks, which are synchronized by photoperiod, but individuals often refine their migratory timing decisions in response to external factors. Using 11 years of satellite telemetry data, we show that Pacific Barrow's Goldeneye (*Bucephala islandica*) at higher latitudes initiated spring and moult migrations later and fall migration earlier than individuals at lower latitudes. We further show that individuals refined migratory timing in response to interannual variation in environmental conditions. Individual Barrow's Goldeneye initiated spring migration earlier in years with warmer springs at their overwintering locations and concluded spring migration earlier in years with earlier annual snow melt on their breeding grounds. Since individuals respond to conditions both where they initiate and where they conclude spring migration, our results suggest that Barrow's Goldeneye update their migratory decisions en route. For all three migrations in their annual cycle, birds delayed initiating migration if they had been captured and tagged prior to that migration. Birds that initiated migration late for their latitude were less likely to include a stopover and completed that migration faster, partially compensating for delayed departures. Our results are consistent with the hypothesis that Barrow's Goldeneye use a combination of endogenous cues and environmental cues in migratory decision making. Sensitivity to environmental cues suggests that Barrow's Goldeneye may have behavioural plasticity that is adaptive when faced with ongoing climate change.

Estuarine habitat associations of juvenile salmon across a degradation gradient

Gan, J.

Estuaries function as critical nursery habitat for many different fish species by providing food and protection. Several species of juvenile salmon use estuaries as stopover habitat during their migration from natal freshwaters to the ocean. However, these ecosystems face multiple anthropogenic stressors, which could degrade the complex and connected habitats that comprise estuaries. This study aims to examine the linkages between the estuarine habitat mosaic and juvenile coho salmon (*Oncorhynchus kisutch*) through sampling nine estuaries across Vancouver Island and the Central Coast of British Columbia, which vary in their state of degradation from human impact. We synthesized 17 stressors from both the watershed- and estuary-scale and used a PCA to order estuaries based on their degree of stressor impact. We assessed patterns of distribution, growth and condition, and gut fullness and diet composition of juvenile coho across three broad but distinct habitat types: beach, estuarine marsh, and estuarine meadow. We compared relative catch per unit effort of coho and found that densities of individuals were significantly higher in estuarine meadows compared to both beach and marsh habitats; furthermore, water temperature has a negative effect on density. Early results suggest that both body condition and gut fullness are higher in beach habitat than in marshes or meadows; however, coho sampled in beach sites had a lower condition score in more degraded estuaries. Illuminating how juvenile salmon use current habitats can shed light on the potential impacts of current and oncoming estuary change and inform prospective and proactive restoration and conservation actions.

Growing with the Times: Adapting GY Modelling to Climate Change

Peterson, K., Wang, T., O'Neill, G., Sattler, D.

Climate change (CC) has already begun to impact the forests of British Columbia, and the effects are predicted to quickly increase in severity and magnitude, making adaptation to climate in forest resource management imperative. However, most growth and yield (GY) models that are used to inform countless vital forestry decisions lack climate-sensitivity. In this research, I consider the barriers to including climate effects in commonly used GY models and present solutions for modelling and implementing CC impacts to facilitate climate-sensitive forest management. Using data from a wide-ranging common garden experiment, I will demonstrate the use of non-linear modelling techniques to predict the population-specific impacts of climate transfer on lodgepole pine (PI, *Pinus contorta* var. *latifolia* Douglas) growth and survival in managed stands in British Columbia. I will use the developed functions in GY simulations to analyze the impacts of CC on current forests and determine possible mitigation strategies for CC-induced losses in timber yield at the stand and landscape level. Preliminary results show a negative association between transfer to warmer climates and PI height and mortality that is greater for populations from warmer regions,

suggesting climate-induced losses that would impact some populations more than others. This study will fill a key gap in forest management under changing climate conditions by providing researchers and foresters with a method to project and manage forest resources for CC impacts on PI, as well as creating a framework for other researchers to adapt to their own species and regions of interest.

Swimming Upstream: How recreational fisheries management structure dictates decision-making

Tousignant, K.

