I. Research Projects

Water quality monitoring in New Haven harbor

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

Student Participants

Summer 2020; Fall 2020; Spring 2021

Nicole Woosley, Biology
Ian Bergemann, Environment, Geography and Marine Sciences

Spring 2021

Sara Gerckens, Undergraduate Student, ESSS
Sydney Peacock, Undergraduate Student, ESSS
Syrenitee Kee, Undergraduate Student, ESSS

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 ninth 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. Our students were able to collect data at Long Wharf in 10 of the past 12 months, providing continuity for our monitoring program. Results of our monitoring show that water temperature (3.2 to 26.3°C) displays a seasonal trend. Dissolved oxygen concentrations (3.00 to13.00 mg/L) at this location also vary with temperature as oxygen solubility in water is a function of water temperature (greater solubility at lower water temperature). Additionally, there have only been three instances (7/16; 7/23; and 7/31) when the dissolved oxygen level measured below the good water quality threshold (5 mg/L). Salinity at this location at high tide varies within a narrow range (22.9 to 29.0 ppt). Water clarity, as measured using a secchi disk, varies from 0.80 to 2.10 meters. The ranges of these values for these water quality parameters are typical for similar parameters reported for Long Island Sound coastal embayments.

The effects of depth, light and 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

Nicole Woosley, Biology, Graduate Student

The effects of depth, orientation and light penetration on the photosynthetic ability of zooxanthellae in the temperate coral *Astrangia poculata* will be examined at Fort Wetherill in Jamestown, Rhode Island where a dense population of colonies exist. A 5m transect line will be laid at depths 2m, 7.5m,15m and 25m and the photosynthetic activity of the first 9 corals encountered along the line will be determined using a Walz Diving- PAM. The PAM will measure and record values for minimum, maximum, and variable fluorescence on individual coral polyps. Light will be determined near the corals using a Hobo-Temp/Light meter and orientation will be determined using a protractor. The coral examined will be collected, transported back to the lab and tissue examined for the concentration of zooxanthellae with a hemocytometer. The effect of depth, orientation and light will be examined using a 3-factor ANOVA where the independent variables are photosynthetic rate (as determined by the PAM) and concentration of zooxanthellae. The hypothesis of this thesis is that there will be a gradual decrease of photosynthesis with depth increases and orientation changes due to decrease in light levels.

Results to Date/Significance

In fall 2020, we investigated several sites in Rhode Island to complete the study. The study will be completed in Spring and Summer 2021 with a potential defense date planned for December 2021.

Quantifying biodiversity and water quality of regenerative 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

Fall 2020; Spring 2021

Lauren Brideau, BS Environmental Systems and Sustainability in Spring 2020

Student Participants

Spring 2021

Miranda Holland, Undergraduate, Environment, Geography and Marine Sciences

Unlike agriculture farming, regenerative 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 Institute (WHOI), our aquaculture industry partners Cottage City Oysters and the non-profit organization GreenWave, this project is quantifying water quality and biodiversity before and after the deployment of aquaculture equipment at a new regenerative 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 metabarcoding of monthly water samples conducted at WHOI. If we find quantitative evidence of environmental benefits of regenerative 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 for this three-year research project began in October 2020 through preliminary funding from Project Blue at SCSU from two external CTNext grants (co-PIs Dr. Patrick Heidkamp and Dr. Colleen Bielitz) that Dr. Cross is a named researcher on. Cottage City Oysters' newly acquired ocean plot currently has no 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 an expected seasonal trend gradually decreasing from 17.2°C in October to 0.5°C in February. Dissolved oxygen concentrations have also exhibited an expected seasonal trend increasing from 7.9 mg/L in October to 11.5 mg/l in February. pH has fluctuated between pH 7.9 and pH 8.1, typical of the winter months in New England. Salinity and turbidity have remained constant between 32.0-33.2 ppt and < 5 NTU, respectively. Dr. Cross has applied to two external grant opportunities for this project as the Lead PI including to the National Oceanic and Atmospheric Administration (NOAA) Saltonstall-Kennedy Competition in August 2020 and the Atlantic States Marine Fisheries Commission (ASMFC) in January 2021, with the ASMFC proposal still under review. This project has created a new partnership 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. Lauren Brideau 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. Miranda Holland has recently started monthly fieldwork in Martha's Vineyard collecting biodiversity data using an underwater ROV as part of her Honors Thesis project. Miranda applied for an Undergraduate Research Grant ($2,995) for the Spring 2021 semester and was the alternate student. Upon positive feedback from the Research and Scholarly Advisory Committee (RSAC) chair, Miranda Holland applied for an Undergraduate Research Grant ($3,000) for summer/Fall 2021 semester to support her fieldwork for this project, which is currently under review.

Werth Center for Coastal and Marine Studies aquarium water quality

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

Student Participants

Summer 2020; Fall 2020; Spring 2021

Melissa Beecher, Undergraduate, Biology
Ian Bergemann, Undergraduate, Environment, Geography and Marine Sciences

Fall 2020; Spring 2021

Nicole Woolsey, Graduate Student Biology
Owen Cassidy, Undergraduate Student, Chemistry
Sara Gerkins, Undergraduate Student, ESSS
Sydney Peacock, 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 (6-7 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 five 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 aquarium temperature is tied into a chiller system that controls the flow of cold water to the aquarium heat exchanger in the Academic Science Building basement where the filter system for the aquarium is located. On Friday, SCSU experienced a power outage on campus. The aquarium system is serviced by the building generator and the aquarium system continued to function properly during the outage. Power was quickly restored, however, unknown to us at the time, the power outage temporarily discontinued power to the chiller system in the facilities building. Over the weekend, due to Covid-19 restrictions, students and faculty did not visit the aquarium knowing the power was restored. Compounding the situation was a winter storm that caused the campus to close on Monday and Tuesday. It was not until Tuesday afternoon that campus police were alerted to a problem by the temperature alarm system in the aquarium lab (SCI 111). Although we responded to the problem quickly, the aquarium water temperature had slowly risen to exceed 85 °F after four days resulting in the death of 13 fish housed in the aquarium. Facilities was alerted to the issue and the chiller system was reset causing the water temperatures to return to normal (66 °F).

To lessen the likelihood of a similar loss of cooling water to the system, we have installed a web camera and a Coralvue Hydros temperature monitoring system. The 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 are also exploring installing a stand-alone chiller system for the aquarium to better maintain control of water temperature.

We have already begun the process of replacing the fish that were lost. We have contacted the MBL specimen lab with a wish list of fish specimens (hake, scup, toadfish) for the large display tanks. The MBL will resume specimen collections in May 2021. 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.

The WCCMS aquarium laboratory continues to host SCSU Open House and public educational programming. Our student interns host SCSU students from throughout the campus and provide tours of the facilities allowing students to learn about LIS fish and invertebrates.

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 Participants

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. Studies focused on macroalgae as bioindicators for trace metal contamination such as mercury show that the concentration of metal in the sediment, water column, and macroalgae are typically proportional.

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 macreoalgae 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

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 recently completed her MS thesis proposal and is currently working on examining temporal variations noted in mercury concentrations of representative species of algae sampled from the same LIS locations in 2017. 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.

Examining the beach dynamics of the Connecticut shoreline and their implications for coastal zone management

Faculty Dr. James Tait
Department of the Environment, Geography and Marine Sciences

Project Description

Ongoing multi-year research focused on testing for seasonal beach profiles on the Connecticut coast has been concluded with documentation of the lack of any significant seasonal beach profiles on five beaches that span the length of the Connecticut shoreline. The beaches include Sherwood Island State Park, Bayview Beach in Milford, Hammonasset Beach State Park, Rocky Neck State Park, and Ocean Beach in New London.

Previous studies by Werth Center researchers have pointed to lack of energy in the fair-weather wave field as being responsible for chronic erosion of Connecticut beaches and exposing coastal structures and infrastructure to damages. Geomorphic evidence for such a hypothesis is the absence of shoreward transport of sediment resulting in beach profile rebuilding. In other words, there is a lack of seasonal beach profiles.

This non-textbook behavior of Connecticut beaches calls for commensurate adjustments in Connecticut's coastal management policies. Current policies have been examined and recommendations for policy changes that enhance adaptive capacity have been articulated by Ms. Mercaldi.

Results to Date/Significance

The final analysis shows that Connecticut's beaches, and the structures located behind them, are particularly vulnerable to erosion and damages due to storm waves because erosion (narrowing of the beach) is not counter balanced by beach recovery during the non-storm season. Currently, eroding Connecticut beaches are periodically replenished by importing sand and placing it on the eroded beach to build the beach back out. This approach is becoming extremely expensive. *A more sustainable strategy to maintaining coastal resilience to storms is suggested by this research.* We have termed this *beach reclamation.* In this scenario, sand eroded from the beach and transported offshore into nearshore sand bars is reclaimed and returned to the beach using basic coastal engineering technology. In more general terms, our recommendation is that beach sand be subject to *sediment management* where high-quality sediment is placed on the beach and subsequently managed rather than being replaced when it moves offshore during large storms.

This research has led to a series of policy recommendations for the State Legislature and for the Department of Energy and Environmental Protection. General recommendations included updating the language of Connecticut's most prominent policy documents, such as the *Connecticut Coastal Management Manual* and the *Overview of the Connecticut Coastal Management Program,* to reflect the unique dynamics of Connecticut's shoreline to ensure maximum policy effectiveness. Also, the language should be updated to emphasize the *urgency* of maintaining Connecticut's beaches.

<u>Climate change mitigation strategies for the shellfish aquaculture industry</u>

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 regenerative 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 regenerative 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 regenerative 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. This is a three-year project involving a two-year field study to assess whether growing kelp with shellfish enhances shell and meat quality of the farmed shellfish and three two-month laboratory multi-stressor experiments at SCSU to identify if co-culturing seaweed and shellfish benefits shell and meat quality under predicted end-century acidification and hypoxia conditions.

Results to Date/Significance

This proposed project would begin in November 2021. Dr. Cross submitted an external grant pre-proposal to NOAA for $449,153 as the Lead PI in December 2020 to support his three-year project, which was highly reviewed and encouraged to submit a full proposal that was submitted in March 2021. Dr. Cross has also applied for two internal grant competitions, Faculty Research and Creative Activity Grant in December 2020 and 2021-2022 CSU – AAUP Faculty Research Grants in January 2021 as well as for 9 hours of reassigned time via the Joan Finn Junior Research Fellowship in January 2021, to support this research project which are all currently under review. Furthermore, Dr. Cross has recently been awarded a Research and Creative Activity Reassigned Time (RCART) award for 3 credits of reassigned time from the Dean of Arts & Sciences for the Spring 2022 semester, which would accelerate the beginning of this project if funded by NOAA or provide preliminary data to strengthen future external grant proposals.

<u>GIS maps of Connecticut coastal harbor sediment metal contamination</u>

Faculty

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

Student Participant

Summer 2020; Fall 2020; Spring 2021

Ethan Mehlin, Undergraduate, Geography

Over the past 18 years, researchers from the Werth Center for Coastal and Marine Studies (WCCMS) have examined the spatial trends of contaminant metals in surface sediments in every major harbor in Connecticut. This sediment database contains the results of the physical and chemical analysis of over 600 sediment samples collected from 14 different Connecticut harbors and is the largest, most comprehensive, sediment metal database for Connecticut coastal embayments. The database includes sediment metals (copper, zinc and iron) and physical properties (% organic matter) and each sediment station is geo-referenced (latitude and longitude). This database represents an excellent opportunity to resolve the physical and chemical factors controlling the spatial distribution of metals in regional coastal harbors.
This project will focus on preparing a visualization of the harbor sediment metal contamination using GIS mapping software. The goal is to prepare contour maps for each Connecticut harbor showing the spatial trends in sediment grain-size, organic carbon and contaminant metals. The location of each of the harbor sediment samples collected over the years has been defined by latitude and longitude. This allows for the preparation of maps identifying the location of each sample in a harbor and the use of GIS software to prepare contour maps showing the trends of sediment physical and chemical properties within each harbor.

Results to Date/Significance

Sediment metal concentrations and physical properties (grain-size and loss on ignition) were mapped in ArcMap 10.5.1 according to categories defined using sediment quality guidelines and known sediment grain-size categories. These points were analyzed using inverse distance weighting, resulting in maps that were then edited in Arcmap to have the same color scheme and comparable scale categories. Each parameter scale was created with seven or eight categories; the highest range for metals was defined by the Effects Range Median for each respective metal while the lowest category was equal to or less than each metals' respective crustal abundance.

This past year, color contour maps have been completed for Norwalk harbor, Branford harbor/river, New Haven harbor, Greenwich/Cos Cob and the Housatonic river. These maps can be useful in identifying areas within harbors for shellfish habitat restoration/expansion, identifying areas of concern for dredging projects, inform harbor development activities, and highlight areas of concern for sediment resuspension (storm events).

<u>The lunar effect on the natural diet of the temperate scleractinian coral *Astrangia poculata*</u>

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Academic Year 2020, 2021

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

This research will be completed in spring and summer 2021.

<u>Comparison of the environmental impacts of different types of aquaculture in LIS</u>

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

The aquaculture industry is one of the fastest growing global food sectors with 17.3 million tonnes of shelled molluscs being produced globally in 2018, representing 56.2 percent of the production of marine and coastal aquaculture producing revenue of USD 34.6 billion. In recent years, global seaweed farming has increased rapidly with almost 40 million tonnes being produced globally in 2018. It is important to quantify the environmental impacts of shellfish aquaculture, seaweed farming and multi-species regenerative ocean farms that incorporate culturing seaweed and shellfish to determine the potential environmental and economic benefits of diversifying the crop of single species ocean farming. This project would quantify water quality and faunal and floral biodiversity at a control site with no aquaculture, a shellfish-only farm provided by Indian River Shellfish, a seaweed-only farm provided by New England Sea Farms, and a regenerative ocean farm provided by GreenWave within a 8.5 mile radius in central Long Island Sound. Water quality parameters that would be measured are seawater temperature (°C), dissolved oxygen (mg/L), pH, specific conductivity (μS/cm) and salinity (ppt) using unattended continuously logging Eureka multi-probes. Biodiversity would be quantified using lift nets, and video and still photo surveys conducted using a ROV. This project would provide the opportunity to directly compare the effects of regenerative ocean farming to those of conventional single-species aquaculture and undisturbed seafloor. Quantifying the environmental impacts of regenerative ocean farming is a necessary next step in the maturation of this promising approach to aquaculture production.

Results to Date/Significance

This proposed project would begin in February 2022. Dr. Cross submitted an external grant pre-proposal to Connecticut SeaGrant for $147,546 as the Lead PI in February 2021 to support this two-year project. This project would strengthen links between SCSU and the University of New Haven in addition to developing new collaborations with aquaculture industry partners based in Long Island Sound, including New England Sea Farms, Indian River Shellfish and GreenWave.

Seasonal variations in microplastic abundance in treated wastewater from the Meriden and North Haven wastewater treatment facilities

Faculty

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

Student Participant

Summer 2020; Fall 2020

Anthony Vignola, Graduate Student, Environment, Geography and Marine Sciences

Municipal wastewater treatment facilities have been identified as primary sources of microplastics to tributary rivers and coastal estuaries through the direct discharge of treated wastewater. At present, little is known about the composition and quantity of microplastics discharged from WWTFs into tributary rivers flowing into Long Island Sound. Additional studies are necessary to better understand and quantify the magnitude of the effluent as a source of microplastics. Previous studies have shown the WWTFs may remove as much as 95-99% of microplastics in wastewater entering WWTFs. However, the large quantity of effluent discharged from these facilities still results in significant quantities of microplastics entering receiving bodies of water. Five WWTFs discharge treated wastewater into the Quinnipiac River, contributing tens of millions of gallons of treated effluent to the river daily.

The goal of this proposed research is to determine the seasonal variation in the composition and quantity of microplastic particles discharged in the effluent from two WWTFs along the Quinnipiac River: Meriden and North Haven. These WWTFs were selected based on differences in the plant design, wastewater capacity, the size of the populations served, and the ease of access to effluent discharge channels for sampling. It is hypothesized that microplastic concentrations and composition will differ among the WWTFs sampled and vary within each facility seasonally (summer, fall, spring and winter).

Results to Date/Significance

Seasonal sampling of wastewater for microplastics was completed for both the Meriden and North Haven WWTFs. Over 6,000 microplastics were collected during this study. The majority of the microplastics identified were microfibers (74%), while lower quantities were classified as films (21%) and fragments (5%). Microfibers were also categorized by size, with 72% being ≤ 600 µm in length. These findings coincide with a study that found that microfibers released during wash cycles were commonly found at lengths of 360 µm–660 µm. Average seasonal wastewater microfiber concentrations ranged from 0.007–0.019 mf/l and average seasonal microplastic concentrations ranged from 0.009–0.025 mp/l. Box and whisker plots showed that there was no significant difference between total mean microfiber or microplastic concentrations between facilities. Linear regression analysis showed that Meriden WWTP had a statistically significant trend between microplastic/microfiber concentrations and seasonal temperature. North Haven WWTP shared a similar relationship with microplastic/microfiber concentrations and temperature, but it was not statistically significant. Based upon each WWTPs discharge volume and the mean microplastic concentration (0.017 mp/l), it was estimated that Meriden WWTP discharges 746,000 microplastics daily and over 272 million microplastics annually, while North Haven WWTP releases 200,000 microplastics daily and over 73 million microplastics annually. Continual research and awareness will hopefully encourage more mitigation efforts and reveal new ways to combat our reliance on plastics, emphasizing the primary goal of significantly reducing the amount of plastic debris presently released into the environment.

<u>Creation of a gamefish occurrence dataset from public-focused informational newsletters</u>

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Academic Year 2020

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) isn't 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.

Results to Date/Significance

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 data-set, the protocol for collating this data, and an assessment of the suitability of the data for different kinds of analysis. The expected defense date is April 2021.

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 2020; Fall 2020; Spring 2021

Renee Chabot, Undergraduate, 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 shellfishing 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. The goal of this study is to determine the potential adverse consequences to the Norwalk River's water and outer harbor sediment quality during bridge replacement construction.

Results to Date/Significance

Sediment metal contamination (copper, zinc, and mercury) for the Norwalk river area is particularly high around the Walk bridge. Contaminant point sources include the sewage treatment plant, the highway (I95), the marinas, and the abandoned landfill. Furthermore, contaminated metals in sediment tended to co-vary. Where copper concentration was high, zinc and mercury concentration were also high. Mercury is extremely high, ranging from 0.248-1.17 mg/kg, while copper exceeds 100 mg/kg. In comparison, sediment metals in the outer harbor are presently at or slightly above their crustal (natural) abundance, which is 0.06 mg/kg for mercury and 25 mg/kg copper. These high metal concentrations in the river directly correlate to the presence of silt-to-clay grain-size of the sediment. This is important because once construction on the bridge starts, these fine sediment grains may be resuspended into the river water and may be transported downstream. The river is tidal influenced, so sediment can flow both north and south in the river away from the construction site, affecting marine life and estuary habitats. This study has also expanded to include an analysis of both temporal and spatial variations in Norwalk river and harbor sediment.

Renee Chabot received an Undergraduate Summer Research grant ($3,000) for summer 2020 to continue her research. Her research focused on the variations in harbor sediment metal concentrations and the important physical and chemical properties in sediment determining spatial trends in sediment contamination. In addition, previous harbor sediment metal data sets are being analyzed to determine changes in sediment metal (copper, zinc and mercury) since the 1970s.

Energetic cost of maintaining calcification in marine calcifiers

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

Student Participants

Spring 2021

Sara Gerckens, Undergraduate, 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 reared 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 purchasing equipment from her start-up funds and starting to build a fully automated recirculation system consisting of 40 independent units that allow the manipulation of carbon dioxide and dissolved oxygen levels via computer-controlled solenoid valves to simulate future ocean acidification and hypoxia conditions. Dr. Cross was awarded a Research and

Creative Activity Reassigned Time (RCART) award from the Dean of Arts and Sciences for 3 credits of reassigned time for the Spring 2021 semester to build this experimental system and to start research with SCSU undergraduate Sara Gerckens in the summer on this project for her Honors Thesis. This will provide preliminary data to strengthen a National Science Foundation Grant that she plans to submit in Winter 2021.

Examination for the presence of microplastics within the gills and digestive tract of Atlantic menhaden (*Brevoortia tyrannus*)

Faculty

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

Student Participant

Summer 2020; Fall 2020

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Microplastics, plastics < 5 mm diameter, are an emerging contaminant and represent a growing threat to coastal ecosystems due to their ability to accumulate hydrophobic contaminants and their ingestion by pelagic and benthic marine organisms. One of the keystone species in Long Island Sound is the Atlantic Menhaden (*Brevoortia tyrannus*), commonly known as Bunker. As the fish feed, they filter water through their gills which prevent harmful algal blooms, providing an important ecosystem service. Additionally, due to resource competition, Atlantic Menhaden have achieved large regional populations and support many different predatory bird and fish species. Since Menhaden are filtering the water for microscopic plankton, it is likely they are also ingesting microplastics. It is important to monitor this species because there is potential for microplastics to be ingested and the toxins they contain to bioaccumulate up the Long Island Sound food chain through predation. The purpose of this research was to determine if there are microplastics present within filter feeding fish by examining the alimentary canal and gill tissue of Atlantic menhaden (*Brevoortia tyrannus*). This study sampled 15 fish from Connecticut and Rhode Island. To examine menhaden for the presence of microplastics, the fish were dissected in order to obtain the gills and the digestive tract. These tissues were then digested separately in nitric acid and the microplastics were isolated from the digest solutions using a density separation and filtration process. Finally, microplastics were characterized by type (fiber, fragment) using a dissecting microscope and polymer composition determined by IR-ATR spectroscopy.

Results to Date/Significance

Microfibers were the predominant form of microplastic identified in menhaden. In total, 49 discrete microfibers and one microplastic fragment were found in the 15 menhaden examined (3.26 microplastics per fish). Overall, more microplastics were identified in the intestinal tissues of the menhaden compared to the gill tissue. The majority (60%) of the fibers identified were clear. Red (17%) and blue (15%) fibers were also abundant, while there were significantly fewer black (8%) fibers. IR-ATR analysis of a fiber isolated from menhaden tissues was positively identified as polyester. The presence of microplastics within Atlantic menhaden raises concern about the potential for chemicals from the microplastics to be incorporated in fish oil supplements from reduction plants. Strategies to minimize the abundance and toxicity of microfibers in the environment include the combination of better laundering techniques, the use of natural or recycled fibers, and using bio-sourced additives within synthetic fibers.