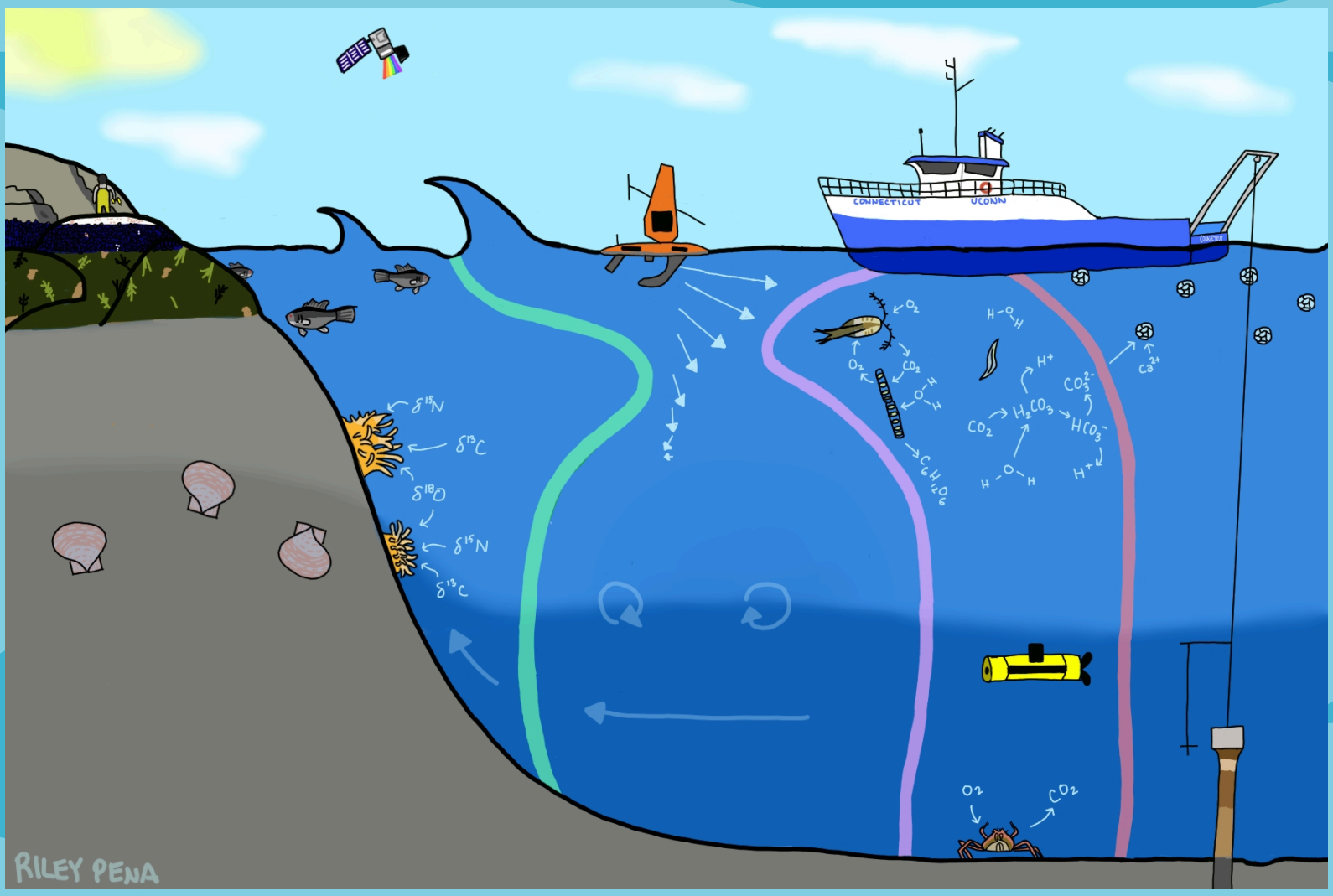
14th Biennial

Feng Graduate Research Colloquium



Thursday, May 18th, 2023

Department of Marine Sciences
University of Connecticut, Avery Point

This colloquium honors the memory of Professor S. Y. Feng, Director of the former Marine Sciences Institute, and founding Head of the Department of Marine Sciences, University of Connecticut. The Colloquium is funded by the Department of Marine Sciences and the S.Y. Feng Scholarship Fund. Donations to this fund are accepted through the University of Connecticut Foundation, and are tax deductible. All donations are greatly appreciated.

The Department of Marine Sciences wishes to thank Mrs. Jean Feng for her support of Marine Sciences and the growth of its students.

Student Steering Committee
Josie Mottram
Lisa Piastuch
Max Zavell

Faculty Coordinator
Hans Dam

Logistical Support
Debra Schuler

Artwork
Riley Pena

Schedule for the Day

9:00 am: Breakfast and Coffee
9:30 am: Opening remarks by Hans Dam

Oral Session I

Moderator: Mackenzie Blanusa

Time	Presenter	Title
9:45-10:00	Molly James	Evaluating the law of the wall in a tidal salt marsh creek
10:00-10:15	Jo-Marie Kasinak	Toward a deeper understanding of human connections with ocean environments: Ocean Identity (OI) as a novel construct, research instrument, and assessment tool
10:15-10:30	Shannon Jordan	Improving site suitability for eelgrass restoration through manipulation of the sedimentary iron cycle
10:30-10:45	Sean Ryan	The role of inducible defenses in mediating algae-herbivore interactions in a warming ocean

Poster Session I & Coffee Break

10:45 – 11:45 am

Presenter	Title
Mehrnoosh Abbasian	Modeling eddy diffusivity and oxygen isotopes to better characterize hypoxia in western Long Island Sound
Rowan Batts	Critical thermal maxima of a foundational copepod species after long-term exposure to climate change conditions
Mackenzie Blanusa	New findings from the U.S. GO-SHIP decadal reoccupation of A16N
Brittney Collins	Monitoring riverine and coastal water quality of Long Island Sound using Satellite Imagery
Catherine Crowley	Small eukaryotes contribution to nitrate-based new production in the north Pacific subtropical gyre
Alexandra Frenzel	Sediment-water alkalinity exchange dynamics on the northwest Atlantic continental shelf
Lucas Jones	Reduced expression levels of key genes in sand lance embryos exposed to elevated pCO_2 conditions
Josie Mottram	A calibration of the relationship between col-water coral skeleton-bound 15N and subsurface nitrate 15N in the subtropical north Atlantic, subtropical north Pacific, and the California margin
Sophia Smith	Speciation and concentration of mercury in the GoM
Graham Trolley	Assessing the impacts of plastic-associated biofilms on ocean color chlorophyll-a retrievals

Oral Session II

Moderator: Lucas Jones

Time	Presenter	Title
11:45-12:00	Wesley Huffman	Size does not matter: Prey species size has no impact on the transfer of MeHg to juvenile pollock in the southeastern Bering sea
12:00-12:15	Max Zavell	Robustness of black sea bass (*Centropristis striata*) early life stages to experimental ocean acidification
12:15-12:30	Paban Bhuyan	Validating saildrone ADCP measurements for high-resolution submesoscale observations: Accuracy and noise analysis
12:30-12:45	Tyler Griffin	A multi-study analysis of gut microbiome data from the blue mussel (*Mytilus edulis*) emphasizes the methodological impact of gut voidance on biological interpretation

LUNCH: 12:45 – 1:45 pm

Oral Session III

Moderator: Molly James

Time	Presenter	Title
1:45-2:00	Michael Mathuri	Concentration-dependence of nitrogen isotope fractionation during ammonium assimilation by marine phytoplankton
2:00-2:15	Hannah Inman	Speciation and distribution of mercury in the water column and sediments of the Bering and Chukchi seas
2:15-2:30	Ewaldo Leitão	Effects of thermal adaptation on predator-prey interactions of the copepod *Acartia tonsa*
2:30-2:45	Hannah Collins	Size-based ingestion of microplastics by Quagga mussels (*Dreissena bugensis*): implications for bioremediation

Poster Session II & Coffee Break

2:45 – 3:45 pm

Presenter	Title
Bernard Akaawase	Directional breaking kinematics observations from three-dimensional stereo reconstruction of ocean waves
Monica Garity	Investigating the role of ocean carbon sequestration leading into the last ice age
Luke Glass	Categorical analysis shows links between wind direction and high bacterial concentrations at Connecticut beaches
Lucy Hendrickson	Timescales for the spray-mediated gas exchange of carbon dioxide
Sydney McDonald	Siderophore utilization by *Amphidinium carterae* as a strategy for iron acquisition
Hung Nguyen	Interdecadal oxygen trend on the northwest Atlantic shelf: A modeling approach
Anagha Payyambally	Development of a headspace equilibration method for the measurement of dissolved methane and nitrous oxide concentrations in water samples
Riley Pena	Specificity of prey response to predation risk on historical coexistence

Lisa Piastuch	The effect of hypoxia on the copepod, *Acartia tonsa* adapted to ocean warming and acidification
Ethan Taylor	Using Foraminiferal Mg/Ca as a proxy for subtropical front position in the Southern Ocean

Oral Session IV

Moderator: Ewaldo Leitão

Time	Presenter	Title
3:45-4:00	Kayla Mladinich Poole	Microplastics in oyster aquaculture
4:00-4:15	Emma Shipley	Detection and quantification of brominated natural products in Arctic and mid-latitude coastal air and waves
4:15-4:30	David Riser	Increasing black sea bass abundance in Long Island Sound
4:30-4:45	Halle Berger	Assessing the vulnerability of the U.S. Atlantic sea scallop to ocean acidification and warming: A dynamic energy budget modeling approach

4:45 pm: Closing Remarks by J. Evan Ward

5:00 pm: End of the Year BBQ

ABSTRACTS

Oral Session I

Evaluating the law of the wall in a tidal salt marsh creek

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Coastal salt marshes provide critical habitat for many waterfowl and fishes, protect coastlines from storm damage, and exchange materials (pollutants, sediments, nutrients, and carbon) with estuaries. The degree of these ecosystem services depends on the circulation within a marsh. The law of the wall (log-law) has been used to model marsh creek velocity profiles, despite scant observations of full current profiles to confirm its applicability. The log-law describes the impact of a solid boundary on the mean velocity profile of turbulent flows. To evaluate the log-law in salt marshes, we compared direct observations of marsh creek velocity profiles to those predicted by log-law. Measurements were subject to thorough quality control and quality assurance for confidence in the persistence and shape of the velocity profiles. Findings suggest the log-law may be an inappropriate formulation for currents in a salt marsh creek under most tidal conditions. Profiles deviating from the log-law are unlikely caused by surface stress from winds. To better understand marsh circulation and its impact on restoration, conservation, and marsh biogeochemistry, more observations of flow within marshes and careful consideration of models are needed.

Toward a deeper understanding of human connections with ocean environments: ocean identity (OI) as a novel construct, research instrument, and assessment tool

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The United Nations declared 2021-2030 as a Decade for Ocean Science for Sustainable Development and paramount in this effort is increasing ocean literacy to increase stakeholder knowledge of and connection to the ocean. The global ocean provides valuable resources (i.e., ecosystem services) and humans have historically shared a deep connection to the ocean, but little is formally known about the multiple dimensions of human connectedness to ocean spaces. Environmental identity is a construct that has been well-studied and can be used to explain a person's connection to the environment. Here we are seeking to clearly define and validate the novel construct of Ocean Identity (OI), which integrates cognitive, affective, and behavioral components to define this identity. Ocean Identity holds promise to be a new tool to measure human-ocean connections and to evaluate the impact of informal and formal education events centered around the ocean. Upon final validation of the instrument, it will be used to assess education and outreach activities' impacts on participants OI by using Project *Limulus*, (a long-term research program on horseshoe crabs) as a testbed. Ultimately, we will develop a toolkit for stakeholders to measure the impacts of their programs using this validated reliable instrument.

Improving site suitability for eelgrass restoration through manipulation of the sedimentary iron cycle

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Slow rates of eelgrass recovery relative to water quality improvements in Long Island Sound highlight a need to better constrain sediment influences on restoration outcomes. Previous studies have demonstrated that high porewater sulfide concentrations infringe on eelgrass health and suggest that sediment iron amendment could reduce production and inventory of porewater sulfide. This study aimed to quantify the ability of iron mineral particles to reduce porewater sulfide concentrations in sediments. Different siderite ($FeCO_3$) and magnetite (Fe_3O_4) mixtures were added to sulfidic sediments. The effect of iron type, mass, and grain size on porewater sulfide and pH were evaluated. Experiments were done at the benchtop and mesocosm scales over periods of one week to six months, respectively. Fine-grained magnetite showed the most efficient sulfide removal and the longest-lasting effect relative to siderite. The pH effects from iron additions were small but more prevalent with magnetite additions. These results identified the iron-type, particle size, and mass additions best suited for treatment of sediments where high sulfide potentially hinders eelgrass reestablishment.

