

**Southern Connecticut State University**  
**Werth Center for Coastal and Marine Studies**



**WCCMS Annual Report 2021-2022**

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Prepared for:

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## **CCMS Annual Benchmark/Evaluation Report 2021-2022**

Each year the participating faculty of the WCCMS prepares and submits to the Werth Family Foundation an annual report describing the Center activities. This report is made available in both electronic and hard copy form. The report provides definitive information and detailed summaries of all yearly projects, events, activities, forums, and accomplishments conducted/achieved by the Center and its personnel. The WCCMS Annual Report is submitted to the Werth Family Foundation during March of each year. Contents of the WCCMS 2021-2022 Annual Report are described below.

This past year we were deeply saddened by the passing in April 2021 of our colleague James Tait. Jim joined the SCSU faculty in 1997 and was promoted to Professor of Marine and Environmental Studies in 2014. Jim was a co-founder of the WCCMS and served as a co-coordinator of the Center for over 15 years. Jim made significant contributions to the development and continued success of the Werth Center for Coastal and Marine Studies. Jim's expertise was in Coastal Processes and his research, conducted with his students, contributed to our understanding of beach erosion along the Connecticut shoreline. The outcomes of this work are now assisting regional managers and regulators as they design strategies to reduce the rate of coastal beach erosion. Jim's approach of teaching science by "doing science" led to his playing an integral role in bringing the NSF-supported program Science Education for New Civic Engagements and Responsibilities (SENCER) to Southern. Jim was part of the university's SENCER team that was awarded The William E. Bennett Award for Extraordinary Contributions to Citizen Science in 2015. In 2005, Jim and Vince Breslin created the honors course: "Science on the Connecticut Coast: Investigations of an Urbanized Shoreline," which was accepted as a SENCER model program and has remained highly popular in the Honors College curriculum. Jim was a supportive mentor and engaged undergraduate and graduate students in his courses and his field-based research focused on environmental problem solving. Many of his former students have achieved success in their graduate studies and careers.

This past summer we were pleased to host the Werth Family on a cruise in New Haven harbor on August 17<sup>th</sup>. Featured on the cruise was sediment sampling and a bottom trawl to capture benthic marine organisms. The cruise was followed by a lunch at the Shell and Bones restaurant along the New Haven waterfront. The cruise was an excellent opportunity for the faculty and students of the Werth Center for Coastal and Marine Studies to meet and interact with the Werth family members. Joining us on the cruise were Werth Center students Makenna Perry, Sara Gerckens, Carolina Capelo, Ian Bergemann and Nicole Woosley.

This past year continued to present challenges as the Covid-19 pandemic presented obstacles to the "normal" conduct of teaching and research at SCSU. In spite of these obstacles, WCCMS faculty and students have achieved success in making progress in their research, publishing, and participating in new research initiatives. Details of their efforts are described in this report.

Werth Family Cruise, New Haven harbor, August 17, 2021



## **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 CO<sub>2</sub> 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 ( $^{\circ}\text{C}$ ), dissolved oxygen ( $\text{mg/L}$ ), pH, specific conductivity ( $\mu\text{S/cm}$ ), 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  $0.1^{\circ}\text{C}$  in February to  $25.2^{\circ}\text{C}$  in August. Dissolved oxygen concentrations have also exhibited an expected seasonal trend ranging from  $5.5\text{ mg/L}$  in August to  $12.2\text{ mg/L}$  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  $< 5\text{ NTU}$ , 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 fluorescence 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 50<sup>th</sup> 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**

<b>Faculty</b>	Dr. Sean Grace Biology Dr. Vincent Breslin Department of the Environment, Geography and Marine Sciences
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## **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.

## **II. Center-Directed/Sponsored Seminars**

A goal of the Center is to conduct interactive faculty/student research and educational outreach programs that elucidate findings and provide public education on Long Island Sound and environs at all levels, including public schools, parochial schools, communities, and governmental agencies. As such, the Center sponsors an annual seminar series in the spring of each year. Center faculty invited two regional experts during the spring 2021 to discuss topics concerning the health and quality of Long Island Sound and its environs as part of the Seventeenth Annual Seminar Series on Environmental Issues of Long Island Sound 2021.

