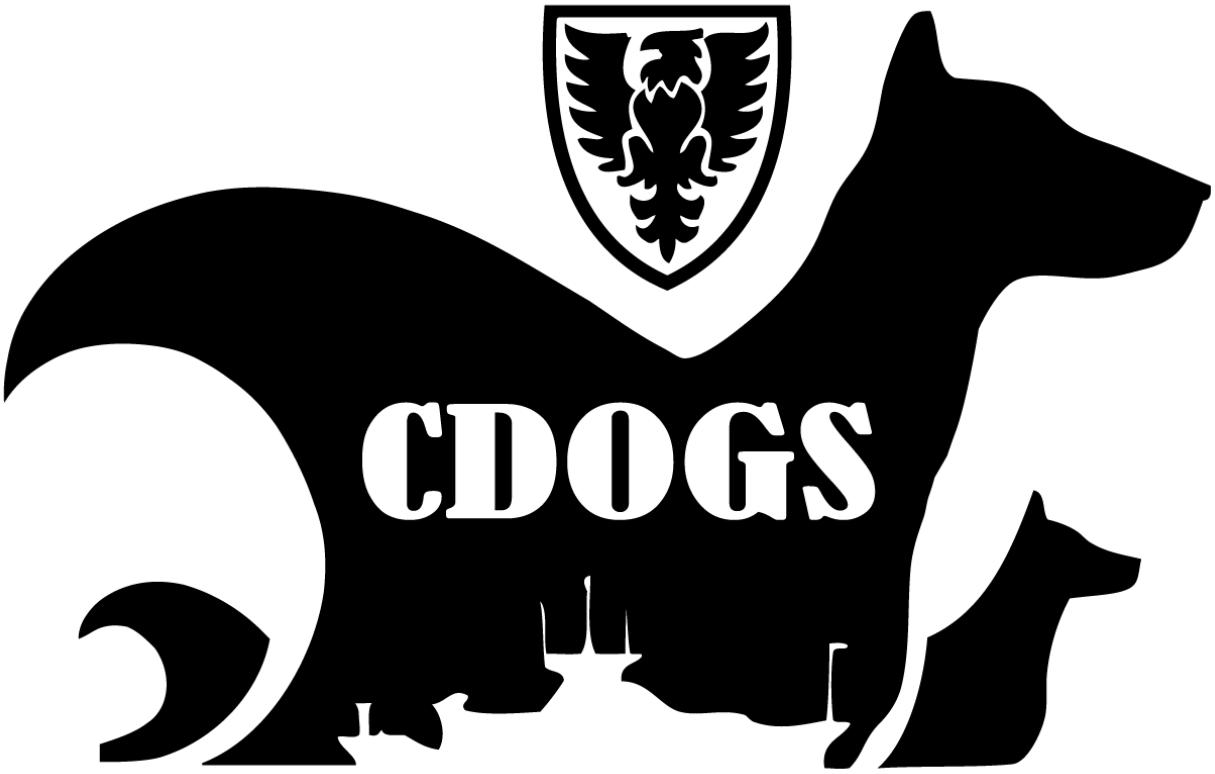
Conference of Dalhousie Oceanography Graduate students 2025

Book of abstracts



Friday April 11, 2025

09:00 – 17:30, McInnes Room, DSU Building

Dalhousie University, Halifax, Nova Scotia

Schedule

09:15 Opening remarks

09:30 Timothy Power

09:45 Brendan Smith

10:00 Emile Weber

10:15 Jacob MacDonald

10:23 Hana Hoursten

10:30 Morning Break

10:45 Jake Tan

11:00 Jessica Sajtovich

11:15 Antonia Kotliarov

11:30 David Fox

11:45 Joseph Barss

12:00 Presented by OFI, OTN and Planetary technologies

Opportunities in Ocean Science

12:15 Lunch and sponsor booths

13:15 Dr. Craig Brown

Plenary speaker

13:45 Lina Rotermund

14:00 Vanessa Zions

14:15 Haley Geizer

14:30 Emma Taniguchi

14:45 Alexis Savard-Drouin

15:00 Poster Session and Break

Claire Girard

Alexandra Hancock

Chris Latimer

Daniel Ng

Jayda Kruger

Jenna Wright

17:00 Break and voting

17:15 Awards and closing remarks

17:30 Reception (+19)

Solitons and Their Applications to Oceanography

Timothy Power

Rossby waves, or planetary waves, are fundamental to the dynamics of the world's oceans, playing a critical role in regulating ocean circulation, redistributing heat and momentum, and influencing global climate patterns. This presentation explores the applications of Rossby waves in modern oceanography, focusing on their contributions to ocean-atmosphere coupling, sea level variability, and the formation of western boundary currents and mesoscale eddies. By examining their interactions with climate phenomena such as the El Niño-Southern Oscillation and the Madden-Julian Oscillation, we highlight the importance of Rossby waves in understanding and predicting long-term climate variability. Advances in satellite altimetry and numerical modelling have enhanced our ability to study these waves, providing critical insights into their behavior in a changing climate. This talk underscores the relevance of Rossby waves to climate science, marine ecosystems, and coastal management, emphasizing their role in addressing global environmental challenges.