The role of inducible defenses in mediating algae-herbivore interactions in a warming ocean

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Rising temperatures are expected to impact plant-herbivore interactions and their effects on community structure and ecosystem function. As temperatures rise, grazing rates of ectothermic herbivores should increase to meet greater metabolic demands. However, mismatches in the outcomes of warming on herbivory and primary production make it difficult to predict the net effect of warming on plant-herbivore interactions. Furthermore, temperature-induced changes in anti-herbivore traits of plants and herbivore tolerance for these traits may impact grazing preferences and rates. We investigated how temperature impacts the trophic interactions between an intertidal fucoid alga (*Fucus vesiculosus*) and a specialist gastropod herbivore (*Littorina obtusata*). We first exposed our seaweed to herbivores during an induction phase at 10,14,18, and 22˚C. We then measured herbivore preference for ungrazed control or induced seaweed in choice assays to determine the net effects of temperature on fucoid inducible defenses. We found a mismatch in the temperature dependence of these traits as our seaweed induced anti-herbivore resistance at low temperatures, but our herbivore only responded with a change in preference at the higher temperature. Our results indicate that predicting the impacts of climate change on natural communities will require mechanistic understanding of ways temperature affects algal-herbivore interactions.

Poster Session I

Modeling eddy diffusivity and oxygen isotopes to better characterize hypoxia in western Long Island Sound

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Eutrophication in estuaries occurs when excess nutrients enter the system from human activities. In the summer, the warmer surface waters of an estuary become less dense and remain separated from the colder, denser bottom waters. This can prevent the mixing of oxygen-rich surface waters with the oxygen-depleted bottom waters, leading to hypoxia. Hypoxia occurs in the western part of Long Island Sound (LIS) during the summer. Summertime hypoxia is caused by a combination of factors, including warm water temperatures and low wind conditions. Continuous monitoring tracks oxygen and detects hypoxia-prone areas. Mixing and respiration affect the oxygen isotope ratio (δ^{18}O) of dissolved oxygen in aquatic systems, providing insights into biogeochemical processes, water movement, and respiration sources affecting dissolved oxygen. To quantify mixing in LIS, we used the model GOTM to estimate turbulent eddy diffusivity, K_z. We then assessed its performance using measurements of the evolution of salinity, temperature and current. The values of K_z will be used in a model that simulates the evolution and structure of the δ^{18}O and enable the diagnosis of the relative importance of benthic and water column respiration in LIS.

Critical thermal maxima of a foundational copepod species after long-term exposure to climate change conditions

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The role of population adaptation to climate change scenarios is poorly understood, particularly costs of adaptation. This study takes advantage of four lineages of a foundational copepod species, *Acartia tonsa*, maintained under ambient (AM), ocean warming (OW), ocean acidification (OA), and combined ocean warming and acidification (OWA) conditions for > 100 generations. Previous observations on these lineages showed complete fitness recovery in the OW, but not the OWA lineage after 25 generations, illustrating non-additive responses to combined stressors and suggesting a possible cost to OWA adaptation. We measured critical thermal maximum (CTmax), equivalent to the temperature of ecological death, in the four lineages. The aim was to quantify the individual and interactive effects of warming and acidification on upper thermal limits. *A. tonsa* had significantly higher thermal limits for the OW and OWA treatments than the AM and OA treatments, yet no difference between the OW and OWA treatment. This suggests no cost of adaptation to OA conditions for CTmax. This hypothesis is currently being tested using reciprocal transplants between CO_2 treatments at each temperature. The results will be compared to previous work that used the temperature LD50, a different metric of thermal performance.

New findings from the U.S. GO-SHIP decadal reoccupation of A16N

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The U.S. Global Ocean Ship-Based Hydrographic Investigations Program (U.S. GO-SHIP) is a NSF funded program, part of international GO-SHIP, with a mission of collecting hydrographic data on decadal timescales. Predicated by the World Ocean Circulation Experiment (WOCE), GO-SHIP uses modern standards to better understand and predict physical, chemical, and biological changes to the ocean. International GO-SHIP has approximately 55 hydrographic reference lines, which are aimed to be sampled every decade. Along these lines, Conductivity, Temperature, and Depth (CTD) measurements using a rosette bottle system are made from the ocean surface to bottom, making GO-SHIP the primary source of deep ocean (>2000 meters) monitoring. In March-May 2023, U.S. GO-SHIP reoccupied the full A16N hydrographic line for the third time, providing an opportunity to begin investigating decadal trends in various oceanic parameters. The A16N line has been previously partially occupied about 10 times, with most of the measurements in the northern mid-latitudes. In this presentation, I will provide an overview of the 2023 A16N reoccupation. Specifically, I will describe methodologies for collecting water samples, what variables were measured, observational difficulties, ship of opportunity prospects, and a scientific analysis comparing the newly collected data with the previous 2003 and 2013 reoccupations.

Monitoring riverine and coastal water quality of Long Island Sound using satellite imagery

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Managing water quality in rivers discharging into Long Island Sound (LIS) is a critical issue for coastal managers faced with changing land use practices. Water quality parameters can be derived from satellite remote sensing including turbidity, total suspended matter (TSM), chlorophyll-a (Chl-a), and colored dissolved organic matter (CDOM). However, considerable uncertainty exists in the application of satellite products in inland and coastal waters. Here, we will evaluate the performance of satellite approaches to derive these parameters in local rivers discharging into LIS including the Thames River and Connecticut River over the course of a year. Bi-weekly sampling of these rivers will allow us to develop a time series of field data reflecting seasonal variation in flow rates, phytoplankton blooms, and storm surges that can be used to tune optical algorithms for these waters. Parameters to be assessed include water-leaving reflectance, TSM, Chl-a, and CDOM. For clear sky days, corresponding satellite data from sensors such as Sentinel-2, Sentinel-3, Landsat-8, and MODIS Aqua and Terra to evaluate and tune models for the riverine and coastal waters of LIS. The goal of this research is to assist in improving methods for monitoring and maintaining water quality standards in this dynamic estuary.

Small eukaryotes contribution to nitrate-based new production in the North Pacific subtropical gyre

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Anthropogenic climate change is expected to result in the expansion of subtropical gyres and greater surface ocean stratification. These changes are expected to result in a decrease in nutrient transport to the surface and a potential weakening of carbon storage into the ocean interior. To understand and anticipate how climate change will impact the primary production of subtropical gyres, their biogeochemistry and nutrient cycling need to be studied. In the North Pacific Subtropical Gyre (NPSG), the supply of nutrients to the surface waters is low and primary production relies on recycled nutrients. However, in the Sargasso Sea, an analogous ocean region, nitrate assimilation occurs throughout the euphotic zone in the summer, in spite of surface stratification. Nitrate assimilation in the euphotic zone is carried out by small eukaryotic phytoplankton. This dynamic suggests that subsurface nutrients are supplied to the strongly stratified surface by mechanisms not yet understood. Here, we aim to study whether surface production at station ALOHA in the NPSG is similarly fueled by nitrate, and whether small eukaryotes account for the majority of new primary production therein. Parallel metatransciptomic analysis will illuminate which groups of phytoplankton rely on nitrate for growth.

Sediment-water alkalinity exchange dynamics on the northwest Atlantic continental shelf

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Rising atmospheric CO_2 increases oceanic CO_2 and consequently reduces pH, a phenomenon termed ocean acidification (OA). Sources of alkalinity to the ocean can dampen the rate of OA. Northwest Atlantic shelf waters are monitored every few years to evaluate the regional OA trajectory. Such efforts have not previously monitored shelf sediments despite recognizing them as a potential source of alkalinity. Sediments can supply alkalinity through anaerobic mineralization pathways and carbonate dissolution. Sediment cores collected from 23 stations were used to: 1) measure direct alkalinity fluxes from sediments; 2) quantify denitrification contributions to alkalinity fluxes; 3) identify porewater indicators of other alkalinity generating processes (e.g. iron and sulfate reduction). Sediments from 22 stations were a net alkalinity source to overlying water. Three quarters of the stations contained high porewater ferrous iron suggesting active iron reduction, but free sulfide concentrations were low everywhere. All stations < 500 m had moderate rates of denitrification ranging from 0.002 to 0.368 mmol m^{-2} d^{-1}. Denitrification was dominated by coupled denitrification and thus may be only a limited source of alkalinity. Identifying the possible sources of alkalinity generated in sediments will be useful for constraining OA models used to quantify mechanisms underlying regional OA trajectories.

Reduced expression levels of key genes in sand lance embryos exposed to elevated pCO_2 conditions.

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Northern sand lance (*Ammodytes dubius*) are important forage fish found on offshore sand banks throughout the Northwest Atlantic (NWA). Recently, this species has been shown to suffer decreased hatching success when exposed to increased pCO_2 levels, but the responsible mechanisms for decreased hatching success remain insufficiently understood. For this preliminary study, we extracted and sequenced total-RNA from 7 individual embryos to test for differential gene expression (DGE) between control (8.2 pH, 7°C) and acidified (7.47 pH, 7°C) treatments. Within the top 50 most variable genes, control treatment embryos displayed higher expression levels relative to those at acidified treatments. The next bioinformatics steps will focus on gene ontology to elucidate the functions of differentially expressed genes, which can help identify the mechanisms behind the observed decrease hatching success.

A calibration of the relationship between cold-water coral skeleton-bound $\delta^{15}N$ and subsurface nitrate $\delta^{15}N$ in the subtropical North Atlantic, subtropical North Pacific, and the California Margin.

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The nitrogen isotope composition of organic material preserved in the skeleton of non-symbiotic cold-water corals (CB-$\delta^{15}N$) is strongly correlated to the $\delta^{15}N$ of organic material exported from the surface ocean, so CB-$\delta^{15}N$ offers a promising paleo-proxy to reconstruct ocean nitrogen cycling. However, a large offset between $\delta^{15}N$ of subsurface nitrate and CB-$\delta^{15}N$ likely arises from two trophic transfers between surface production and coral tissue biomass – rendering the proxy potentially sensitive to changes in food web structure. To further evaluate the faithfulness of CB-$\delta^{15}N$ to the $\delta^{15}N$ of surface production, we analyzed skeleton samples collected along depth profiles in the subtropical North Atlantic, the subtropical North Pacific, and the California Margin. We compared CB-$\delta^{15}N$ to nitrate $\delta^{15}N$, the $\delta^{15}N$ of suspended particulate nitrogen, as well as the $\delta^{15}N$ of zooplankton. Preliminary results reveal unexpected variations of coral $\delta^{15}N$ with depth, which may arise from depth-specific differences in the $\delta^{15}N$ of prey – suggesting a sensitivity of the proxy to food web structure.

Speciation and concentration of mercury in the Gulf of Maine

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Mercury (Hg), in the form of methylmercury (MHg), is a neurotoxin that bioaccumulates in organisms and biomagnifies up the food chain. Thus, understanding its behavior is important, especially in major fishing grounds such as the Gulf of Maine (GoM). Due to climate change, the GoM has received greater watershed inputs, resulting in an increase in terrestrial organic matter (OM). This change is important because terrestrial OM could also transport Hg, and greater inputs of OM may lead to increased *in situ* MeHg production. The impact of increased watershed inputs will be examined over the course of four cruises in the GoM and its major tributary, the Penobscot River, taking place between April 2023 to April 2024. Dissolved and particulate elemental Hg, methylated Hg (MeHg), including monomethylmercury (MMHg) and dimethylmercury (DMHg), and total Hg concentrations will be measured throughout the water column, as well as their rates of interconversion. OM quality will also be measured and contrasted with the historical information available regarding DOM quality and quantity. Ultimately, this study will expand upon the limited pool of Hg measurements in the GoM, allow for better understanding of Hg cycling, and help clarify the relationship between Hg, MeHg, and DOM.

Assessing the impact of plastic-associated biofilms on ocean color chlorophyll-a retrievals

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The Great Pacific Garbage Patch (GPGP) represents a region of enhanced plastic accumulation containing an estimated 1.8 trillion floating pieces and up to 1,000,000 pieces/km^2. Currently, monitoring tools are not well developed to assess global distributions of these particles, and sensitivity analyses are underway to assess remote sensing capabilities for plastic detection. Microplastics harvested from ocean gyres show four characteristic NIR and SWIR absorption bands, but little is known about how natural biofilms influence these spectral properties. We collected spectral reflectance measurements of freshly harvested floating microplastics in the GPGP with biofilms, then again after a cleaning procedure. Biofilms were found to reduce reflectance in the visible and introduced a 670nm absorption feature, commonly associated with chlorophyll-a. This indicates that plastics are substrates for photosynthetic biofilms which are not separately accounted for in ocean color chlorophyll algorithms, which could impact phytoplankton biomass and ocean carbon biogeochemistry estimates. The extent of this error was determined via linear mixing simulations, which calculated deviations from the expected chlorophyll-a retrieval under varied plastic abundances. These simulations suggest that current plastic concentrations are not significantly affecting chlorophyll retrievals, and that a 10-fold increase in surface plastic concentration would be necessary to observe systematic error.