The seminar series consisted of one-hour seminars by invited experts on Long Island Sound environmental issues during the spring 2021 semester. A number of faculty teaching marine science, marine biology, geography, zoology, environmental science and earth science courses during the spring 2021 semester attended and encouraged their students to attend the seminar series. A primary goal of the seminar series is to distribute information about Long Island Sound research among faculty and to encourage interdisciplinary collaborative research at SCSU.

Wednesday, April 21, 2021, 1:00-2:00 pm Zoom Virtual Seminar

**Dr. Catherine M. Matassa**, Assistant Professor, Department of Marine Sciences,  
University of Connecticut

### **The ecology of fear: how ‘scared’ prey shape the cascading effects of top predators**

Predators can drive trophic cascades by consuming their prey but also by causing prey to engage in anti-predator behaviors such as reduced feeding rates or habitat shifts. However, the energetic costs of anti-predator behaviors require that prey carefully balance the need to avoid both predation and starvation. While a growing body of theory predicts optimal prey foraging behavior, more empirical work is necessary to identify the mechanisms that link anti-predator behaviors to their population-, community-, and ecosystem-level consequences. My research on benthic marine communities demonstrates that the cascading effects of ‘fear’ on prey behavior

can be more pronounced and more dynamic than the numerical effects of predators on prey density. This contrast arises because predation risk influences not only the intensity of prey foraging, but also when, where, and how prey gather and utilize energy from lower trophic levels. Emerging from the ecology of fear is a “middle-out” perspective: the cascading effects of predators and the flow of energy and nutrients to higher trophic levels ultimately depend on the organisms that connect the tops and bottoms of food chains. Because most species are in the middle of food chains (and must therefore balance foraging/predation risk trade-offs), understanding how fear and other environmental stressors interact will be necessary to effectively predict and manage the impacts of climate change and trophic downgrading on marine ecosystems.

Wednesday, March 24<sup>th</sup>, 1:00-2:00 pm Zoom Virtual Seminar

Dr. Maria Rosa, George & Carol Milne Assistant Professor of Biology, Connecticut College

**Life in transition: can feeding flexibility help larval bivalves in a changing environment?**

Organisms living in variable environments are generally thought to be more resilient. This resiliency can present itself in how organisms respond, or locally adapt, to changes in their environment. Generalist are thought to be more adaptable in their responses. These responses can include anything from food choice to reproduction, and can have cascading effects in ecosystems. At the organismal level, for example, food choice and feeding are critical for larvae to gain the nutrition needed for development and metamorphosis. However, surprisingly little is known about the traits of microalgae that larvae capture or preferentially ingest. Here I report results of experiments conducted to determine the rules larval bivalve molluscs use to select food. Differences in particle selection by larvae of different species were found, and indicate that more work is needed on other species of molluscs to determine if there are any general patterns for the rules that govern particle selection, and what mechanisms could drive the patterns observed. These findings provide some insight into how foundational species may respond to environmental changes. Understanding how organisms and communities respond to current and projected environmental changes can aid us in developing appropriate conservation and restoration projects.

### **III. Collaborations and Partnerships**

**The sound of silence; environmental benefits of solar powered pump-out boats in Branford Harbors:** Dr. Grace is collaborating with Michael Pascucilla M.P.H., CF-SP, R.S., Director of Health (East Shore District Health Department, serving East Haven, Branford, and North Branford) to determine the difference in sound produced by the new solar powered pump-out vessel versus the traditional motorized pump-out vessel and relating sound to the health of local marine invertebrates.

**Evaluation of Biofouling Communities on Wind Turbine Foundations at the Block Island Wind Farm, Rhode Island:** Dr. Grace is collaborating with Drs. John King and Zoe Hutchinson (University of Rhode Island), Paul English (Fugro GB Marine Ltd.) and Anwar A. Khan (HDR) to re-examine (year 3) the community structure of sessile and mobile organisms on the offshore wind mill farm at Block Island, Rhode Island. This is part of a U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs Grant. A preliminary report was submitted on 2-14-20 and results were presented at the OSM (Ocean Sciences Meeting) in San Diego a week thereafter. A final report for publication was submitted by May 1, 2020.

**Similarities and differences between genomes of temperate and tropical corals:** Dr. Grace is collaborating with Drs. Ilaina Baums, Katie Barott, Kathryn Stankiewicz, Sheila A. Kitchen, and Meghann K. Devlin-Durante: Department of Biology, Pennsylvania State University; Koty Sharp: Roger Williams University; Hollie Putnam: University of Rhode Island; Randi Rotjan, Sarah Davies, John Finnerty, and Leslie Kaufman: Boston University) to determine the genome of the temperate coral *Astrangia poculata*. By determining the order of DNA nucleotides (the genome) in this coral species which, unlike tropical corals, exists over a large geographic and temperature range (0° – 30° C) we will be able to examine the factors that are expected to affect corals and their survival in the future when sea-water temperatures and  $p\text{CO}_2$  levels are expected to increase. Currently, the work is being presented at the 50th Annual Benthic Ecology Meeting in Portsmouth, NH, from March 29-April 2, 2022.

**Marine heatwaves and the collapse of marginal North Atlantic kelp forests**

Dr. Grace is collaborating with a team of international researchers to examine the collapse of kelp forests in the North Atlantic. This collaboration with Dr. Karen Filbee-Dexter (University of Western Australia; Laval University; Institute of Marine Research, Norway), Thomas Wernberg (University of Western Australia), Dr. Colleen Feehan (Montclair State University) and others are examining the ecological consequences of a change in the dominant macroalgal species in local coastal waters caused by marine heatwaves. We experimentally demonstrated a relationship between strong and severe 2018 heatwaves and high kelp mortality in both regions. Patterns of kelp mortality were strongly linked to maximum temperature anomalies, which crossed lethal thresholds in both regions. Translocation and tagging experiments revealed similar kelp mortality rates on reefs dominated by healthy kelp forests and degraded sediment-laden algal ‘turfs’, indicating equal vulnerability to extreme events. These results suggest a mechanistic link between MHWs and broad-scale kelp loss, and highlight how warming can make ecosystem boundaries unstable, forcing shifts to undesirable ecosystem states under episodically extreme climatic conditions. Please see Publications section.

**The Maritime Aquarium at Norwalk** and SCSU have developed and signed a memorandum of understanding to facilitate collaborations among faculty, staff and students of our two institutions. At present, Maritime Aquarium staff are assisting Dr. Breslin with the stocking and maintenance of the two large display aquaria associated with the Werth Center in the new science building. This past year, Maritime Aquarium Research Scientist David Hudson collaborated with Renee Chabot and Vincent Breslin in conducting the Walk bridge research in Norwalk harbor. Maritime Aquarium staff are also collaborating with Maeve Rourke by providing herring and bunker in support of her work with microplastic accumulation in LIS fish.

We have submitted an Environmental Education Grant to the Mitsubishi Corp. to develop a display concerning microplastics in collaboration with the Maritime Aquarium.

**Long Island Sound Coastal Embayment Water Quality Monitoring Program:** WCCMS researchers are participating partners in the Long Island Sound Study funded Long Island Sound Embayment Monitoring Project. This program, now referred to as the Unified Water Study, is organizing and standardizing water quality measurements in the region to assure reliable, high quality water monitoring data for researchers and managers. This program is a collaboration between WCCMS, the Long Island Sound Study, New England Interstate Water Pollution Control Commission, The Maritime Aquarium, UCONN, Save the Sound and the Citizens Campaign for the Environment.

### **Woods Hole Oceanographic Institution (WHOI)**

Dr. Cross is collaborating with Dr. Annette Govindarajan at WHOI to conduct environmental DNA (eDNA) metabarcoding analysis to quantify biodiversity changes associated with aquaculture equipment at Cottage City Oysters' ocean farms in Martha's Vineyard, MA. This collaboration enabled a WHOI guest student appointment for SCSU undergraduate and now graduate student, Miranda Holland, to be trained in eDNA metabarcoding analysis as part of her Masters thesis project. So far, Miranda has been travelling once a month to WHOI to filter seawater samples and extract DNA, which are the first two steps in this analysis.

### **Cottage City Oysters**

Dr. Cross has developed a partnership with Cottage City Oysters, a shellfish and kelp aquaculture company in Martha's Vineyard, with the ultimate goal of developing an ecolabel for sustainable aquaculture products produced in multi-species ocean farms. This collaboration began after meeting at the National Seaweed Symposium in Providence, RI in March 2020 and discussing our shared interests of providing environmental and economic resilience to the aquaculture industry. Collaborative monthly fieldwork began in October 2020 to start collecting baseline water quality and biodiversity datasets of a new open ocean plot that has had no previous aquaculture activities. This partnership has strengthened links between the seafood industry and academia and is providing fieldwork experiences for SCSU undergraduate and graduate students outside of CT. It also is providing opportunities for SCSU students to be exposed to the aquaculture industry to broaden their future career prospects.

### **GreenWave**

Dr. Cross is collaborating with GreenWave, the non-profit organization who are the pioneers of the regenerative ocean farming model, to provide seaweed hatchery internships for SCSU students. Dr. Cross is also facilitating GreenWave providing their expertise in multi-species ocean farming to Cottage City Oysters.

### **Skalanes, Earlham College and Liverpool John Moores University**

Dr. Cross is collaborating with international partners Óli Pétursson (Skalanes), Rannveig Thorhallsdottir (Skalanes), Dr. Tim Lane (Liverpool John Moores University) as well as national partners Dr. Emmett Smith (Earlham College), Dr. Charlie Peck (Earlham College) and SCSU colleagues, Dr. Patrick Heidkamp, Dr. Scott Graves and Dr. Megan Hill to start a marine monitoring site in east Iceland to determine anthropogenic impacts on a fjord ecosystem. This

collaboration with international partners at Skalanes field station in east Iceland will provide annual international marine fieldwork experience for students.

### **Project Blue @ SCSU**

Dr. Cross is collaborating with SCSU colleagues Dr. Patrick Heidkamp and Dr. Colleen Bielitz to develop the Long Island Sound blue economy through creating a research, tech transfer and innovation hub in New Haven. This project leverages expertise from the academic sector, business sector and the public/government sector to address the UN Sustainable Development Goal #14: to conserve and sustainably use the oceans, seas and marine resources. This project has been externally funded by CTNext for three consecutive years and provides entrepreneurship skills and experience for students as they create innovations and solutions for the kelp/seaweed industry and blue-green initiatives.

## **IV. Community Outreach, Education, and Research Communication**

### **Publications**

Trumbauer, W., S.P. Grace, and L.J. Rodrigues. 2022. Seasonal bioaccumulation of heavy metals in the tissues of *Astrangia poculata*. Marine Pollution Bulletin.

<https://doi.org/10.1016/j.marpolbul.2021.113180>

Pessarrodona, A., K. Filbee-Dexter, T. Alcoverro, J. Boada, C. J. Feehan, S. Fredriksen, S.P. Grace, Y. Nakamura, C. A. Narvaez, K. M. Norderhaug, and T. Wernberg.

2021. Homogenization and miniaturization of habitat structure in temperate marine forests. Global Climate Change. <https://doi.org/10.1111/gcb.15759>

Trumbauer, W., S.P. Grace, and L.J. Rodrigues. 2021. Physiological seasonality in the symbiont and host of the northern star coral, *Astrangia poculata*. Coral Reefs.

<https://doi.org/10.1007/s00338-021-02119-5>

Filbee-Dexter, K., S. Augustine, F. de Bettignies, M. Burrows, J. Byrnes, J. Campbell, D. Davoult, K. Dunton, C. J. Feehan, J. N. Franco, I. Garrido, S. P. Grace, K. Hancke, L. E. Johnson, B. Konar, K. Krumhansl, P. J. Moore, M. F. Pedersen, K. M. Norderhaug, A. O'Dell, A. Salomon, D. Smale, I. Sousa-Pinto, S. Tiegs, T. Wernberg, and D. Yiu. (in review). Kelp carbon sink potential increases with latitude due to slowing decomposition. PNAS

Brideau, L., Cross, E. L., Govindarajan, A. F., Martino, D., Martino, G., Holland, M. L., Triay, G. & Heidkamp, C. P. (under review). