I. Research Projects

Water quality monitoring in New Haven harbor

Faculty Dr. Vincent T. Breslin
Environment, Geography and Marine Sciences

Student Participants

Summer 2021; Fall 2021; Spring 2022

Sara Gerckens, Undergraduate Student, ESSS
Makenna Perry, Undergraduate Student, ESSS
Syrenitee Kee, Undergraduate Student, ESSS
Ian Bergemann, Graduate Student, Environmental Studies

Spring 2022

MAR 460 Field Techniques in Marine Studies, Undergraduate Students

Long Island Sound is an ecologically diverse environment with rich and varied ecosystems for marine organisms while also providing important environmental and recreational services for Connecticut and New York residents. Despite its ecological and economic importance, water quality throughout the Sound is vastly under-monitored, particularly in the especially vulnerable and densely populated coastal embayments. The Long Island Sound Study recently highlighted the importance of expanding and integrating water quality monitoring efforts throughout the Sound to provide uniform, reliable near-shore monitoring data to watershed managers and the broader scientific/technical community. The students and faculty of the Werth Center for Coastal and Marine Studies at SCSU established a long-term water quality monitoring program at Long Wharf Pier, New Haven harbor in January 2012. Weekly water quality testing at this location occurs once per week coinciding with high tide. Water quality and meteorological parameters measured include salinity (ppt), specific conductance (mS/cm), dissolved oxygen (mg/L), air and water temperature (°C), wind speed (m/s), relative humidity (%), light intensity (lux), secchi disk depth (m), turbidity (NTU), Chlorophyll *a* and pH.

Results to Date/Significance

The WCCMS recently completed the tenth year of water quality monitoring at the pier at Long Wharf, New Haven. The water quality monitoring at Long Wharf continued during the pandemic. All participants were required to wear PPE and maintain appropriate social distancing during water quality sampling.

Students and faculty of the Werth Center for Coastal and Marine Studies established a long-term water quality monitoring program in January 2012 to address the lack of water quality data in Long Island Sound. Now at the ten-year mark of the program we have analyzed the past decade (2012-2021) of water quality and atmospheric conditions at Long Wharf, New Haven,

Connecticut. The parameters measured weekly included air temperature, relative humidity, wind speed, solar radiation, salinity, conductivity, specific conductance, water temperature, turbidity, pH, and dissolved oxygen. Daniel Andrien, undergraduate, is examining the ten-year New Haven harbor water quality data for long-term trends in water quality. Trends were identified through linear regression analysis of annual mean measurements of the respective parameters. Results showed that pH decreased over time possibly due to increased CO2 in the atmosphere. Slight increases in water and air temperature were likely due to a changing regional climate. Variations in salinity at this location correlated with extreme weather events (precipitation) and seasonal conditions. Overall, water quality at this location is good as determined by secchi disk depth and dissolved oxygen measurements. There were only a few days in this ten-year period where dissolved oxygen was below the 5 mg/L water quality threshold, indicating hypoxic conditions are rare at this location. The WCCMS will continue to collect weekly water quality measurements at Long Wharf to determine future changes in Long Island Sound estuary water quality. Daniel Andrien will be presenting results of this study at the 2022 Undergraduate Research Conference in April.

Quantifying biodiversity and water quality of multi-species ocean farming to assess the feasibility of developing an ecolabel certification to enhance marketing of sustainable aquaculture products

Faculty Dr. Emma L. Cross
Environment, Geography and Marine Sciences

Research Assistant

Summer 2021

Lauren Brideau, BS Environmental Systems and Sustainability in Spring 2020

Student Participants

Summer 2021; Fall 2021; Spring 2022

Miranda Holland, Undergraduate Student, ESSS
Sara Gerckens, Undergraduate Student, ESSS

Fall 2021; Spring 2022

Makenna Perry, Undergraduate Student, ESSS

Fall 2021

Maeve Rourke, Graduate Student, Environmental Studies
Ian Bergemann, Graduate Student, Environmental Studies