Clearly defined objectives are required to make effective management decisions and to evaluate progress and success. It is often difficult to determine clear objectives and goals of recreational fisheries management bodies because objectives are often broad or ill-defined and encompasses social and biological processes. This study examined the structure and function of recreational fisheries management in Nebraska. To understand the management context, interviews were conducted with 16 individuals involved in Nebraskan recreational fisheries management and monitoring. All interviewed individuals interpret fisheries monitoring data and/or make recommendations based on research actions in their positions. Results of the interviews led to a broader question about the management structure and how that impacts recreational fisheries outcomes. I found that biologists conduct population assessment surveys and make recommendations to administration, who then compile this information and make recommendations to a group of politically appointed commissioners. The commissioners reject or accept the recommended actions. Each level in the Nebraska management system holds differing perspectives and goals, many of which are unstated. Thus, outcomes of management actions cannot be clearly linked to system indicators in this hierarchical structure due to inconsistent interpretations of, and responses to, information. Shedding light on the structure of decision-making in this recreational fishery may help other organizations and managing bodies create more effective objectives and procedures to meet their respective goals. As the analysis continues, emergent questions regarding the management objectives, triggers for management action, and the value of field surveys will be addressed.

Functional responses of male and female European green crabs suggest potential sex-specific impacts of invasion

Kattler, K. R., Oishi, E. O., Lim, E. G., Watkins, H. V., Côté, I. M.

Predicting the impacts of predatory invasive species is important for prioritizing conservation interventions. Functional response experiments, which examine consumption by predators in relation to prey density, are a useful way to assess the potential strength of novel predator-prey relationships. However, such experiments are often conducted without consideration of sex or only with males to reduce invasion risk. Here, we compared the functional responses of male and female European green crabs (*Carcinus maenas*), a global invader, feeding on varnish clams (*Nuttallia obscurata*) to test whether the two sexes have similar potential for impact. We also examined potential correlates of predation behaviour by measuring sex-specific movement and prey choice. Both sexes displayed a Type II asymptotic functional response, which can destabilise prey populations at low prey densities. However, males and females exhibited some differences in foraging behaviour. Female green crabs had slightly lower attack rates, which were not linked to sex differences in movement, and slightly longer handling times, which were not linked to sex differences in prey choice. There was no difference in the proportion of clams consumed between males and females with similar crusher claw heights, but females have smaller crusher claws on average, hence they consumed a smaller proportion of clams. Repeated surveys of four populations of European green crabs established in British Columbia, Canada, showed that sex ratio is highly variable. Taken together, these results and population-level modelling suggest that trying to evaluate the potential impact of European green crabs on clam populations by sampling only males could result in overestimation, even in populations that have male-biased sex-ratios. Consumer sex might generally be an important feature to consider when forecasting the impact of new invasive species.

Extracting atmospheric river storm history from tree ring stable isotopes

Mackey, L., Kohfeld, K., Allen, D.

Oxygen isotopes in tree rings can be effective paleoclimate proxy records, but little research exists assessing their application as a proxy measure of Atmospheric River (AR) storm patterns. AR storms are characterized by a band of dense water vapor that precipitates rapidly and can lead to landslides, flash floods, major infrastructure damage, and even loss of life. As such, developing a historical record of AR storm patterns beyond those which exist will improve future infrastructure planning to better accommodate these destructive storms. This research examines the strength of tree ring Oxygen-18 ($\delta^{18}\text{O}$) as a proxy record for AR storm patterns in Southwestern British Columbia. ARs affecting this region tend to precipitate water molecules more enriched in $\delta^{18}\text{O}$ compared to non-AR storms; therefore, tree rings may record this signal in the new growth of years with high AR precipitation contribution. To test the strength of tree ring $\delta^{18}\text{O}$ as an AR proxy record, annual $\delta^{18}\text{O}$ was measured using Douglas Fir (*Pseudotsuga menziesii*) tree cores from the Capilano watershed in North Vancouver and the Aloutette watershed in Maple Ridge, BC. The correlation between annual $\delta^{18}\text{O}$

and the percentage of precipitation falling from AR storms from the corresponding water year was then tested. The pending results of this analysis will suggest whether tree ring $\delta^{18}\text{O}$ is a strong proxy record for AR storm patterns in Southwestern BC. If a strong correlation is found, this research may indicate the potential to extend existing data on Atmospheric River storm patterns by decades and even centuries using the tree ring $\delta^{18}\text{O}$ method.

Characterizing the diversity of microbial eukaryotes in oxygen minimum zones

Lawton, M.

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.

Does novel competition drive diversification or convergence in controphic sparrows?

Duchesne, M., Arcese, P.

Climate and land use change facilitate rapid range shifts and novel competitive interactions among species; but case studies of the eco-evolutionary responses of native and colonist species remain rare. Grant & Grant (2006) reported rapid evolution

in bill shape in response to competition between native and colonist finches on Isle Daphne (Galapagos) with similar preferences and abilities to exploit seeds, leading to rapid divergence in morphology via natural selection. I will develop a parallel analysis of temporal change in traits affecting competitive ability in Song Sparrows (*Melospiza melodia*) resident on XOX DEL, BC, using 48 years of morphology and fitness data for ~3,500 birds subject to increasing competition for seeds following colonisation by Fox Sparrows (*Passerella iliaca*). I predict that temporal variation in seed abundance and diversity, and competition, has caused rapid evolution in Song Sparrow bill shape with two possible outcomes (cf Abrams 1986). 1) if seed diversity is limited, I expect bill dimensions to converge on those of Fox Sparrows, a socially dominant competitor, but nevertheless, drive declines in Song Sparrows. Alternatively, 2) given sufficiently diverse resources, natural selection may instead promote divergent evolution and facilitate the coexistence of both species on this small (6 ha) island. My results will offer a novel test of theory and advance our understanding regarding the role of rapid evolution in the coexistence of a native species and new socially-dominant competitor, in a system wherein trait heritability and selection strength were extensively demonstrated when very few Fox Sparrows were present (1975-80).

Cumulative exposure: What do you miss when excluding spatial seasonality?

Orobko, M., Beauchesne, D., Brownlee, S. F. R., Therriault, T. W., Archambault, P., Côté, I. M.

Mapping is a key tool for informing and guiding marine conservation planning and management at various scales. Maps of cumulative exposure show the spatial distribution of the combined intensity of multiple environmental drivers. Areas of high cumulative exposure likely experience high cumulative impacts from human activities and may benefit from more research and management. However, these maps are commonly produced as static composites of data averaged over time, which excludes consideration of temporal variability, despite many drivers having seasonal patterns of intensity. Our objective was to determine the seasonal variability of cumulative exposure using the St. Lawrence System as a case study, which is a complex social-ecological system in Eastern Canada that provides important ecosystem services to many people. We gathered spatial data on the distribution and intensity of 22 coastal, climate, fisheries, and marine traffic drivers in different seasons. We produced maps of cumulative exposure (i.e., the sum of all scaled driver intensities in each 1km² grid cell) in each season, as well as the deviation of cumulative exposure from the annual average in each season. Analysis is ongoing, but preliminary results indicate that cumulative exposure to environmental drivers is highly seasonal. Additionally, this seasonal variation is missing if only annual averages are available, which highlights the importance of considering seasonality, and temporal variability more broadly, in mapping used for marine planning and management. Additionally, seasonal maps of cumulative

exposure can help inform not just where, but also when, to direct management and research efforts.

Flow Characteristics of *Z. marina* beds in proximity of *Z. japonica*

Raee, N., Kwoil, E.

The benefits of eelgrass (*Zostera marina* L.), a native seagrass species in North Pacific Coast, for the estuaries and marine environments are well understood. The alarming decline rate of eelgrass beds has been reported by numerous researchers. One contributing factor for the ongoing eelgrass loss is changes in physical condition they grow in (Walter et al., 2020). Those changes may occur by the presence of the neighboring introduced seagrass species *Z. japonica*. The main objective of this study is to investigate the influence of presence and proximity of *Z. japonica* beds as well as level of submergence on flow characteristics in *Z. marina* including vertical and longitudinal velocity profiles as well as TKE distribution using a physical model.

Present and future juvenile Pacific salmon growth across estuarine habitat mosaics

Gross, P., Gan, J., Scurfield, D., Moore, J.

Estuaries are complex and dynamic systems that support many important species, including anadromous fishes like Pacific salmon (*Oncorhynchus* spp.). Juvenile salmon transit through estuaries during seaward migration, but may spend time rearing in these productive systems before ocean entry. During estuarine residency, growth can be rapid relative to upstream habitats, which has been shown to significantly improve marine survival. Fish growth is temperature-dependent and spatiotemporal temperature dynamics play a key role in shaping growth opportunities across estuaries. Studies in freshwater systems have increasingly revealed how fishes rely on both broad- and fine-scaled spatiotemporal temperature variability; however, few studies have investigated these dynamics in estuarine systems. In addition, research is needed to understand how these dynamics may shift given oncoming climate warming. We addressed these knowledge gaps by (1) monitoring summer temperatures across different habitats in two estuaries on Vancouver Island, BC, (2) assessing temperature-dependent juvenile salmon growth across each system with bioenergetic modeling, and (3) simulating changes in growth patterns under a scenario of increased water temperature. We found that high spatiotemporal heterogeneity of water temperatures across habitats leads to variable growth potential within and between systems, with the highest growth during early summer. Increased temperatures led to significant late-summer declines in growth in one system, while growth potential largely increased across the other. Together, this work serves as a first step towards understanding present and future juvenile salmon

estuarine growth patterns, which can serve to inform restoration and management of estuarine habitats that support high growth potential.