Passive acoustic monitoring of hydrothermal vent collapse

Brendan Smith

High temperature, black smoker hydrothermal vents can form tall chimney-like structures due to precipitation of minerals from the vent fluid when it meets cold seawater. As these chimneys grow taller, they become more unstable and prone to collapse, sometimes triggered by local seismicity. These collapse events generate a distinct sound which can be detected by hydrophones. Passive acoustic recordings were obtained from Ocean Networks Canada's observatory at the Main Endeavour Hydrothermal Vent Field, on the Juan de Fuca Ridge in the Northeast Pacific. The hydrophone is located adjacent to the Grotto vent mound. An audio detection algorithm was developed to detect vent collapses at this site from June 2022 – January 2023. During this time, there was also a video camera and lighting system which periodically recorded illuminated video footage of the Grotto mound. Frames were extracted from these videos to create a timelapse over the 6-month period, showing visible growth and collapse of multiple vent chimneys. An image feature tracking algorithm was developed to measure the growth and collapse of the chimneys and create an approximately scaled time series of vent height. These vent height and collapse data were compared with audio recordings of vent collapses to investigate the relationship between the acoustic signal and hydrothermal vent collapse.

Investigating the Impacts of Climate Change and Sewage Pollution on Oxygen Concentrations in the Bedford Basin

Emile Weber

Emile Weber[1], Bin Wang [2], Arnaud Laurent[1], Katja Fennel[1]

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As we fail to mitigate climate change and as coastal populations continue to grow, the problems of decreasing oxygen (DO) concentrations worsen for coastal ecosystems globally. Climate change reduces the availability of DO in the water column by lowering oxygen solubility and intensifying density stratification, which hinders the ventilation of subsurface waters. Furthermore, increasing sewage inputs in urbanized regions can provide an overabundance of nutrients that fuel excessive algal biomass production, which then sinks, decomposes, and consumes oxygen. The Bedford Basin is naturally prone to seasonal hypoxia (low DO concentrations) and is at risk of anoxia (no DO) due to limited ventilation of its subsurface waters. Concerns about DO concentrations in the basin are growing as temperatures and the population density of the surrounding municipality increase. A high-resolution biogeochemical model of the Bedford Basin will be used to develop a better predictive understanding of the relationship between climate change, sewage pollution, and hypoxia. The overarching goal is to address whether reducing the sewage's nutrient load could prevent prolonged hypoxic/anoxic conditions in the Bedford Basin in the future. As this project is in its early stages, this talk will specifically focus on validating the biogeochemical component of the model using oxygen data sampled at the Compass Bouy station by the Bedford Basin Monitoring Program and transects from monthly surveys.

Enhancing Models to their Fullest Potential: Constraining Error in a Biogeochemical Regional Model of Halifax Harbour

Jacob MacDonald

Jacob MacDonald[1], Bin Wang [2], Arnaud Laurent[1], Katja Fennel[1]

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Biogeochemical models are crucial for addressing questions that cannot be resolve by observations alone, such as estimating future or hypothetical states of oceanographic systems. This is particularly crucial in the context of marine carbon dioxide removal (mCDR) efforts aimed at mitigating climate change. The Halifax Harbour is an active area of mCDR research on ocean alkalinity enhancement (OAE), a technology whereby surface alkalinity is increased to enhance the natural in gassing of atmospheric CO2. Such research relies on models for the monitoring, reporting, and verification (MRV) of ocean CO2 uptake. However, models have inherent limitations, and it is important to improve and assess their associated uncertainties and errors. An existing biogeochemical regional model of the Halifax Harbour was used to produce a 20-year hindcast and 10-day forecasts. The model aligns reasonably well with observations; however, for the model to most effectively be used in support of ongoing OAE work, the model must be as accurate as possible. Therefore, model errors and their sources must be identified and reduced. This talk will explore sources of model errors and introduce techniques to enhance the model to its fullest potential by constraining such errors.

14 years on the Halifax Line: Water mass properties, trends, and variability

Hana Hoursten

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The Halifax Line (HL) is a transect of the Scotian Shelf that has been monitored using underwater gliders since June 2011. Underwater gliders are autonomous profiling instruments to which sensors such as conductivity, temperature, depth (CTD) and optical sensors can be affixed to sample water properties. Monitoring of the HL is shared by the Dalhousie-based Coastal Environmental Observation Technology and Research (CEOTR) group and Fisheries and Oceans Canada. Previous studies have led to a seasonal climatology of glider-based temperature, salinity, and potential density for the period from June 2011 to September 2014 down to a maximum depth of 200 m and to a distance of 150 km from the Halifax Harbour (Dever et al., 2016). Here, we present an updated climatology for temperature for June 2021 to September 2024 with extended coverage of the continental slope waters down to 650 m. By analyzing this 14-year timeseries, we will be able to quantify inter-annual variability and examine how conditions on the Scotian Shelf have changed over the duration of this record.

How viable are data features extracted by neural networks for benthic habitat mapping?

Jake Tan

Yan Liang Tan (Jake)[1], Benjamin Misiuk[2, 3], Thomas Trappenberg[4], Craig J. Brown[1]

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Bathymetry and backscatter data acquired by acoustic sensors such as multibeam echosounder systems give information about seafloor topography and sediments. As these are primary drivers of benthic habitat, habitat mapping workflows commonly involve the selection of data features derived from bathymetry and backscatter – e.g. seabed slope or roughness from bathymetry and textural metrics from acoustic backscatter. However, selecting an optimal set of data features remains a subjective and laborious process even with best practices proposed in the literature. Moreover, an inappropriate selection of data features could have a substantial influence on the resultant model and subsequent analysis.

This study examined the use of neural networks to mitigate the challenges of data feature selection for benthic habitat mapping. Convolutional autoencoder neural networks were built to extract data features from multibeam bathymetry and backscatter data from the Bay of Fundy and Georges Bank. These features were used as predictor variables to build habitat suitability models for sea scallop (*Placopecten magellanicus*). Bathymetry and backscatter data features used in conventional benthic habitat mapping workflows were also used to build separate habitat suitability models. The utility of data features extracted by neural networks were evaluated by comparing the different models using selected performance measures and analysing their spatial outputs.

Our results show that neural networks provide a viable avenue that is objective and automatic for deriving data features in benthic habitat mapping research. Data features derived using neural networks were found to be reliable for building habitat suitability models across study sites with differing geological contexts. This motivates further research into utilising more sophisticated neural network architectures to extract richer features from data and to improve the efficacy of benthic habitat mapping processes.

THE DEVELOPMENT AND APPLICATION OF BRUVS-LITE: A STEREO-BRUV SYSTEM WITH INTEGRATED LIGHTING FOR SEASCAPE ECOLOGY

Jessica Sajtovich

Baited Remote Underwater Video Systems (BRUVS) are cost-effective, non-invasive monitoring tools. Since their development, BRUVS use has expanded considerably. However, most BRUVS surveys have been conducted in the photic zone of the Southern Hemisphere, with limited studies exploring their effectiveness in low-light or aphotic environments. BRUVS in these regions typically lack integrated lighting and record continuous video over short deployment durations, resulting in significant knowledge gaps regarding their use in Northern Latitudes.

Seascape ecology, a rapidly emerging field in marine research, examines the influence of habitat structure on species distributions and ecological processes. A key focus within seascape ecology is edge habitats, or ecotones, which describe zones of transition between habitats of differing structural complexity. Previous ecotone research has typically focused on discrete habitat types displaying clear boundaries (e.g., seagrasses). Significant knowledge gaps remain in marine environments characterized by broad-scale heterogeneity and gradual transitions. Additionally, the use of BRUVS to assess marine ecotones is controversial, as the use of bait may introduce biases that obscure natural habitat associations.

This research presents the design and proof-of-concept testing of BRUVS-Lite, an open-source, cost-effective stereo-BRUV system with integrated lighting, and its application for seascape ecology. BRUVS-Lite was deployed to investigate gradual marine ecotones between rocky reef and sand habitats within the Eastern Shore Islands**,** Nova Scotia, using both baited and un-baited deployments to assess the influence of bait along habitat ecotones.

BRUVS-Lite was found to be an effective monitoring tool across various marine environments and effectively detected ecotone effects within the Eastern Shore Islands across both baited and un-baited deployments. By addressing knowledge gaps in both BRUVS methodology and seascape ecology, this study advances our understanding of species-habitat relationships in temperate marine ecosystems and informs best practices for BRUV-based ecological monitoring.

Benthic Assemblages of Prince Edward Island, Canada: A Cross Disciplinary Approach to Habitat Mapping

Antonia Kotliarov

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Seafloor habitat mapping approaches often combine multibeam echosounder (MBES) data with seafloor video or photographic ground validation data. This methodology relies on seafloor surficial information when other factors such as water column parameters and subsurface geology may also play a role in determining benthic habitat patterns. Integrating sub-surface geology and water column information with surficial data can provide a more comprehensive approach to habitat mapping.

In 2021, MBES and sub-bottom data were collected off the northern coast of Prince Edward Island (PEI), Canada, as part of an Ocean Frontier Institute (OFI) project investigating the presence of offshore freshwater reserves. The presence of freshwater was confirmed using pore water samples extracted from sediment gravity cores during this expedition, and the area was mapped using a Kongsberg EM710 MBES. This area was revisited in 2024 to pinpoint zones of potential groundwater discharge and to identify any effects of freshwater on benthic communities. The 2024 survey included 24 stations within which water column and biological data were collected using a CTD, ADCP, and video footage from a drop camera, along with some additional bathymetric and backscatter data collected with a Kongsberg EM 2040P MBES. Video data was annotated using BIIGLE 2.0 (Browsing and Annotating Large Marine Image Collections) to identify benthic fauna and surficial substrates. Sub-bottom and MBES data from the 2021 survey were integrated to map benthic assemblage patterns, integrating both subsurface geology and water column data sets.

All data sets were integrated to generate a benthic habitat map of the study area, linking biological diversity patterns with surficial sediment patterns, seafloor morphology and subsurface geology. The resulting project map will help with future resource planning around PEI as well as act as a baseline characterization for future monitoring activities at the site.

Mapping lobster habitat suitability: A geospatial approach to conservation in the Northumberland Strait

David Fox

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In the Southern Gulf of St. Lawrence, fishing exclusion zones were established to mitigate habitat degradation from scallop dredging and protect nursery grounds for Amerian Lobster (Homarus americanus). However, their effectiveness in supporting suitable habitat across multiple life stages remains poorly understood. Our study focuses on broadscale mapping of lobster habitat suitability in the Northumberland Strait, aiming to inform conservation strategies and evaluate the effectiveness of these fishing exclusion zones.

We integrated multiple datasets to model adult habitat suitability. Bathymetric data were acquired from the Canadian Hydrographic Service NON-NAvigational (CHS NONNA) Data Portal and interpolated at 100m resolution across the Strait via inverse distance weighting (IDW). Bathymetric derivatives—including mean and standard deviation, standardised broad and finescale Benthic Position Index (BPI), slope, rugosity, eastness, and northness were generated and exported at the same resolution for inclusion in the model. Benthic video surveys were conducted at 133 stations by teams at DFO (2023) and Dalhousie University (2023-2024) over a two-year period using 4K drop camera systems. The videos were annotated in the web-service interface BIIGLE 2.0 to identify and classify seafloor substrata into distinct seafloor habitats based on visible seafloor attributes (e.g., surficial sediment types) using a modified Folk 5 classification scheme, and to record the presence of lobster before export to ArcGIS Pro. These geological and lobster records, combined with geospatial data layers, were used to model (1) seafloor substrate from classified video transects and (2) lobster habitat suitability from georeferenced video locations across the study area.

To assess exclusion zone effectiveness, we compared habitat suitability and predictor importance inside and outside protected areas. Preliminary results will be presented at the conference. The findings of this study will enhance our understanding of benthic habitat use, inform conservation planning, and contribute to sustainable fisheries management in the Northumberland Strait.

Spatiotemporal Modelling of Lobster Abundance

Joseph Barss

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Species distribution models are often used to make abundance predictions across a region, but must properly account for the presence of spatial and temporal correlations in ecological survey data. In this study, we consider a data set on lobster abundance collected by trawl survey programs in the Bay of Fundy, and additional modelling challenges including the use of different types of sampling gear, varying survey coverage by program and year, and a highly skewed data distribution with many zero observations. We fitted a negative binomial geostatistical generalized linear mixed model to these data, mapped predictions of lobster abundance across the study area, and produced a relative abundance index displaying an increasing trend between 1995 and 2023. Model selection was performed using marginal and conditional information criteria, as well as k-fold spatial block cross-validation. Simulation studies yielded the important conclusions that combining data from two survey programs is appropriate and results in narrower index confidence bounds, and that models for standardized count data based on the Tweedie or Delta distributions yield inconsistently biased index estimates.

What drives the seasonality of near-inertial waves in the Canadian Arctic Archipelago?

Lina Rotermund

Lina Rotermund[1], Ruth Musgrave[1], and Clark Richards [1, 2]

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The variability of near-inertial waves (NIWs) was examined through a 13-year (1998 - 2011) in situ record of ocean and ice velocities across Barrow Strait, Nunavut. NIWs are waves that occur near the Earth's inertial frequency and are typically generated through the interaction of wind stress on the ocean's surface. A dominant portion of the variability in baroclinic currents and shear was contained in the near-inertial (NI) band, suggesting that NIWs play an important role for localized turbulent mixing. NI speed within the mixed layer exhibited a clear seasonal cycle, with increased strength from July to October, and decreased strength December to May. Below the mixed layer the seasonal cycle was not observed. A 1D ice-ocean slab model was used to explore the importance of numerous parameters on NIW generation within the mixed layer. Parameters include sea ice concentration, thickness, strength, and drag between ice-ocean, ice-atmosphere and ocean-atmosphere as well as ocean damping and mixed layer depth. Examining NIW variability leads to a better understanding of their influence on mixing in the region.

The Far-field Effects of Salmon Aquaculture Activities on the Benthic Environment

Vanessa Zions

The far-field effects of salmon aquaculture on the benthic environment remain understudied, particularly at bay-wide scales beyond 250 meters from fish farms. This research examines the accumulation of organic matter and aquaculture waste using sediment traps, core sampling, and chemical tracers to quantify sediment flux and organic enrichment. Size analysis of bottom sediments and stable isotope analysis help distinguish aquaculture-derived organic matter from natural sources, while radiocarbon dating reconstructs sediment history to assess long-term environmental impacts. Findings from this study will improve understanding of aquaculture waste dispersal, contributing to more sustainable management of salmon farming operations.

Carbon storage and remineralization in fjords along the Nunatsiavut coast

Haley Geizer

Haley Geizer[1], Christopher Algar[1], Alexandre Normandeau[2], Kumiko Azetsu-Scott[3], Paul Snelgrove[4], Maria Armstrong[1], Stephan Hamisch[4], Silas Jones[4] and Rodd Laing[5]

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High latitude fjords are significant carbon (C) sinks. Their morphology and deep estuaries create high sedimentation rates that enhance carbon capture and storage for long time periods. The amount of C buried depends on a balance of sedimentation and remineralization – the decomposition of organic matter (OM) to its inorganic components (i.e., CO_2 and nutrients). In sediments, microbial activity primarily drives remineralization through reactions that break down OM delivered to the seafloor. C that escapes these processes is then buried. Human-induced climate change is causing an imbalance of C therefore quantifying its burial rate in these ecosystems is imperative. Past studies have suggested fjords sequester millions of tons of C globally, however none have assessed the contribution of fjords along the Nunatsiavut coast to this total. During the summers 2022-2024 we collected sediment cores from four Nunatsiavut fjords: Hebron Fjord, Okak Bay (fjard), Nachvak Fjord and Saglek Fjord. Following flux experiments onboard to quantify remineralization, we sectioned sediment cores to determine total organic C (TOC). Using previously recorded sedimentation rates along with Pb210 profiles from cores collected in parallel with our fluxes, we will estimate carbon burial and residence times in these fjords. This project will provide critical C storage rates across various fjords to enhance our understanding of the mechanisms that control them. These results will inform Nunatsiavut Government's Imappivut Marine Plan and the Nunatsiavut Climate Change Strategy.

Quantifying and comparing the carbon stock and sequestration rate of an eelgrass bed on the Nova Scotian coast to global estimates

Emma Taniguchi

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In recent years, seagrass has been presented as a solution to sequester excess carbon emissions from the atmosphere, with reports that seagrass meadows are responsible for burying as much as 10% of anthropogenic carbon per year. However, this estimate has started to seem improbable as more recent studies report carbon stock estimates much lower than the global average. Here, we present estimates of organic carbon (OC) stock in an eelgrass meadow on the Eastern Shore of Nova Scotia. To quantify sediment OC stock, we combined sediment geochemical analyses with geospatial mapping based on high-resolution optical aerial imagery collected by drone flights. Three sediment cores, plus a control, were extracted from the meadow in regions with differing levels of vegetative cover. The control core was used to establish a background signal for sediment OC, which we assume to be representative of nearshore unvegetated sediments in the region.

Despite the health and anecdotally reported longevity of this eelgrass meadow measuring 4.7 Ha in size, the carbon stock is estimated to be less than 10 Mg OC/Ha. This is significantly lower than global average estimates of ~163.3 – 660 Mg/Ha but is comparable to other reports emerging from the North American east coast (e.g. 3.7 Mg/Ha from coastal Virginia, US). From the individual core slices, the maximum sediment OC did not exceed 2.5 weight % even in the densest, healthiest part of the meadow. There was also a notable correlation between presence of coarse biomass and higher sediment OC in the bulk sample, suggesting that the carbon is mostly associated with living biomass rather than being buried and stored in the sediments. Further, radiocarbon ages of the bulk OC of up to 1,140 years in the topmost sediment layer imply a significant admixture of pre-aged, likely terrestrial, OC to the bulk OC, rendering the stock estimates absolute maximum estimates. Overall, this study adds to the growing body of evidence that suggests that global estimates of OC storage in eelgrass beds need to be carefully reevaluated.

Resilience and restoration potential of kelp forests in Nova Scotia, Eastern Canada

Alexis Savard-Drouin

Marine ecosystems are unprecedently impacted by global change, causing ecosystem distributional shifts and emergence of alternative states. Kelp forests form some of the most productive marine ecosystems on the planet and have been subject to declines worldwide. In southwestern Nova Scotia, warming waters and invasive species have led to the defoliation of kelp forests and favour algal turf beds. With further temperature increases, other regions in Nova Scotia are expected to follow similar shifts. The Eastern Shore Islands, an area selected as a potential Marine Protected Area, is an exposed archipelago in Nova Scotia where healthy kelp forests remain. Understanding the life history characteristics that support the resilience of these kelp forests is critical, particularly under rapidly changing conditions. This research models the dynamics of kelp forests at the Eastern Shore Islands using matrix population models for the kelp species *Laminaria digitata* and *Saccharina latissima*. Through model simulations and empirical validation, we quantified life history traits most important to population resilience and the potential of both species to be restored following future declines. For both species, models showed that the successful recruitment and survival of juvenile kelp had the biggest impact on population resilience. These results align with previous research correlating loss of available substrate for recruitment due to the proliferation of turf algae. *Laminaria digitata* is projected to be more resilient with better restoration potential than *Saccharina latissima*, indicating that kelp forests will further lose species diversity but remain a resilient ecosystem in Eastern Canada.

Determining sex and age classes in sperm whales using aerial photogrammetry

Ana Eguiguren

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[1]Department of Biology, Dalhousie University, Halifax, NS Canada

Field studies of sperm whales have categorized individuals into age/sex classes based on boat-based appraisals of size, general morphology, and social behaviour. This approach groups individuals into four classes: calves (< 5.5 m long), mature males (> 12 m long), bachelor males (7 – 10 m and observed alone), and mature females/immature individuals (7 – 10 m long and found in groups of two or more). As the behaviours of mature females and immature males and females are shaped by different social and ecological processes, this grouping may mask details about the behaviour and demography of sperm whales. Aerial images offer a chance to refine sperm whale age/sex class classification through two avenues. First, photogrammetry provides length estimates, enabling us to tease apart age/sex classes based on life history events. However, size alone is insufficient to differentiate some categories. Although sex can be identified by genital slit configuration when whales are whales are dorsal side up, this posture is rare. To address this, we can rely on the sexual dimorphism in sperm whales—particularly the males' substantially larger nose-body ratio, which becomes detectable in early adolescence and intensifies with age to complement classification. Here, we evaluate the feasibility and accuracy with which sperm whale sex can be determined based on aerial photogrammetry, thus providing a valuable tool for drone-based research on body conditions, demographic trends, and social behaviour.

Quantifying demographic differences in the body condition and health of Eastern Canada - West Greenland bowhead whales