Oral Session II

Size does not matter: prey species size has no impact on the transfer of MeHg to juvenile pollock in the Southeastern Bering Sea

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The Southeastern Bering Sea (SEBS) supports one of the most economically important global fisheries, with Alaska pollock (*Gadus chalcogrammus*) as a major catch (3.2 billion pounds annually). Pollock is a major global seafood product and may act as a significant route of human exposure to methylmercury (MeHg). Thus, understanding the sources of MeHg to pollock is imperative. Juvenile pollock consume small and large crustaceans such as copepods and euphausiids. Previous research in the North Atlantic suggests MeHg concentrations increase with animal size; thus, we investigated if the prey size of different copepods species or euphausiids matters for MeHg exposure in SEBS pollock. Based on our sampling in SEBS in June and September 2018, we examined MeHg concentrations in copepods, euphausiids, and pollock. We found that MeHg was not significantly different between smaller and larger copepod species (*Oithona sp*., 1.02 ± 0.28 vs. the largest *Calanus sp*., 1.54 ± 0.36 ng/g wet weight; p = 0.22). Moreover, no significant difference was detected between copepods and the much larger euphausiids (0.35 ± 0.32 vs. 1.1 ± 0.5 ng/g wet weight; p = 0.09). Thus, MeHg transfer from copepods and euphausiids to juvenile pollock is similar.

Robustness of black sea bass (*Centropristis striata*) early life stages to experimental ocean acidification

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Black sea bass (BSB) are both a commercially and recreationally important gamefish in the Northwest Atlantic. Over the past decade, BSB abundance has rapidly increased in the northern extent of their range, but little work has examined the effects of future climate scenarios across both organismal and population-level scales. To test the effects of ocean acidification (OA) on early life stages of BSB we reared embryos and larvae under three contrasting pCO_2 conditions: ambient (8.15 pH ~ 400 µatm), elevated (7.45 pH ~ 2200 µatm), and extreme (7.20 pH ~ 4,200 µatm). OA treatments did not affect initial hatching success (~30%) or larval meristics (total length and body depth). While survival and mean growth rates from 0 – 10 days post hatch was highly variable across replicates, there was no difference across treatments; yet growth was ~ 52% higher in fish reared under high pCO_2. These initial results suggest that BSB are potentially highly resilient to OA. Planned future studies will include OA and warming to identify potential interactive effects BSB early life stages.

Validating saildrone ADCP measurements for high-resolution submesoscale observations: accuracy and noise analysis

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Submesoscale ocean processes require high-resolution observations in space (≤ 1km) and time (≤ 1hr) to accurately capture their dynamics. Saildrone technology provides a cost-effective tool for simultaneous high-resolution measurement from multiple platforms, but the accuracy of its ADCP measurements is yet to be validated. This study validates Saildrone ADCP measurements against the R/V *Oceanus* platform, quantifies the noise, and assesses the accuracy of submesoscale kinematics (i.e., vorticity and divergence) calculated from Saildrone ADCP data. We analyzed measurements from the Submesoscale Ocean Dynamics Experiment (S-MODE), calculating along-track velocity difference variability and performing kinetic energy spectral analysis. Results show along-track velocity difference variability of 3 cm/s in standard 5-minute Saildrone ADCP data, consistent with observations from the R/V Oceanus. Furthermore, resampling the 1hz data to various time-averaging windows (from 2 seconds to 3 minutes) shows significant noise reduction with more averaging, and averaging above the 3-minute window does not include any noise. For submesoscale kinematics, our analysis suggests that to calculate current gradients at least four drones are essential. Our results will help researchers make informed decisions about the use of Saildrone data to investigate ocean dynamics, and wind-wave-current interactions at submesoscales.

A multi-study analysis of gut microbiome data from the blue mussel (*Mytilus edulis*) emphasizes the methodological impact of gut voidance on biological interpretation

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The blue mussel (*Mytilus edulis*) is a model organism used in several gut-microbiome surveys. Although raw sequence data are often publicly available, unifying secondary analyses are lacking. The present work analyzed raw data from seven projects conducted by one group over seven years. Although each project had different motivations, experimental designs and conclusions, all selected samples were from the guts of *M. edulis* collected from one location in Long Island Sound. The goal of this analysis was to determine which independent factors (e.g., collection date, depuration status) were responsible for governing composition and diversity in the gut microbiomes. The primary trend in the results was a clear differentiation between microbial communities from mussels that had been allowed to void their gut during a no-food period prior to dissection and those from mussels that had not. This finding supports the developing paradigm about the difference between transient microbes ingested with food and then voided shortly afterward and resident microbes that reside permanently in the digestive tissues. Ultimately this effort highlights the importance of performing secondary multi-study analyses of raw microbiome sequence data, and of tailoring experimental designs and sampling schemes to match the specific experimental questions being addressed in future work.

Oral Session III

Concentration-dependence of nitrogen isotope fractionation during ammonium assimilation by marine phytoplankton

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The extent to which stable nitrogen (N) isotope ratios ($^{15}N/^{14}N$) are fractionated by biological reactions, quantified as the N isotope effect, provides constraints on N biogeochemical cycling in the ocean. We investigated N isotopic discrimination during ammonium (NH_4^+) assimilation using batch cultures of the diatom *Thalassiosira weissflogii*, the prasinophyte *Tetraselmis* sp., and the cyanobacteria *Synechococcus* spp. Analyses of ammonium $^{15}N/^{14}N$, corroborate a previously reported dependence of N isotopic fractionation on ammonium concentration – isotope effects were as high as 21‰ for *T. weissflogii*, 28‰ for *Tetraselmis* sp. and 15‰ for *Synechococcus* spp. and decreased considerably at lower concentrations. We constructed a physiological model of ammonium assimilation to determine which steps of the pathway fractionate N isotopologues. Specifically, we queried whether fractionation occurs externally during the active ammonium transport by membrane proteins and/or passive diffusion of ammonia (NH_3) into the cell, or whether it occurs internally and propagated to the cell exterior by passive ammonia efflux. Model results suggest that cells growing at high concentrations meet their physiological N demand by passive ammonia uptake, with an associated NH_4^+- NH_3 equilibrium isotope effect of 30‰, and that active ammonium transport is a non-fractionating step that is activated at lower concentrations.

Speciation and distribution of mercury in the water column and sediments of the Bering and Chukchi seas

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The Arctic is a sink of atmospheric mercury (Hg) and source of monomethylmercury (MMHg). The bioaccumulation of MMHg into seafood and marine mammals consumed by people is an important human health concern. The atmospheric deposition and evasion of Hg in the Arctic is not well constrained due to ice cover and other factors, which are experiencing climate change. Additionally, sediment and riverine inputs of Hg and MMHg are poorly constrained. Estimating the net external inorganic Hg and MMHg inputs to the Arctic is complicated by the lack of information on the distribution of mercury species in the polar mixed layer and sediments, and of the internal conversion between Hg forms. Here we report the results of studies completed in May/June 2021 aboard the RV *Sikuliaq* in the Bering and Chukchi Seas. Waters were mostly shallow (<100 m) and water and sediment samples were collected and analyzed for Hg^0, dimethylmercury, total mercury and total methylated mercury, to assess the distribution of mercury species through the water column, sediments, and potential fluxes. This study has further resolved the distribution of mercury species in the water column and sediments in this area and the exchange of Hg at the sediment-water and ocean-atmosphere interfaces.

Effects of thermal adaptation on predator-prey interactions of the copepod *Acartia tonsa*

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The effects of temperature on species interaction remain understudied despite well-established knowledge on its impact on individual producers and consumers. Moreover, assuming invariance of physiological traits across populations can hinder our ability to understand ecological systems under future warming. By investigating the evolutionary changes in functional response (ingestion vs prey concentration) parameters and metabolic rates of the copepod *Acartia tonsa*, we sought to test for the effects of thermal adaptation in predator-prey interactions. We exposed populations of *A. tonsa* to ambient (18°C) and elevated (22°C) temperatures for >100 generations and determined functional responses at multiple temperatures using the phytoplankter *Tetraselmis sp*. as prey. Our findings suggest that handling time decreased at higher temperatures for the ambient treatment, indicating increased consumption at higher prey concentrations, but not for the warm-adapted one. Attack rate decreased at higher temperatures only for warm-adapted one, indicating a decrease in consumption at low prey concentrations. Our future research will involve assessing metabolic rates and parameterizing a populations dynamic model with varying temperatures. Overall, understanding thermal adaptation in predator-prey interactions can improve our ability to predict ecological responses to future warming.

Size-Based Ingestion of Microplastics by Quagga Mussels (*Dreissena bugensis*): Implications for Bioremediation

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Quagga mussels (*Dreissena bugensis*) are a freshwater species invasive to the United States. Their ability to process large volumes of water may have applications for freshwater clarification. In particular, dreissenid mussels have been proposed to remove microplastics (MP) from wastewater treatment plants; however, data are lacking on MP particle capture by quagga mussels and whether large MP are ingested or rejected. Whether MP are sequestered in feces or pseudofeces has implications for the design of removal and settling systems. To address these questions, quagga mussels were isolated in 250-mL beakers and exposed to a known number and type of MP. For each type of particle 15-20 mussels were allowed to process particles for 3.5 hours. Biodeposits were collected at 1, 24, and 28 hours post exposure period, and digested using potassium hydroxide to isolate MP. Microplastics rejected in pseudofeces and egested in feces were quantified to determine the proportion of MP of each type rejected vs. ingested. Preliminary results suggest that *D. bugensis* rejects nearly all 500-µm microfibers. Further data on size-based ingestion will inform future work regarding the efficiency and limits of MP removal from engineered systems by this freshwater mussel.

Poster Session II

Directional breaking kinematics observations from three-dimensional stereo reconstruction of ocean waves

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Short gravity waves are important for remote sensing, air-sea exchange, and underwater acoustics. However, there is a limited understanding of the processes that regulate the directionality of their energy spectrum. This study investigates the directionality of breaking to interpret the azimuthally bimodal spectral shape of short gravity waves. The bimodality of the wave spectrum has been extensively documented from measurements in the literature, but until recently spectral wave models were unable to reproduce it. We reconstructed the sea surface elevation in three dimensions (3D) from stereo visible imagery collected from the Aqua Alta tower in Venice, Italy, using the Waves Acquisition Stereo System. The measured wave field was used to compute the three dimensional-wave spectrum and extract the horizontal kinematics of breaking waves. The resulting statistical distribution of the lengths of breaking crests is azimuthally much narrower than the energy spectrum. This is consistent with the idea that the energy dissipation due to breaking couples with the non-linear energy fluxes due to wave-wave resonant interactions yielding a broad spectrum with strong bimodality. The findings from this study are useful for further optimization and the constraining of dissipation parameterizations in spectral wave models, and an improved understanding of air-sea exchanges.

Investigating the role of ocean carbon sequestration leading into the last ice age

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The last million years of Earth's climate history has been dominated by the Ice Ages, the cyclic variation between cold glacial conditions with low atmospheric pCO_2 and warm interglacial conditions with high pCO_2. Leading into the last Ice Age, pCO_2 decreased in two major steps, at ~115,000 and ~70,000 years ago (115 ka and 70 ka). Despite extensive research, the mechanisms responsible for CO_2 drawdown remain uncertain, leaving a gap in our understanding of the carbon cycle. One possible mechanism is a change in Atlantic circulation, leading to increased isolation of the deep Atlantic and accumulation of carbon. In order to determine whether the deep Atlantic sequestered carbon, we generated vertical profiles of carbonate ion ($[CO_3^{2-}]$) from 1800 to 3500 m water depth in the South Atlantic before and after intervals of CO_2 drawdown. Because $[CO_3^{2-}]$ is inversely related to the concentration of dissolved inorganic carbon, we would expect lower $[CO_3^{2-}]$ if the Atlantic sequestered carbon. The vertical profiles are consistent with greater carbon storage in the deep Atlantic at ~70 ka, but not ~115 ka. Therefore, carbon accumulation in the Atlantic likely played a significant role in the second drawdown, but separate mechanisms are required to explain the first drawdown.

Categorical analysis shows link between wind direction and high bacterial concentrations at Connecticut beaches

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Public access beaches throughout Connecticut provide recreational value for many people, but beach closures due to high bacterial concentrations can prevent access. It is important to understand the environmental conditions that can lead to high bacterial concentrations. The 48-hour precipitation level is the sole environmental marker taken into consideration when pre-emptively enforcing beach closures, but other environmental factors can be influential. It was hypothesized that onshore winds will negatively impact the severity of beach bacteria outbreaks, but the extent to how much is unknown. Using a categorical analysis approach, NOAA meteorological data from 2003-2021 was cross-referenced against Sound Health Explorer beach bacteria data to ascertain how wind direction aligns with high bacteria events. Results show that onshore winds are as common as the occurrence of precipitation in the 48 hours prior to sampling during bacteria outbreaks. This suggests that onshore winds could force and trap coastal waters against the shoreline, thereby increasing bacterial concentrations. This finding opens the door for more holistic approaches to beach closures, seeking predictive improvement with more variables that can be used to make more informed closure decisions. Results point to the need for increased beach sampling, bacteria source modeling, and distribution of localized meteorological stations.

Timescales for the spray-mediated gas exchange of carbon dioxide

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Modeling the diffusion and effusion of carbon dioxide with seawater is a key factor in understanding climate change and predicting its effects. The contribution of sea spray to this flux is highly uncertain yet important for reducing error margins in global estimates. While the timescale for CO_2 gas diffusion within sea spray is known to be shorter than the timescale for droplets' physical changes while aloft, the rate of aqueous carbonate reactions relative to these timescales has not been assessed. We explore the timescales of the carbon dioxide flux relative to the timescales of transformations across the carbonic acid/bicarbonate/carbonate sequence. The rate of diffusion and effusion of carbon dioxide depends on atmospheric temperature, relative humidity, surface ocean water temperature and salinity or ionic strength, and wind speed. The timescales of physical processes (evaporation) depend on droplet size. For larger droplets, they are much greater than reaction or diffusion equilibria timescales and thus control gas exchange. For an evaporating droplet, there is a critical droplet radius at which the conversion of bicarbonate to carbonic acid becomes the limiting factor as diffusion is so rapid.

Siderophore utilization by *Amphidinium carterae* as a strategy for iron acquisition

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Iron is a limiting nutrient for primary production in 30% of the global ocean. Dinoflagellates thrive in a wide variety of coastal and oceanic environments, including iron-limited regions. As iron is a biologically essential element for the growth and proliferation of marine algae, dinoflagellates may have evolved strategic mechanisms to combat iron limitation. Presently, these mechanisms have been scantly investigated in dinoflagellates. Here, we compare the growth response of the well-studied diatom *Thalasiossira weissflogii* to that of the model dinoflagellate *Amphidinium carterae* to different iron conditions: (a) iron-replete medium, (b) iron-limited medium, and (c) iron-limited medium supplemented with the siderophore Deferoxamine B (DFB). Preliminary observations suggest that *A. carterae* is able to assimilate iron bound to DFB, in contrast to *T. weissflogii*. A survey of the transcriptome of *A. carterae* will reveal whether it possess genes analogous to the TonB-dependent receptors (TBDRs) associated with iron-siderophore transport in prokaryotes. A more comprehensive understanding of dinoflagellate acclimation to low iron conditions is key to understanding the biogeochemical dynamics of iron-limited regions.

Interdecadal oxygen trend on the northwest Atlantic shelf: a modeling approach

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Since the middle of the 20th century, oxygen concentrations have been declining in the open ocean and the coastal ocean with significant regional variability. Located near the crossroads of the subtropical and subpolar circulations, the Northwest Atlantic (NWA) Shelf is sensitive to climate variability, which has been shown to be important for oxygen trends in the region. The relative contribution of biological and physical drivers to the decline of oxygen varies regionally and with time, making it challenging to diagnose drivers of recent oxygen trends with available historical observations. Numerical models complete with biogeochemical processes that drive oxygen concentration variation can help, but only if they skillfully simulate the regional variability and regional trends. Here, ROMS equipped with COBALT for the NWA is used to simulate the historical decadal trends and spatial patterns in dissolved oxygen concentrations over the shelf. Using in situ measurements from World Ocean Database (WOD), we evaluate model biases and performance. Using a dynamically downscaled projection out to 2100 under SSP5-8.5, we quantify the projected trends and determine the relative roles of circulation and biological activity to that trend.

Development of a headspace equilibration method for the measurement of dissolved methane and nitrous oxide concentrations in water samples

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With the increasing prominence of climate change, studies of greenhouse gases are highly relevant. Nitrous oxide (N_2O) and methane (CH_4) are two important greenhouse gases having high global warming potential. Here, we are developing an analytical technique to measure these dissolved gases from discrete water samples using a headspace equilibration method, coupled with gas chromatography (GC). Water samples are equilibrated with an N_2 headspace and then the headspace is transferred to a pre-evacuated vial that is loaded onto an autosampler for GC analysis. We use an SRI 8610C GC with flame ionization detector (FID) for CH_4 and electron capture detector (ECD) for N_2O measurement. This method was tested using measurements of air-equilibrated water samples at varying temperatures and standards. The results showed good agreement with expected values derived from solubility calculations. For air-equilibrated water at room temperature, N_2O measurements had a precision (standard deviation) of 2% and error of 6% (0.5 nM) and CH_4 measurements had a precision (standard deviation) of 10% and error of 9% (0.3 nM). Following further refinements, our approach for measurement of N_2O and CH_4 will be applied to improve understanding of the concentrations of these gases in natural waters and their exchange with the atmosphere.

Specificity of prey response to predation risk depends on historical coexistence

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Predator effects on prey behavior and physiology can have cascading effects on ecological communities. Evaluation of and response to risk is expected to be refined over evolutionary time to balance predation risk with the costs of anti-predator responses. While these responses can be energetically costly, failure to recognize and effectively respond to cues from novel predators can result in increased prey mortality. Here, we assessed risk cue sensitivity of multiple prey populations of the Atlantic dogwhelk (*Nucella lapillus*) existing along a gradient of historical coexistence with a native, an established invasive, and a range-expanding predator. Prey had reduced feeding rates and growth in response to all predator cues, but specificity varied across prey populations and predator species. Prey responses to risk cues from native and well-established invasive predators were most sensitive to predator diet, indicating higher risk cue specificity. Prey response to a poleward-shifting predator, however, was only sensitive to diet for the southernmost prey population. These results suggest that relatively novel predators can elicit strong anti-predator behaviors regardless of whether they consume novel prey. Understanding the response of prey to novel risk cues is critical for predicting how species invasions and climate-driven range shifts may alter trophic dynamics.

The effect of hypoxia on the copepod, *Acartia tonsa* adapted to ocean warming and acidification.

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Hypoxia, >2 mgl^{-1} dissolved oxygen concentration (DO), is widespread and increasing in coastal waters and has deleterious effects on metazoans due to increased energy requirements for homeostasis. Hypoxia studies showed an overall decrease in egg production rates in copepods exposed to sublethal DO levels (1.5 ml l^{-1}) and a general trend of decline in survivorship. There is evidence of limited copepod adaptation to combined ocean warming and acidification (OWA), however, the effect of hypoxia on these copepods has yet to be investigated. In this study, *Acartia tonsa*, a dominant coastal copepod, from lineages kept for over 100 generations under ambient conditions (18°C, 400 ppm CO_2), ocean warming (22°C, 400 ppm CO_2), ocean acidification (18°C, 2000 ppm CO_2) and OWA (22°C, 2000 ppm CO_2) will be exposed to 1.5 ml l^{-1} and 0.7 ml l^{-1}, DO levels simulating sublethal and lethal hypoxic conditions. The effects of combined stressors on population fitness will be tested using fitness-related traits of egg production, hatching success, survivorship, development time and sex ratio. Understanding how *Acartia tonsa* will respond to hypoxia and OWA will help predict cascading effects throughout the marine food web.

Using foraminiferal Mg/Ca as a proxy for subtropical front position in the Southern Ocean

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Warm, saline surface waters from the Indian Ocean penetrate into the South Atlantic via the Agulhas leakage, which may act as a key moderator for the strength of the Atlantic meridional overturning circulation (AMOC). Northward migration of the subtropical front (STF) during glacial periods may reduce Agulhas leakage and subsequently weaken the AMOC. Because the STF marks the boundary between cold, low salinity sub-Antarctic waters and warm, saline waters of the South Atlantic subtropical gyre, meridional gradients in temperature and $\delta^{18}O_{sw}$ can be used to infer the position of the STF. Using foraminiferal Mg/Ca results from a transect of sediment cores in the Atlantic sector of the Southern Ocean, I will present preliminary sea-surface temperature estimates to infer the position of the STF during the late Holocene. If the temperature reconstructions are in good agreement with satellite and hydrographic observations, we may apply this proxy to reconstruct STF position in the geologic past.

Oral Session IV

Microplastics in oyster aquaculture

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There are concerns regarding the amount of microplastics (MP) released into the environment by aquaculture activities and if farm-grown bivalves have higher MP loads than those collected from undisturbed recreational beds. To explore this concept, water, aquaculture gear, and oysters (*Crassostrea virginica*) were sampled from an aquaculture site in Niantic Bay and a two-week transplant experiment was performed in which oysters were transplanted between the aquaculture site and a plastic-free cage off the dock at the University of Connecticut-Avery Point campus. Microplastics were extracted from water and oyster gut (digestive gland-stomach complex) samples using previously validated extraction methods. Extensive quality control and assurance measures were taken to reduce MP contamination. Water samples contained 0-0.3 MP/L and oyster gut samples contained 0-3 MP/individual across sites indicating that MP concentrations are very low. There was no difference in MP concentrations for oysters transplanted to or away from the farm and aquaculture gear was not contributing to MP ingestion in farmed oysters. Oysters can eliminate $\geq$90% of ingested particles within 48h so the animals do not retain particles from the farm or off the docks over a 2-week period. Oyster aquaculture is not contributing significantly to the MP pollution in Long Island Sound.

Detection and quantification of brominated natural products in Arctic and mid-latitude coastal air and waters

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Halogenated natural products are organic compounds that can be produced by marine bacteria and other marine organisms, or abiotically through anthropogenic activities. These compounds can exhibit toxicity, bioaccumulate in the environment, and perform important roles in the regulation of the tropospheric and stratospheric ozone. A subset of these compounds that are of particular interest in marine environments include bromophenols (BPs) and one of their derivative classes, bromoanisoles (BAs). To date, these compounds are understudied, particularly in Arctic and mid-latitude systems, with limited global data or understanding of their spread, and particular emphasis has been placed on the need for measurements in systems that will be subject to increasing variability as a result of climate change. This project will provide both concentration and air-sea flux data on both BPs and BAs from the Western Arctic collected on a May-June 2021 cruise in the Beaufort and Chukchi Seas, as well as data collected from the mid-latitude estuary of Long Island Sound during 2022. These data will help to close knowledge gaps for these compounds, and inform future studies and risk assessment.

Increasing black sea bass abundance in Long Island Sound

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Black Sea Bass (BSB, *Centropristis striata*) is a temperate protogynous hermaphroditic grouper species, whose abundance in Long Island Sound (LIS) has significantly increased over the last ten years. For stock assessment purposes, fisheries managers assign ages to LIS BSB trawl data based on an age length key maintained by the Massachusetts Division of Marine Fisheries. We created a LIS-specific Black Sea Bass age length key from 813 samples from the 2021 and 2022 LIS trawl survey conducted by the Connecticut Department of Energy and Environmental Protection (CTDEEP). We observed BSB from nine to 54 cm in length, from one to 11 years old, and a sex ratio of 50/50 in LIS. Measurement of the gonadosomatic index shows that BSB recruitment occurs at age two in LIS. We then statistically compared my LIS BSB age length key to the Massachusetts key to test the hypothesis that BSB stock structure in LIS differs from the stock structure within the waters of Massachusetts. This work provides a tool to assess the potential impacts of this increasing population of BSB in LIS.

Assessing vulnerability of the U.S. Atlantic sea scallop to ocean acidification and warming: a dynamic energy budget modeling approach

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The U.S. Atlantic sea scallop (*Placopecten magellanicus*) fishery is valued at more than $500M per year, making it the second highest valued fishery in the country. While the fishery is considered to be well-managed, managers and industry stakeholders are concerned that changing ocean conditions will cause declines in scallop availability, harvest, and revenue. Subsurface scallop habitats in the Northeast and Mid-Atlantic already experience suboptimal temperature and carbonate chemistry conditions episodically. Future projections indicate that conditions in some areas will begin to surpass these suboptimal thresholds persistently by the end of the century. Here, we project the phenotypic plasticity effects of ocean acidification (OA) and warming on scallop growth and reproduction historically and over the next century using a dynamic energy budget (DEB) model forced by a regional ocean model. Preliminary results suggest that end-of-century OA and warming, together, will cause scallops to grow faster but reach a smaller maximum size. Our future work will couple the DEB model to a larval transport model. This novel combination of approaches will allow us to quantitatively relate changing ocean conditions to changes in scallop population vulnerability and inform fisheries management by estimating changes in growth and identifying candidate areas for future fishing zones.