Examining how animal traits and abundance influence landscape resource heterogeneity

Little, C., Banville, P. E., Germain, R., Ford, A.

Resource heterogeneity influences the growth, reproduction, and distribution of animals and plants in a landscape. In addition, animal-landscape interactions create feedbacks between animal behavior and the physical and biotic landscape. Foraging behavior can erode or maintain resource heterogeneity through the selection of foraging areas based on their nutrient content. In addition, by foraging in some areas and excreting nutrients elsewhere, animals contribute to the dispersal of nutrients. Species' traits such as body size, aggregation behavior, and role as habitat generalists or specialists determine their movement on the landscape, and thus how they disperse resources. Moreover, competition between generalists and specialists can modify foraging behavior and consequently impact resource heterogeneity. We studied how traits and abundance of herbivores affect resource heterogeneity in a patchy landscape. We developed an individual-based model where generalist and/or specialist herbivores forage and move in a landscape composed of nutrient-rich patches interspaced in a matrix of lower nutrient content. Individuals foraged across the landscape according to the marginal value theorem, leaving areas when available nutrients dropped below the average level of the entire landscape. We ran multiple scenarios with different combinations of traits and abundance and then quantified the change in resource heterogeneity by analyzing spatial statistics over the landscape, such as Moran's I. Understanding how animals, and their traits, impact resource heterogeneity will increase our knowledge of ecosystems' functioning, and of the factors that can promote ecosystem resilience. In an era of global change, such understanding can have important applications for biodiversity conservation and habitat preservation.

Multi-event modeling shows variable nest success for the at-risk double-crested cormorant population

Stapleton, R., Cowen, L., Wilkin, R., Cragg, J., Lenske, A., McClelland, G.

The Double-crested Cormorant (*Phalacrocorax auratus*; DCCO) experienced a loss of 68% of its population within the Strait of Georgia between the years 1987 and 2009, and is a species of 'special concern' within British Columbia. The reason for their decline is unknown as there has been a lack of monitoring in the region for the often disparaged species. To study the DCCO, advances in remote, time-lapse photography captured the entire nesting season at three locations within the Strait of Georgia during the years 2020, 2021, and 2022. These locations include two sea cliff breeding

colonies, and one colony under a Vancouver highway bridge. With the collected data, a multi-event capture-recapture model compared differences in breeding success between locations and years. This model estimates probabilities of egg and chick survival, detection, and state transitions. From these, we estimate overall nest success, an important indicator of colony health. Results showed that the small rounded cliff colony had high nest failures, while the steep cliff colony experienced success in half the nests present. The Vancouver bridge colony, the largest DCCO nesting colony in the province, experienced the highest nest success. Although the bridge is the most productive nesting site for the DCCO, there is consideration by local and provincial governments to exclude the cormorants due to the potential impact their acidic guano has on the structure. This management action could further threaten population declines as natural cliff nesting sites may struggle to support the DCCO population under the era of rapid environmental change.

Individual Variation and Plasticity of Egg Size in European starlings

Barbera, R., Williams, T.

Avian egg mass varies markedly within populations, with the largest eggs measuring up to twice the size of the smallest, and ~70% of this variation is due to variation among individual females (Christians 2002). Many studies highlight the high repeatability of egg size, suggesting that this trait is relatively inflexible within individual female birds. In contrast, some studies continue to suggest that there can be substantial, “adaptive” plasticity in egg investment. If egg size is a phenotypically plastic life-history trait, we predict that it would show potentially adaptive variation in different ecological contexts (e.g. seasonally, yearly). Using data from a long-term study of European starlings (*Sturnus vulgaris*, 2002-2022), my research will a) analyse individual variation in egg size, focusing on phenotypic plasticity and b) analyse covariation between egg size, life-history traits, lifetime productivity, and survival. By understanding how egg size correlates with fitness and individual quality, egg size can be included in the suite of traits used to predict reproductive success.

Microbe-mediated attraction of stable flies to host cattle

Nayani, S., Meraj, S., Mohr, E., Kovacs, E., Gries, G.

Stable flies, *Stomoxys calcitrans*, are significant blood-feeding pests of livestock (cattle) but little is known about the cattle semiochemicals that attract the flies to their host. We tested the hypothesis that cattle skin microbiota and their semiochemicals, respectively, play a role in fly attraction. Isolated microbial strains first obtained from cow skin were identified by Matrix Assisted Laser Desorption/Ionization Time of Flight – Mass Spectroscopy (MALDI-TOF MS) or genetic sequencing. In two-choice behavioral bioassays, flies preferred a number of grouped and single strains growing on agar to

control agar, as well select gases emitted by the microbes at several doses. Follow-up bioassays conducted on the larger scale of a greenhouse showed similar results. Research is currently underway to identify: 1) the semiochemicals that mediated the attraction of flies, and 2) a synthetic semiochemical blend comparable to the real microbes in fly-attraction ability.

Year-round bird-window collision monitoring at Simon Fraser University's Burnaby campus

Hum, V.

In Canada, window collisions are responsible for approximately 16 – 42 million bird deaths a year, this is one of the main causes for anthropogenic bird population decline. Simon Fraser University's Burnaby campus provides critical information on seasonal variation in window collisions and mortality at a high elevation site surrounded by forest that provides habitat for many species breeding or migrating along the Pacific flyway. This research evaluates seasonal variability of collisions, evaluates species vulnerability due to collisions, determines what makes a building high-risk to collisions, and determines high-risk facades to later evaluate the efficacy of bird window deterrents. Collision surveys are performed year-round to monitor for collision evidence at random buildings stratified by size and surrounding vegetation over the course of four 45-day seasons. Additionally, scavenging and detection trials are performed to quantify for collision biases such as carcasses scavenging rates and survey detection efficiency. This research will provide an understanding of how collisions effect declining avian populations in western North America. The determined features of high-risk facades can be applied elsewhere to identify other facades that may be responsible for bird mortality, this prompting implementation of mitigation efforts such as policy development and bird-friendly films.

Universal Response Function for Interior Spruce and Its Spatial Validation

Ye, Z., Wang, T.

It is predicted that the rapid climate change will have a huge effect on forest health and productivity as tree populations are exposed to new climates. A reliable ecological model and a robust validation method are critical for understanding the impact of these changes. In this paper, we developed universal response functions (URF) for a tree taxon of great ecological and economic importance in British Columbia – interior spruce (*Picea glauca*, *Picea engelmannii*, and their hybrids). We first made

several candidate response models and tried to validate them with conventional statistical methods. Although these models showed high predictive powers and performed well in statistical validation, the map visualizations of these models vary greatly. Therefore, we employed site productivity data and developed a pixel-wise correlation approach to spatially validate the model. Our findings suggest that: 1) incorporating spatial validation can enhance the selection of ecological models as relying solely on statistical validation can be misleading; 2) the URF developed with mean coldest month temperature, mean annual precipitation, degree-days above 5 °C, and their interactions performed best; and 3) interior spruce showed a relatively weak genetic effect, showing modest productivity gain potential from seed transfer, and the gain is larger in the southern regions.

Posters (alphabetical order by first name)

Associated Ecological Risks in Salmonid Enhancement Facilities of Metro

Vancouver

Munday, A.

This presentation examines ecological risks presented by Salmonid Enhancement Program (SEP) facilities and offers insights into their effects on wild-spawning salmon populations in British Columbia. This cross-section analysis of SEP practices and current research regarding the effects of hatchery activities on Pacific salmon are combined with interviews and evaluation of facility operations. This case study analyzes the extent to which egg collection, rearing and release practices may be attributable to reduced ecological fitness in wild salmon. This presentation reviews methods and practices at three enhancement facilities (referred to as facilities, A,B,C) and subsequently compares these procedures to the Department of Fisheries and Oceans' (DFO) A Biological Risk Management Framework for Enhancing Salmon in the Pacific Region and the Community Involvement Program Best Management Practices Guide. This presentation investigates whether hatcheries are meeting their intended goals of rebuilding wild salmon populations, or if they instead contribute to further harm. The author inquires into the differences between large-scale DFO enhancement facilities and smaller Community Economic Development Project (CEDP) and Community Involvement Program (CIP) facilities which operate in conjunction with DFO goals but are managed by local or Indigenous communities throughout British Columbia. An inspection of the risks and outcomes to enhancement of Pacific salmon in Metro Vancouver thus concludes with an urgent request for common ground to be

achieved between common hatchery practices and current knowledge surrounding ecological risk prevention.

Analysis of plainfin midshipman (*Porichthys notatus*) otolith annuli for aging

Townsend, A., Quindazzi, M., Balshine, S., Juanes, F.

The plainfin midshipman, *Porichthys notatus*, is a species of fish found in intertidal and deep-sea waters off the western coast of North America. It is a model organism for animal behaviour, particularly for bioacoustics and for the differential reproductive strategies of its two distinct male subtypes, guarder males and sneaker males. This project aims to develop a model of aging midshipman using the biodata and otoliths from female (n=72), guarder male (n=97), sneaker male (n=23), and juvenile (n=30) midshipman. Otoliths grow in conjunction with the fish and display annuli corresponding to the fish's age. Otoliths were processed using surface aging, coronal cross sections in crystal bond, and the crack and burn method to obtain age estimates, with the various methods being compared and evaluated against each other. Age estimates between females, guarder males, and sneaker males will be compared, and the associated biodata used in conjunction to create models of midshipman aging using a von Bertalanffy growth function. The results aim to contribute to a better understanding of the life histories of midshipman and to aging models in wild fish populations.

Salmon as “samplers”: Using adult Chinook Salmon diets to understand prey distributions in British Columbia coastal ecosystems

Kraemer, C., Duguid, W., Greentree, W., Maher, B., Qualley, J., Quindazzi, M., Juanes, F.

Conventional fisheries surveys are limited in their ability to capture the spatial and temporal variation in the distribution of forage species throughout the year due to the constraints of resources and weather. Adult Chinook Salmon are generalist predators, and their diet composition can offer insight into the ecology and distribution of forage species along the British Columbia coast throughout the year. Collaboration with recreational anglers can complement conventional surveys through salmon stomach collections. Since 2017, we have collected >3300 adult Chinook Salmon stomachs from over 30 salmon anglers in British Columbia. Here we show the spatial and seasonal distribution of different forage species in Chinook Salmon diets in British Columbia marine waters. In summer and winter, Pacific Herring are the most common and widely distributed prey. Furthermore, age classes of Pacific Herring vary in importance spatially and seasonally. Other prey, including Northern Anchovy, Pacific Sand Lance, myctophids, and squid, have a more variable spatial and seasonal distribution. Using salmon as “samplers” provides important insights into the structure and function of British Columbia coastal ecosystems. This study is an important example of how

researchers and anglers can come together to improve understanding of salmon food webs and forage species distribution.

Attraction of horn flies, *Haematobia irritans*, to cattle host semiochemicals

Kovacs, E., Gries, R., Pinard, C., Manku, A., Gries, G.

Horn flies (HFs), *Haematobia irritans*, are blood-sucking parasites of pastured cattle. Fly burdens associated with fast-growing, dark-coloured, and large cattle are higher than normal but the underlying mechanisms as to how HFs sense these differential cues have not yet been thoroughly investigated. A main question to be studied is: what are the multi-modal semiochemical, visual, polarized-light, thermal (infrared) and gustatory cues that HFs exploit to find and recognize target cattle? Here we tested the hypothesis that various semiochemicals (message-bearing chemicals) emanating from target host cattle are important host foraging and host recognition cues for HFs. Data collections for this hypothesis were ongoing at the time of the abstract submission deadline.

The effect of hatchery rearing conditions on otolith composition in juvenile Coho Salmon

Gaffney, L., **Polard, E.**, Quindazzi, M., Juanes, F.

Although Coho Salmon are of cultural, ecological, and economic importance, anthropogenic activities have led to widespread declines in natural populations. To mitigate such declines, federal and provincial organizations have undertaken large-scale hatchery-rearing of juvenile Coho Salmon. Unfortunately, hatchery-reared Coho Salmon juveniles survive at generally low rates compared to wild-origin juveniles. Differences have been observed between the sagittal otoliths of hatchery-reared and wild-origin Coho Salmon. Otoliths are essential sensory structures that enable fish to hear and maintain balance. They 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 reduces otolith function and causes hearing impairment in salmon; potentially leading to compromised marine survival rates and restoration efficiencies. At present, the causes of vaterite formation are largely unknown. Our research aims to investigate which hatchery-rearing conditions cause vateritic otoliths to form in Coho Salmon juveniles. We reared Coho Salmon from first ponding to smolt under different environmental rearing conditions by manipulating tank water flow direction (clockwise-only flow vs counterclockwise-only flow vs alternating flow) and feed composition (fishmeal/fish oil vs black soldier fly larvae) to investigate how these conditions influenced vateritic otolith frequency, asymmetry, and percent

composition. This research has the potential to increase the poor success rates of Coho Salmon restoration efforts and improve the welfare of hatchery-reared salmon worldwide.

Abundance, distribution, seasonality and habituation of Roosevelt elk

Rutherford, K., Visscher, D., Fowler, G., St. Clair, C. C.

Like other elk species and subspecies, Roosevelt elk readily habituate to human activities such as forestry and agricultural operations, transportation infrastructure, and approaches by people. In the southeast area of Vancouver Island near Duncan, British Columbia, many landowners have reported that Roosevelt elk are becoming increasingly abundant and reliant on people, appearing more frequently in and near cropland. Despite the increasing prevalence and sedentary behaviour in these elk, there is little information about their total population size, distribution, abundance, and degree of habituation. In this study, we deployed 35 remote cameras along the edges of crop fields where elk have previously been observed and encouraged landowners to take and share photos of elk sightings. We aim to (1) calculate a minimum population estimate for the monitored region, (2) compare elk visitation rates at cameras to remotely-sensed information about adjacent land cover and human use, (3) model elk distribution based on habitat suitability, and (4) compare elk responses among sites to novel objects and automated deterrents. From the first 6 months of camera deployment, elk were detected at 31 out of 35 cameras. The average elk group size was 4.8 individuals with a range of 1-48. Elk detection rates varied temporally, peaking in September and between the hours of 6am and 11am. We hope that our results can be used to support subsequent management actions to mitigate human-elk conflict associated with damage to crops, wildlife-vehicle collisions, property damage, and risk of human injury from habituated animals.

Demographic History of the Pacific Nudibranch Genus *Hermisenda*

Dennis, M., Williams, K., Mooers, A., Hart, M.

The nudibranch *Hermisenda crassicornis* (sensu lato) is a well-known model organism in neuroscience. This species was recently split into the three pseudo-cryptic species *H. emurai*, *H. crassicornis*, and *H. opalescens* that differ in genetic, morphological, and behavioural traits. We used restriction-site associated DNA sequencing (RAD-seq) data and coalescent isolation-with-migration (IM) models to estimate divergence times among these species, and variation in population sizes and gene flow. Surprising results include: (1) a relatively recent split between the sympatric species *H. opalescens* and *H. crassicornis*, and (2) a much larger population size in the southern species *H. opalescens*. These results are consistent with the expected effect of Pleistocene glacial cycles on marine invertebrates. We also found (3) unexpected

evidence of gene flow between species. Hybridization is surprising because previous findings show assortative mating between the two sympatric species. We are testing the plausibility of these results using forward simulations (SLiM). Estimating divergence times and gene flow between these species may prompt a re-assessment of past studies which have utilized *H. crassicornis* (sensu lato).

What makes sponges contract? In-situ observations on a sponge

Diluvio, M. S., Harrison, D. E., De Leo, F. C., Leys, S. P.

Sponge contractions – called ‘sneezes’ – have been documented both in lab and field settings, but it is still unknown what triggers sponges to sneeze in their natural habitat. Here we analyze a timeseries of images of a marine sponge, *Suberites concinnus*, together with environmental data (pressure, currents, light, temperature, salinity and chlorophyll) collected concurrently from Ocean Networks Canada’s NEPTUNE observatory. Images were captured hourly at Folger Pinnacle at 23 m, while instruments recorded every 10 s for 4 years. Sponge area was extracted using colour segmentation and a neural network machine learning algorithm developed previously (Harrison et al. 2021). To determine whether sponge contractions were caused by biotic and abiotic factors, animals in contact with the sponge were annotated using ImageJ. Relationships between sponge behaviour and environmental variables were investigated using correlation analyses and assumptions were tested with the autocorrelation function (ACF). In all years, the sponge was most active in spring and summer and remained contracted all winter. When active, sneezes lasted roughly 8 hours. Animal-sponge interactions were more common in summer when the sponge was active, but the presence of animals was not correlated with sponge contractions. Spring/summer contractions were not correlated with any abiotic parameters. However, the winter contraction (dormancy) was correlated with the absence of chlorophyll in the water. Our data suggest that the sponge behavior may result from a complex interaction of factors such as seasons and food availability. Our next steps are to assess sponge behaviour under controlled conditions of food, light, temperature, and flow.

Do Glaucous-winged Gulls Indirectly Effect Black Oystercatcher Breeding Success?

Scott, M., Gaston, A., Dickson, R., Hui, C., Green, D.

Territorial predators can have an indirect positive influence on prey species by warding off other potential predators. Our objective is to investigate the positive indirect

effects that Glaucous-winged Gulls (*Larus glaucescens*) have on Black Oystercatchers (*Haematopus bachmani*). While gulls do defend against oystercatchers, they also attack shared predators by diving, pecking and giving warning calls. We predict that oystercatcher nests associated with gull colonies will have greater breeding success due to the exclusion of other avian predators by territorial gulls.

Using a long-term dataset collected by Laskeek Bay Conservation Society in Haida Gwaii, we will compare site occupancy and number of offspring produced, between oystercatcher territories associated with gull colonies to those that are not. To isolate the effect of gulls, we will account for factors such as distance of trees from oystercatcher nests, and island size, which are predictors for oystercatcher presence in an area. Our analysis will build upon previous studies of oystercatchers and gulls, and the indirect effects of territorial predators. The implications of our analysis, having the benefit of a lengthy data set, could indicate an ecological connection between Black Oystercatchers and Glaucous-winged Gulls.

Optimizing trapping strategies of European green crab (*Carcinus maenas*)

Wiebe, M., Green, S., Artelle, K.

Invasive species have continued to spread globally over the past decade, potentially damaging habitats and increasing competition and predation on native species. These impacts are not only felt within the system itself but can result in losses to human populations if the habitat supports species of cultural or commercial importance. The European green crab (*Carcinus maenas*) is a particularly concerning invader impacting coastal natural systems and communities and is expanding northward on Canada's Pacific coast. In collaboration with the Heiltsuk (Haí_zaqv) Integrated Resource Management Department of the Haí_zaqv First Nation, this project focuses on determining the effort necessary to reduce the adverse effects of green crabs on clam populations within the Territory. Specifically, we aim to determine the removal effort necessary to decrease green crab below abundances that deplete clam populations in the region. Removal is being conducted via trapping, with trapping efficacy quantified by tracking green crab catch per unit effort, size structure, and sex ratios in relation to the density of clams at invaded beaches over time. Monitoring size structure also allows us to evaluate if an increase in population abundance is occurring due to the removal of cannibalistic adults that suppress the growth of juveniles from the population, an unintended consequence that has been found in other trapping efforts. Our results will inform efforts by communities along North America's Pacific coasts who are investing considerably in controlling green crab populations by optimizing trapping that will support the efficient allocation of resources.

Marine vessel noise impacts on endangered Southern Resident killer whales

Murphy, O.

Marine vessel noise disturbance is becoming more apparent across many marine taxa as vessel traffic increases across the world. One such impacted species of marine mammal, the Southern Resident killer whale (SRKW) (*Orcinus orca*) rely heavily on the underwater acoustic environment to maintain communication between pod members resulting in an extensive acoustic repertoire of pulsed calls. The SRKW have been documented to increase their communication effort and energy expenditure in order to be heard over loud vessel noise – a phenomenon termed the Lombard effect. These behavioural changes are suspected to be a major factor contributing to the lack of recovery of the endangered SRKW in the Salish Sea. In an attempt to lessen this impact, various management measures have been established including a minimum approach distance, a commercial vessel slowdown, and interim sanctuary zones along the inshore waters of Boundary Pass, an area of heavy vessel traffic in the Salish Sea. This research aims to determine the effectiveness of these measures. Sixteen SRKW acoustic events from Boundary Pass were analyzed to call type between 1 June - 25 October 2022. Noise levels of surrounding vessels were isolated and compared to the duration, loudness, frequency, and type of SRKW calls analyzed. In total, 963 calls were identified across 18 call types. Upon completing the data analysis comparing call parameters to ambient noise levels, it will be assessed if the current management measures are enough to reduce vessel noise impacts on SRKW in this area of the Salish Sea.

Far From Home: Selected African-Eurasian Testudines imports into the US

Sardari, P., Badelu, N.

Despite international efforts to regulate the global wildlife trade, it continues to have a negative impact on wildlife populations. Reptiles, including turtle and tortoise species, constitute a significant portion of the illegal and legal wildlife trade. However, the extent and impact of the trade on wild populations are not well understood. We used US Fish & Wildlife Service import-export data logs and analyzed the import of six African-Eurasian freshwater turtle and tortoise species (*Testudo horsfieldii*, *Testudo graeca*, *Testudo kleinmanni*, *Emys orbicularis*, *Mauremys caspica*, and *Trionyx triunguis*) into the United States between 1999-2018. Results showed that over the 19 years, 487,857 animals were imported, with a staggering 92% being wild-caught. *T. horsfieldii* was the most imported species (n=434,108), with *T. kleinmanni* being the least (n=6). The highest number of imports occurred in 2012 and most imports were during spring and summer. The majority were live animals and were classified as “commercial”, meaning they could have been imported for the pet trade. This information provides crucial insights into the scale and nature of the African-Eurasian turtle and tortoise imports into the United States. In addition, this information can be

used to understand its impact on wild populations as it highlights the need for further research and conservation efforts to protect these species and their habitats.