Alexis Bazinet

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Climate-caused changes in oceanographic conditions and prey shifts are potentially reducing the carrying capacity of the Eastern Canada - West Greenland (ECWG) bowhead whale population and could lead to a plateau in abundance. Aerial drone footage (still images and/or videos) of free-swimming bowhead whales was collected from Cumberland Sound, Nunavut, an important foraging area, to evaluate nutritional (body) condition (7,661 raw images and 213 videos, 2016-2023). Photo-identification was used to match unique individuals (from 27 up to 186 individuals per year) and all images were scored for measurability (> 2500 filtered images). Measurements of total length and width at 5% increments along the dorsal surface were used to calculate a Body Area Index (BAI) comparable across years and demographic (age and sex) groups. Preliminary comparisons of body condition followed natural progressions in morphology, with younger (or smaller) age-classes (calves, yearlings, and juveniles) having higher BAI values. Similarly, based on total length estimates, there were disproportionately more juveniles and subadults measured in Cumberland Sound across years. For a subsample of the ECWG population, information on sex (n=38, 2017; n=1, 2018; n=28, 2019) and age (n=67, 2017-2019) was also obtained using molecular techniques from biopsy tissue samples. Sex ratios from 2017 (26/28, 68%) and 2019 (18/28, 64%) were skewed towards male bowhead whales. All biopsied individuals with epigenetic aging estimates were sexually immature (< 25 years), ranging from 1+ to 23 years (mean 9.97, SD 4.33 years). These results agree with previous findings, suggesting that Cumberland Sound may be a preferred summer foraging area for smaller juvenile and subadult males. Combining photogrammetric measurements, spanning multiple years, with biopsy results, we hope to gain further insight into the vulnerability of different demographic groups within the ECWG bowhead whale population and to monitor their long-term overall health.

Behavioural responses of Southern right whales to whale watching vessel in Brazil

Daiane Domingos Manholer

Daiane Domingos Manholer[1,2], J.H.F Prado[3], A. Andriolo [4,5], I.L. de Oliveira[6,7], D. Danilewicz[8], T. Fettermann[8], J. Karasek[8,9], H. Ortêncio Filho[1] & Sarah Fortune[2]

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[9]Acquaplan Tecnologia e Consultoria Ambiental Ltda., Environmental consultant, Balneário Camboriú, Santa Catarina, Brazil

Boat-based whale watching (WW) was conducted in the Right Whale Environmental Protection Area, Brazil, from 1999 to 2012. In 2018, regulations for WW in this area were established to enhance protection for the whales. However, the behavioural effects of WW vessel on nursing Southern right whales and their calves in this area and under this specific regulation remain unknown. We collected whales' behaviour data from land using theodolite and aerially with a drone, between July and November from 2022 to 2024. Whales' behaviour in the presence and absence of the vessel was compared using swim speed (SS), linearity (L), reorientation rate (RR), proportion of time spent in different behavioural states, and frequency of occurrence of behavioural events. A Mann-Whitney test was used to compare all behavioural metrics between presence/absence of a vessel, while whale movement was analyzed at different WW vessel distances (61-100, 101-140 and 141-180 m) using a Kruskal-Wallis test. Using theodolite tracking, 45 groups were monitored in the presence and 39 in the absence of a vessel. Drone based observations included 15 groups in the presence of a vessel and 13 in its absence. Theodolite data revealed that in the presence of a vessel, calves exhibited a lower surface frequency ($p = 0.0231$) while mothers displayed higher SS ($p = 0.0003$), L ($p = 0.0003$) and respiration rate ($p = 0.0346$) along with a lower RR ($p = 0.0473$). These behavioural changes suggest avoidance strategies in response to vessel presence. Additionally, swim speed increased when boats were within 61-140 m of whales. Drone videos provided further information about mother and calf behaviour, such as apparent nursing, bubble blasts, mouth opening and respiration. Our preliminary results indicate that maintaining greater distances between vessel and whale can minimize effects on whales' movement behaviour, suggesting that boats should remain at least 160 m away from mother-calf pairs (current

regulation allows approaches up to 120 m). Furthermore, drone imagery can provide valuable information into mother-calf interactions, and could enhance WW management in this protected area.

Posters

Patterns of offspring care in northern bottlenose whales

Claire Girard

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

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

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

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

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Consumption of omega-3 fatty acids is necessary for human health, development, and disease prevention However, long-chain omega-3s, including eicosapentaenoic acid (EPA), are primarily sourced from (over)harvested wild fish stocks. Omega-3s accumulated in fish are produced by phytoplankton and can be obtained directly by cultivating phytoplankton. Phytoplankton growth rates and yields can be enhanced with plant hormones like indole-3-acetic acid (IAA). The amino acid tryptophan is the biosynthetic precursor for IAA, and cheaper than the plant hormone. In culture, phytoplankton omega-3 yield rates depend on growth rates, standing biomass stock, and cell quotas of omega-3s. These factors vary by growth phase (stationary vs exponential), and growth medium (inorganic mineral medium vs organic-amended medium). This study compares EPA yield rates of two phytoplankton, *Cylindrotheca closterium* and *Nannochloropsis oculata*, in an inorganic mineral medium vs a tryptophan-amended medium, in exponential vs stationary phases. Phytoplankton omega-3 production rates were assessed using a combination of bio-optical monitoring and growth modeling. In tryptophan dose-response screening, there was no significant increase in growth rate for either species with tryptophan addition. However, the biomass yield for *C. closterium* was significantly higher in 2.5 mM tryptophan than in control cultures ($p < 0.001$). Omega-3 yield rates were calculated from cell quotas measured with gas chromatography following transesterification. The EPA production rate and yield for both species await analysis. At scale, tryptophan fertilization could reduce the cost of producing high-value omega-3s used for human food supplements and animal feed. Using these sustainable omega-3s will relieve the pressure on weakened wild fish.

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

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Pacific white skate (*Bathyraja spinosissima*) nurseries were discovered in 2015 at the active Galápagos hydrothermal vent field Iguanas-Pinguinos. At these nurseries, skate eggs of various colours (i.e. yellow-green, brown, white) appeared to be close to active vents. These skates were hypothesized to utilize slightly elevated water temperature from vent fluids to accelerate their eggs' estimated 9.6-10-year incubation period, but specific environmental drivers that influence these skate egg distributions remain unquantified. Our study aimed to examine how seafloor morphology, geology and proximity to active vents relate to egg locations at Iguanas-Pinguinos. Utilizing 17.8 km^2 of high-resolution multibeam sonar, we processed bathymetry and backscatter data collected in 2010 by an autonomous underwater vehicle (depth: 1576-1762 m), and derived seafloor morphology maps for the site. From 3 remotely operated vehicle dives collected in 2023 aboard a Schmidt Ocean Institute expedition, high-resolution video footage was analysed using the software BIIGLE to georeference skate egg locations, which were subsequently imported into ArcGIS Pro and overlaid on seafloor environmental layers. Combining skate egg presence-absence with predictor layers, skate egg nurseries were predicted using a random forest habitat suitability model. Our model (accuracy: 94%; kappa: 0.94) confirmed high skate egg concentrations within 50 m from active vents at a narrow depth range of 1641-1692 m and were found on narrow-flat scarps. Our findings provide the first quantitative evidence of Pacific white skates laying their eggs near active vents at specific depths and seafloor structures, further contributing to our ecological understanding of these skates at Iguanas-Pinguinos.

Remediating Waste, Capturing CO2, and Building a More Sustainable Future with Algal-Enriched Concrete

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The demand for concrete is increasing as new infrastructure is built for growing global populations and there is an increased need for coastal armoring to prevent coastal erosion. However, concrete production is currently responsible for 8% of global carbon dioxide emissions, contributing to climate change. We tested an analog of Microbially Induced Calcite Precipitation (MICP) — a process in which bacteria incorporated in concrete increase its strength — with microalgae, which are net carbon dioxide absorbers. Preliminary tests demonstrate a 30% increase in the compressive strength of algae-enriched concrete cured under suboptimal conditions, while sequestering the carbon embodied in their biomass. We then tested whether municipal and food wastes could be used to satisfy the nitrogen and phosphorus requirements for algal growth. We optimized algal growth in wastewater, which could link remediating waste nutrients to algal carbon capture and sequestration in concrete. By increasing concrete's strength under suboptimal curing conditions, the energetic cost of concrete production is decreased. The reduced need for maintaining optimal curing conditions, coupled to the carbon-sequestration ability of the algal admixture, could reduce the carbon footprint of the concrete industry. Remediating the excess nutrients in wastewater would reduce their discharge into local water bodies. This could reduce the risks of eutrophication (e.g., coastal hypoxia, harmful algal blooms, habitat loss). Current research efforts focus on screening local isolates of algae to identify optimal candidates for producing admixtures for concrete at pilot scale.

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

Jenna Wright

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

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

Meghan Oliver

Sperm whales (Physeter macrocephalus) have complex social structures that give rise to sophisticated communication networks. Codas, rapid, rhythmic bursts of sounds, are a primary type of social vocalization in this species. Based on their patterning, codas can be categorized into types, which are used to identify vocal clans: large associations of individuals from multiple kin-based social units that share acoustic repertoires. Understanding these clans is crucial for studying the species' behavioural ecology, population biology, and culture, which, in turn, inform conservation methods. Traditionally, vocal clan identification has involved manual analysis of acoustic recordings, a time-consuming process. This project tested the first automated coda analysis software developed by marine technology researchers from the University of Halifax, Israel, to compare its efficiency with that of traditional manual analysis methods. The automated software was then used to analyze acoustic recordings of Galápagos sperm whales, collected in 2022 and 2023, to identify the vocal clans present during these surveys. Preliminary results suggest that the automated detector can surpass manual auditing in efficiency when constraints are applied to both the software's auditory factors and to the coda detection threshold. Next steps for this project include identifying the vocal clans present in this dataset, using the identify call method (IDCall), which analyzes files with annotated codas for distinct patterns and categorizes them hierarchically based on coda type. This work advances our understanding of Galápagos sperm whale population biology and social structure, while also exploring the potential of novel technologies and methods for analyzing their vocalizations.

Reconstructing Seasonal Changes in Surface Particulate Organic Matter Using Carbon Isotopes of Amino Acids

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

Spatial variation of community compositions across the Northumberland Strait

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Located in the southern Gulf of Saint Lawrence, the Northumberland Straight is home to a diversity of marine species. In 2017, Fisheries and Oceans Canada (DFO) designated approximately 5,835 km2 of the strait as Scallop Buffer Zone marine refuges, which prohibit scallop dragging to preserve juvenile American lobster (*Homarus americanus*) and their habitat. Scallop dragging has been shown to change the faunal composition of sites, disturb the top layer of sediment, and lower the nutrient quality of remaining substrate. These marine refuges serve a secondary purpose through protecting habitat used by endangered winter skates (*Leucoraja ocellata*), an endemic lady crab (*Ovalipes ocellatus*) population, and other ecologically important species. Currently, there are limited studies that investigate how community composition varies spatially across the strait. This study aims to describe the spatial distribution of marine benthic communities across the Northumberland Strait and compare the communities inside and outside the marine refuges. Between 2023 and 2024, teams from DFO and Dalhousie University conducted 133 drop camera transects in the Northumberland Strait. Videos were recorded using 4K drop camera systems and annotated through the platform BIIGLE. Annotations consisted of kelp and epifaunal identification, as well as visual surface substrate classification using a modified Folk 5 classification scale. Transects were standardized by length, and species counts were used to run a Bray-Curtis dissimilarity analysis. Results were visualized using multidimensional scaling ordinations and overlay of environmental variables. Communities were then mapped to understand their spatial distribution relative to their dissimilarity scores. Results of this study are important for understanding the efficacy of the Scallop Buffer Zone marine refuges in conserving epifaunal species, and can be used to inform future management decisions in the Northumberland Strait.

Investigating Patterns in Phaeocystis in the Southern Ocean and its Contributions to the Biological Carbon Pump

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Phaeocystis is a globally distributed genus of marine phytoplankton that plays a significant role in ocean ecosystems and carbon cycling. It exists in two forms: solitary cells and colonies embedded in a gelatinous matrix. Despite its potential ecological significance, the role of *Phaeocystis* in the biological carbon pump (BCP)— a critical mechanism for carbon sequestration in the deep ocean—remains poorly understood. Particularly, *Phaeocystis* can form massive blooms in the Southern Ocean, having critical effects on the BCP in this area; however, one challenge encountered during research is damage to the fragile colonies during processing or preservation. To overcome this, field data was collected using an Underwater Vision Profiler 6 (UVP6), which uses 2D imaging of particles >600 µm to quantify abundance without disturbing large colonies. The data for this study was collected in the Weddell Sea (Southern Ocean) on a mooring that held the UVP6 at a depth of 200 m. The data is in the form of a yearlong time series that allows the comparison of *Phaeocystis* concentration to the concentration of detritus, fecal pellets, and zooplankton. Our objective is to investigate how *Phaeocystis* contributes to the BCP by investigating its temporal evolution in relation to other organism abundance. Through initial exploration of the time series, we have identified the concentration of *Phaeocystis* at 200 m depth to be rapidly increasing and then declining from the end of December until the middle of February, with peak concentration seen on January 31st. Further exploration of relevant factors, such as mixed layer depth, is needed to determine if this is a sinking event or a bloom that we are observing. Early results indicate that this study will produce information pertinent to the understanding of *Phaeocystis* in the BCP and the environmental drivers that influence its carbon sequestration potential.

Identifying optimal phosphate delivery for sugar kelp (Saccharina latissima) in the nursery phase

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Kelp aquaculture has been on the rise globally in recent years due to the growing need for sustainable, resource-efficient and cost-efficient food sources. Although the kelp aquaculture industry is small in Nova Scotia at the moment, it has the potential to be a multi-million-dollar industry in the future (EAC 2023 report). While the recent rise of kelp aquaculture has prompted research into investigating optimal temperature, salinity, and pH conditions, little research has been conducted on the optimal nutrient constituents of the water which kelp is grown in. Most sugar kelp hatcheries use Guillard F/2 medium, a media nutrient solution that has been optimized for microalgal growth however, there has been a wide variety between recommended media concentrations. In the Kelp Cultivation Handbook published by the Puget Sound Restoration Fund, the recommended concentration of F/2 is 10-20 ml/L. On the contrary, some kelp farmers have had success adding no F/2 medium at all. The aim of this research project is to identify the optimal phosphate delivery for sugar kelp growth in the nursery stage.

To achieve this, spools of sugar kelp were grown for 5 weeks in one of four treatments. One treatment consisted of tanks inoculated with 500 spores/ml and supplemented with 0.044 ml/L F/2, another treatment consisted of tanks inoculated with 5000 spores/ml and supplemented with 0.044 ml/L, a third consisted of tanks inoculated with gametophytes and supplemented with 0.044 ml/L, and a fourth consisted of tanks inoculated with 5000 spores/ml and supplied a constant flow of seawater from the Northwest Arm. Water samples were sampled at the beginning and end of each week, and phosphate concentrations were measured using spectrophotometric analysis to determine how much phosphate was taken up. The density and length of kelp sporophytes were measured to determine which treatment yielded the best growth.

Quantifying Recent Sedimentation on Eastern Canadian Shelves

Aiden Soth

Marine sediment on continental shelves plays a crucial role in Earth's carbon cycle, serving as a reservoir and sequestration site for organic carbon. Continental shelves are rich in organic carbon due to input by coastal productivity and terrestrial runoff. However, very little is known about actual carbon accumulation rates (g m-2 yr-1) of marine sedimentary organic carbon across Canadian continental shelves and elsewhere. In addition, recent estimates of organic carbon stock on Canadian shelves have yielded high uncertainty. Despite these knowledge gaps, some authors suggest that marine sedimentary carbon should be included in current carbon accounting inventories to better understand how the Canadian continental shelf serves as a national carbon sink. This thesis quantifies organic carbon accumulation on Eastern Canadian shelves based on 12 recently recovered multicores from the Scotian Shelf, Foxe Basin and Labrador Shelf. Downcore measurements of organic carbon, dry bulk density and opal concentration were determined to answer the following research questions:

(1) How fast is organic carbon is accumulating across Eastern Canadian Shelves?

(2) How do actual measurements compare to the most recent predictive model?

(3) What are the implications of model-data differences?

Results show organic carbon concentration is higher than model predictions across all study regions. Opal values indicate a positive relationship between organic carbon concentration and opal concentration on the Scotian Shelf. Using a sedimentation rate value from the literature (30cm ka-1 or 0.3 mm yr-1, Keigwin et al. 2003), accumulation rates of organic carbon on the Scotian Shelf estimated in this thesis range from 2.1 to 5.2 g m-2 yr-1. If confirmed in future studies, the underprediction of organic carbon by recent models poses environmental and economic implications and might suggest a that greater consideration of marine sedimentary organic carbon in global accounting systems is warranted.