Unlike agriculture farming, multi-species ocean farms require zero inputs of feed, fertilizer or freshwater, and also sequester carbon and nitrogen more effectively. Seaweed could also raise seawater pH and dissolved oxygen through photosynthesis. Furthermore, they provide temporary and permanent habitats for other species, therefore, potentially increasing local biodiversity. Despite the potential beneficial environmental impacts of multi-species ocean farming, there is limited quantitative evidence to support these trends. In collaboration with academics at the Woods Hole Oceanographic Institution (WHOI), our aquaculture industry partners Cottage City Oysters and the non-profit organization GreenWave, this project is quantifying water quality and biodiversity at a year-round multi-species ocean farm off the coast of Martha's Vineyard, MA. Water quality parameters that are being measured are seawater temperature (°C), dissolved oxygen (mg/L), pH, specific conductivity (μS/cm), salinity (ppt) and turbidity (NTU) using unattended continuously logging Eureka multi-probes. Monthly water samples are also being collected for total alkalinity measurements to determine carbonate chemistry and nutrient analysis to determine nutrient extraction. Biodiversity is being quantified using environmental DNA (eDNA) metabarcoding of monthly seawater samples conducted at WHOI and complemented with traditional visual surveys including video analysis from GoPros and plankton tows. If we find quantitative evidence of environmental benefits of multi-species ocean farms, then we can assess the feasibility of developing an ecolabel for sustainable aquaculture products produced in such ocean farms.

Results to Date/Significance

Monthly fieldwork began in October 2020 at Cottage City Oysters' newly leased ocean plot that has had no previous aquaculture equipment deployed with the sampling site consisting of a sandy bottom with no obvious marine life. Preliminary water quality results demonstrate typical values and trends of a coastal region exposed to the open ocean. Specifically, seawater temperature demonstrates expected seasonal trends ranging from 0.1°C in February to 25.2°C in August. Dissolved oxygen concentrations have also exhibited an expected seasonal trend ranging from 5.5 mg/L in August to 12.2 mg/L in February, with more variability in the summer months. pH fluctuated between pH 7.8 and pH 8.3, also with more expected variability in the summer months a coastal region in New England. Salinity and turbidity have remained constant between 32.0-33.2 ppt and < 5 NTU, respectively. Preliminary results from the video analysis and plankton tows demonstrate higher species diversity and individual abundance at the multi-species ocean farm compared to a site of no aquaculture 100 m away. This indicates that the implementation of shellfish aquaculture equipment increases local biodiversity. This project has created partnerships between academics at SCSU and WHOI and with the aquaculture industry through collaborating with Cottage City Oysters, a shellfish and kelp aquaculture company in Martha's Vineyard. So far, this project has led to a book chapter under review, two Undergraduate Honors Theses (one completed and one in progress) and a graduate student gaining a WHOI guest student appointment. Lauren Brideau, a WCCMS alumna, is currently leading a co-written book chapter on how academics and industry partners can provide different perspectives and co-create knowledge about topical environmental issues, which is currently under review. Miranda Holland has been participating in monthly fieldwork in Martha's Vineyard since January 2021, was awarded an Undergraduate Research Grant ($3,000) to support her research in summer/fall 2021 and completed her Undergraduate Honors Thesis on biodiversity changes associated with shellfish aquaculture equipment in December 2021. Miranda is now a graduate student at SCSU who is

conducting the eDNA analysis as part of this research project whilst also continuing her biodiversity video analysis. Sara Gerckens has been participating in monthly fieldwork in Martha's Vineyard since July 2021, was awarded an Undergraduate Research Grant ($3,000) to support her research in spring 2022 and is currently working on her Undergraduate Honors Thesis on the impacts of multi-species ocean farming on mesozooplankton communities. This research project has provided students with fieldwork experience outside of CT and also collaboration experience of working with the aquaculture industry broadening their career prospects.

The effects of time, light and polyp orientation on the flourescence of the symbiont *Breviolum psygmophilum* in the *Astrangia poculata*

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Academic Year 2020, 2021, 2022

Nicole Woosley, Biology, Graduate Student

The effects of time, depth, and orientation on the photosynthetic ability of zooxanthellae (phytoplankton) in the temperate coral, *Astrangia poculata* (Ellis and Solander 1789), was examined at Fort Wetherill in Jamestown, Rhode Island, where a dense population of coral colonies exist. Aposymbiotic corals that appeared white were used for this study. Light absorption of the symbiont, with a focus on fluorescence, of the first forty corals encountered at three main depths of Site A, 9m, 6m, and 3 m was determined using a Walz Diving- PAM for each dive. At Site B, 15 polyps at each depth interval (six in total) were measured. The Diving-PAM measured fluorescence yield on individual coral polyps. Polyp orientation of the corals will be determined based on whether the polyps are perpendicular or parallel to the cliff wall and will be denoted as vertical or horizontal. SigmaPlot 14.5 (Systat Software, Inc) was used to perform the statistical analyses of this study. There was a significant increase in fluorescence in corals from May through September. There was a significant decrease in fluorescence with depth at Site A and no significance in fluorescence dependent on polyp orientation. At Site B, fluorescence was variably high at shallow depths with a precipitous drop-off of fluorescence below 14.1 m depth. The results from this study can potentially be utilized for future studies on other corals that may be aposymbiotic or those that are not the textbook definition of symbiotic.

Results to Date/Significance

This study is now completed and Nicole defended her thesis successfully on April 4, 2022.

Temporal Trends in Sediment Metal Contamination in New Haven harbor (2001-2021)

Faculty Dr. Vincent T. Breslin
Environment, Geography and Marine Sciences

Student Participants

Summer 2021; Fall 2021; Spring 2022

Abby Lucas, Undergraduate Student, ESSS
Carolina Capelo, Undergraduate Student, ESSS

The presence of contaminated sediment in the inner, northern portions of New Haven harbor is an issue of concern. New Haven Harbor sediments are known to be contaminated with high concentrations of zinc, copper, lead, silver and cadmium. Previous studies of Long Island Sound urban-industrialized harbor sediment show sediment metals are preferentially concentrated in fine-grained sediment and metal concentrations frequently exceed NOAA Sediment Quality Guidelines indicating harm to benthic marine organisms. Previous Werth Center for Coastal and Marine Studies (WCCMS) research showed a well-defined spatial trend in all Long Island Sound harbors where sediment metal concentrations decrease from north to south and co-vary with sediment grain-size. Utilizing new (2021) and existing (2001-2019) New Haven harbor sediment metal databases collected by WCCMS researchers over the past twenty years, an opportunity exists to examine the changes in the sediment chemical (zinc, copper and iron) and physical (grain size and LOI) properties over time. New Haven harbor sediment quality data sets will be assigned to four-year time periods that will be used to examine temporal trends in sediment metal contamination. Temporal trends in surface sediment metal concentrations will be determined by calculating mean metal values for each defined harbor section for each time period. Linear regression analysis of the mean sediment metal contents for each harbor section over time will be conducted to determine temporal trends in sediment metals.

Results to Date/Significance

The objective of this study was to determine the spatial and temporal trends in sediment metal contamination. The chemical (copper, zinc and mercury) and physical (LOI) analyses of the sediment have been completed. Two sediment sampling cruises were conducted in June 2021, collecting a total of 27 sediment samples throughout New Haven Harbor to determine both the sediment's physical (loss on ignition) and chemical (copper and zinc) properties. Results showed spatial trends with mercury, copper and zinc concentrations decreasing north to south in the harbor. The inner harbor contained mercury, copper and zinc concentrations exceeding four to six times their respective crustal abundances. The spatial trends in sediment copper, zinc, and iron concentrations correlated with the sediment's physical characteristics (grain-size and LOI). The results of this study will also be compared to contaminated metals measured in previous New Haven harbor studies over the past 20 years (2001-2021). Linear regression analysis will be used to examine temporal trends in sediment copper and zinc contamination over time. Carolina

Capelo and Abby Lucas will be presenting results of this study at the 2022 Undergraduate Research Conference in April.

Energetic cost of maintaining calcification in marine calcifiers

Faculty Dr. Emma L. Cross
Environment, Geography and Marine Sciences

Brachiopods possess a large calcium carbonate shell in relation to their little animal tissue. Despite this, Dr. Cross' Ph.D. research revealed that brachiopod calcification is resilient under future predicted climate change. This, however, must come at a cost to the animal as calcification is an energetically expensive process. Brachiopods are found in all of the world's oceans, albeit in a patchy spatial distribution. This project will collect brachiopods from Maine, the only accessible brachiopod collection site along the New England coastline and rear them under predicted future acidified and warming conditions in a new climate change experimental system that Dr. Cross is building in her research lab at SCSU. At designated time intervals, physiological processes such as feeding efficiency, animal tissue growth rate, metabolic rate, respiration and reproduction will be measured to reveal any modifications to their energy budget. It is crucial to determine the level of acidification and warming which will critically impact energy required for vital physiological processes.

Results to Date/Significance

Dr. Cross is currently building a fully automated recirculation experimental system that will allow the manipulation of seawater temperature, carbon dioxide and dissolved oxygen levels to simulate future ocean warming, acidification and hypoxia conditions. Dr. Cross was awarded a Joan Finn Junior Faculty Research Fellowship for 9 credits of reassigned time for the Spring 2022 semester to build this experimental system and to start this research project with SCSU undergraduate students in the summer.

Defining *Arbacia punctulata* algal feeding preferences in Southern New England and their potential role as ecosystem shift drivers

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Academic Year 2021, 2022

Sophia Kelly, Biology, Graduate Student

As marine heatwaves are becoming more prominent, it is increasingly important to study local habitats and the accompanying flora and fauna in efforts to further understand ecosystem shifts.

The marine benthic communities of Southern New England have changed drastically over the last few decades, such that the warmer water is inviting invasive species to dominate in-shore regions, therefore altering the original ecosystem, and as a result may be pushing local species, such as kelps to deeper, off-shore regions. One such local species, *Arbacia punctulata*, the Atlantic purple sea urchin, has been a strong model organism for developmental biology, however, little knowledge exists on their basic ecology. Here, through laboratory experiments, field studies, and chemical analyses, we aim to define *A. punctulata*'s feeding preferences and rates on both kelps and turf algae. Although this species seemingly has a strong tendency towards carnivory, they gravitate towards what is most abundant in their surrounding ecosystem. As turf algae is dominating the marine benthic community, we hypothesize that these urchins may have the ability to act as ecosystem-shift drivers by actively feeding on and clearing the turf algae. The outcome of this data will not only provide further ecological information about a poorly studied species, but it also may have positive implications for restoring inshore communities of Southern New England by clearing turf algae and allowing local kelp and coral species to re-establish.

Results to Date/Significance
Laboratory work for this project was completed at the University of Chicago's Marine Biological Laboratory (MBL) in Woods Hole, MA in summer 2020. This will be repeated again at MBL in late spring 2022 and in the field in Rhode Island in summer 2022. Additionally, preliminary data was presented (poster) at the 50th Annual Benthic Ecology Meeting held at the University of New Hampshire on March 31, 2022.

Werth Center for Coastal and Marine Studies aquarium water quality

Faculty Dr. Vincent T. Breslin
Environment, Geography and Marine Sciences

Student Participants

Summer 2021; Fall 2021; Spring 2022

Ian Bergemann, Graduate Student, Environmental Studies

Fall 2021; Spring 2022

Sara Gerckens, Undergraduate Student, ESSS
Mitch Mcdunnah, Undergraduate Student, ESSS
Makenna Perry, Undergraduate Student, ESSS
Rianna Albert, Undergraduate Student, ESSS
Syrenitee Kee, Undergraduate Student, ESSS

Werth Center facilities include two-large (approximately 2500 gallon each) display aquaria, touch tank (500 gallons) and associated laboratory (SCI 111). WCCMS students and staff have supervised the conditioning of the aquarium system and the introduction of fish and

invertebrates. Marine fish were first introduced to the aquarium in December 2015 (Tank #2 coastal aquarium) and January 2016 (Tank #1 open water aquarium). The aquaria were designed to mimic Long Island Sound ecosystems and contain only local fish and invertebrate species. Student interns have performed frequent water quality testing (4-5 days per week) and fish and invertebrate condition observations (6 days per week). Student interns are also responsible for daily feeding of the fish and invertebrates in each aquarium and touch tank.

Results to Date/Significance

WCCMs student interns have completed six years of water quality measurements on the aquarium system. These records show that during that time we have maintained water quality in the aquarium system to support the health and growth of the fish and invertebrates in the aquarium and associated touch tanks. We continue to add new fish and invertebrates to the aquarium facility. We have also established a relationship with the Marine Resource Center (https://www.mbl.edu /mrc/) at the Marine Biological Laboratory, Woods Hole, MA.

The university purchased an Aqua Logic MT9 Air Cooled water chiller ($14,831) in support of the 5,000-gallon Werth Center aquarium system. The water chiller was necessary due to annual water temperature fluctuations in the marine aquarium display tanks. The rapid temperature changes in the aquaria resulted in fish mortalities in 2020. The chiller installation was completed in January 2022 and should ensure long-term control of aquarium water temperature. The aquarium system is also equipped with a web camera and a Coralvue Hydros temperature monitoring system. The Coralvue Hydros system sends text messages and emails to notify staff if the set temperature rises above a set threshold. We now have multiple, redundant systems to remotely monitor the aquarium water temperature. These systems should reduce the likelihood of a slow continuous rise in water temperature that could harm the aquarium fish and invertebrates.

We continue to maintain our IACUC certification and all our students conducting water quality and feeding the fish are now required to be IACUC trained and certified. We also submitted our annual invertebrate collection report to the CT DEEP and recently renewed our CT DEEP Specimen Collection Permit (6/1/2019-5/31/2022) allowing our students to continue to collect invertebrates and fish from local habitats.

Our student interns continue to host SCSU students from throughout the campus and provide tours of the facilities allowing students to learn about LIS fish and invertebrates. We look forward to once again resuming Open House events and hosting school and community group tours of the facilities once Covid restrictions ease.

Macroalgae as bioindicators for mercury contamination in Long Island Sound

Faculty Dr. Sean Grace
Biology
Dr. Vincent Breslin
Department of the Environment, Geography and Marine Sciences

Student Participant(s)

Summer 2020; Fall 2020; Spring 2021

Cassandra Bhageloo, Graduate Student, Chemistry

Macroalgae are suitable bioindicators for metal contamination in marine environments due to their wide distribution and abundance, ease of collection and identification, year-round availability, and tolerance of a wide variety of temperatures and salinities. The use of macroalgae to monitor for marine pollution allows for the assessment of contamination on living organisms and their environment, as well as their potential application in bioremediation. This study focused on determining the mercury content of various divisions of macroalgae (brown, red, green) to identify potential temporal and spatial trends along the coast of CT. Macroalgae sampled in fall 2020 include *Fucus distichus* (brown), *Chondrus crispus* (red), *Spermothamnion repens* (red), *Daysa baillouvia* (red) and *Ulva lactuca* (green). As the affinity for macroalgae to bind trace metals often increases relative to division (brown > reds > greens), the mercury content of the aforementioned species were investigated to identify which species can uptake the largest metal concentration. Additionally, this data will be cross referenced with data sampled from similar locations and species in fall 2017 to examine the presence of potential temporal trends. Due to the geography of Long Island Sound, the occurrence of spatial trends in mercury increasing from eastern LIS to western LIS will also be investigated. Freeze-dried algae tissue samples (0.100-0.250 g) were analyzed directly for mercury by thermal decomposition amalgamation and atomic absorption spectrophotometry using a Milestone DMA-80 direct mercury analyzer.

Results to Date/Significance

Researching the mercury levels in Long Island Sound and how they may vary with time will aid in understanding how water quality in LIS may affect the regional algal aquaculture industry. Results from data in 2017 showed that macroalgal tissue mercury concentrations varied by species but no significant west to east trends in algal tissue mercury were observed. Mercury concentrations were typically lowest in green algae species, intermediate in red algae species and highest in brown algae species. Preliminary data from 2020 also shows similar trends though fewer species were sampled due to Covid-19 restrictions. Graduate student Cassandra Bhageloo is completing her MS thesis in anticipation of graduating in May 2022.

Climate change mitigation strategies for the shellfish aquaculture industry

Faculty Dr. Emma L. Cross
Environment, Geography and Marine Sciences

Acidification and hypoxia threaten the future of the US $1 billion shellfish aquaculture industry by decreasing shell growth, weakening shells, reducing meat quality and increasing mortality. One potential approach to buffer these anthropogenic effects is multi-species ocean farming, which co-cultures seaweed and shellfish. The buffering capacity of seaweed raises seawater pH and

dissolved oxygen, which could promote shell production and decrease mortality of the farmed shellfish. Despite these potential benefits, it remains unknown how shellfish produced in multi-species ocean farms will fare under future acidification and hypoxia conditions. It is crucial to assess the capabilities of this emerging aquaculture technique as an acidification and hypoxia mitigation strategy for the shellfish aquaculture industry before arguing for a scaling up of multi-species ocean farming practices. This project is in collaboration with our aquaculture industry partners Cottage City Oysters, a kelp and shellfish aquaculture company off the coast of Martha's Vineyard, MA.

Results to Date/Significance

This is a four-year project involving a three-year field study to assess whether growing kelp with shellfish enhances shell and meat quality of the farmed shellfish and a long-term laboratory multi-stressor experiment at SCSU to identify if co-culturing seaweed and shellfish benefits shell and meat quality under predicted end-century acidification and hypoxia conditions. Preliminary laboratory analyses are currently being conducted on field specimens of Eastern oysters collected from a multi-species ocean farm and compared to those collected from a shellfish monoculture farm. Dr. Cross received four internal awards to support this research (Faculty Research & Creative Activity Grant (FCARG), CSU Faculty Research Grant, Joan Finn Junior Faculty Research Fellowship and Research and Creative Activity Reassigned Time (RCART) award).

Long-term monitoring of marine biodiversity in West Haven

Faculty Dr. Emma L. Cross
Environment, Geography and Marine Sciences

Student Participants

Fall 2021; Spring 2022

Makenna Perry, Undergraduate Student, ESSS
Sara Gerckens, Undergraduate Student, ESSS
Abby Lucas, Undergraduate Student, ESSS
Ian Bergemann, Graduate Student, Environmental Studies

Spring 2022

Rianna Albert, Undergraduate Student, ESSS

Fall 2021

Maeve Rourke, Graduate Student, Environmental Studies

Long-term monitoring of marine environments is essential to be able to understand our natural ecosystems and detect any changes. Such datasets create baseline data and establish temporal

trends that can identify patterns over an extended period. Long-term monitoring can also aid in determining climatic changes to environmental parameters, increases in marine pollution, introduction of invasive species as well as biodiversity loss or gain. Sandy Point Beach and adjacent Morse Beach in West Haven consists of barrier beach, marshes, tidal creeks, and mudflats and provides habitats for many marine organisms, including nesting birds like Piping Plovers, Least Terns, Common Terns, Roseate Terns, Black Terns, Black Skimmers, Red Knots and Saltmarsh Sharp-tailed Sparrows. Sandy Point Beach was chosen to create a long-term biological monitoring site to supplement other ongoing research being conducted in New Haven Harbor by WCCMS faculty and students. This research will allow a greater understanding of marine biodiversity and ecosystems processes in the central basin of Long Island Sound.

Results to Date/Significance

Biweekly beach seines and water quality measurements at Sandy Point in West Haven have been conducted since Fall 2021. Makenna Perry has been leading these field trips and is currently analyzing preliminary data as part of her Undergraduate Honors Thesis project to be completed in May 2022. Makenna was also awarded an Undergraduate Research Grant ($3,000) to support this research. Biweekly beach seines and water quality measurements will continue with participation from other Werth Center students to establish a long-term biodiversity monitoring site in the central basin of Long Island Sound.

The lunar effect on the natural diet of the temperate scleractinian coral *Astrangia poculata*

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Academic Year 2020, 2021, 2022

Leah Hintz, Biology, Graduate Student

The effects of the lunar cycle on the natural diet of the temperate scleractinian coral *Astrangia poculata* will be investigated. Since the 1700's, the diet of this species has been documented to be a large Corophium amphipod species that is never found in the plankton though found as a substratum associated species (stays on the substrate). Given that this coral, like its tropical relatives have long tentacles to capture prey from the water column, this study will examine the lunar effect on diet of corals and how the Corophium species is influenced by the lunar stages. This will be the very first study to examine the lunar effect on temperate corals.

Results to Date/Significance

Given Covid, this research will be completed in spring and summer 2022.

Assessment of the Walk bridge construction on the sediment quality of the Norwalk River and harbor

Faculty Dr. Vincent Breslin
Department of the Environment, Geography and Marine Sciences

Student Participant

Summer 2021

Renee Chabot, Undergraduate Student, Chemistry

The Walk Bridge in Norwalk, CT is notorious for its aged mechanical mechanisms that have failed time and time again, delaying transportation on and below it on the Norwalk River. The DOT Walk Bridge Project is designed to greatly increase the dependability of service rail, but presents a challenge to the ecology of the Norwalk Harbor. The Harbor's active shellfish industry has a large economic and cultural importance to the area; civic leaders and shellfish industry representatives are calling for water quality monitoring to protect the natural resources and shellfish beds during bridge construction. WCCMS researchers have shown that the sediment below the bridge is contaminated with metals of environmental concern. Bridge construction activities may re-suspend contaminated river sediment and transport the sediment to the outer harbor oyster beds. The re-suspended sediment may be ingested by the oysters and cause unacceptably high metal contamination in their tissues.

Results to Date/Significance

The objective of this study was to determine the spatial and temporal trends in sediment metal contamination. Sediment samples were collected on three separate occasions in 2018-2019 to determine the sediment physical and chemical properties. Results show that there is a well-defined spatial trend, with sediment metal contamination decreasing from north to south in the harbor. Sediment copper, zinc, and mercury concentrations ranged from 169 to 29.5 mg/kg, 396 to 95 mg/kg, and 1.23 to 0.13 mg/kg, respectively. The spatial trends in sediment metal contents correlated with the sediment physical properties (loss on ignition and grain-size). A comparison of sediment metal concentrations with NOAA Sediment Quality Guidelines showed that the majority of the harbor sediment is at or below toxicity thresholds. Sediment copper concentrations generally exceeded the ERL threshold throughout the harbor while zinc concentrations had eight stations that fell below the ERL threshold. Zinc concentrations at two river stations (13 and 14) approached the ERM with values of 390 and 396 mg/kg, respectively. Sediment mercury, however, exceeded the ERL value throughout the harbor and six stations also exceeded the ERM value (primarily in the Norwalk river). Results of this study were then compared to contaminated metals measured in previous Norwalk harbor studies over the past four decades (1976-2019). Linear regression analysis results showed decreasing trends over time, primarily in sediment copper and zinc within the river and inner harbor sections of Norwalk harbor.

This study is now completed and Renee graduated in August 2021 and will begin graduate studies at Sony Brook University in the School of Marine and Atmospheric Sciences in fall 2022.

Creation of a gamefish occurrence dataset from public-focused informational newsletters

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Academic Year 2020, 2021

Rebecca Hedreen, Biology, Graduate Student

In order to properly assess current ecological conditions, we need long-term ecological data. Historical ecology focuses on that long term, including the need to synthesize data from diverse sources. In the Long Island Sound, the Connecticut Department of Energy and Environmental Protection has been collecting data for both scientific and recreational purposes for decades, but the format of the recreational data (narrative) is not suitable for scientific analysis. This project is to collate and annotate game fish occurrence data from the Fishing Report newsletters put out by DEEP every week during the fishing season and the DEEP Trophy Fish annual reports, over a 12-year period. Species, location, and measurement data (as available) have been compiled into a data set, with geolocation coordinates added for the identifiable locations. This thesis consists of the machine-readable dataset, the protocol for collating this data, and an assessment of the suitability of the data for different kinds of analysis. The dataset will be published openly for reuse, reanalysis, and collaborative additions.

Results to Date/Significance:

This MS thesis was defended on October 18, 2021 and Rebecca Hedreen was awarded her MS degree in December 2021.

Anthropogenic driven ecosystem change in the SubArctic

Faculty Dr. Emma L. Cross
Environment, Geography and Marine Sciences

Climate change is causing sea ice to melt causing increased accessibility of the polar regions that could be exploited by human activity such as longer shipping seasons, increased fishing activity and the addition of aquaculture farms. As ships sail between geographic oceans, they carry a plethora of marine organisms as fouling organisms attached to/bored into the hull and also in ballast water facilitating non-native species dispersal. Increased fishing activity and the introduction of fish farms can also contribute to habitat destruction. An increase in these human activities can lead to extensive ecological, environmental, economic and other societal impacts, therefore, it is paramount that long-term monitoring sites are established to monitor marine biodiversity as our polar regions become more accessible. This research project will establish a long-term marine monitoring site in east Iceland to determine human impacts on the fjord

ecosystem. This will complement the existing annual faculty-led study abroad trips to Iceland and research connections of SCSU colleague Dr. Patrick Heidkamp.

Results to Date/Significance

Since summer 2021, Dr. Cross has participated in biweekly meetings with international collaborators to plan the establishment of this long-term marine biodiversity and water quality monitoring program. Dr. Cross is leading the water quality analysis and co-leading the environmental DNA (eDNA) analysis of regular seawater samples from two fjords in east Iceland. Unfortunately, trial field sampling in Iceland in January 2022 had to be cancelled due to rising COVID-19 cases, however, Dr. Cross will be travelling in April to collaborators based at Earlham College, Indiana to trial as many field methods as possible before field sampling begins this summer.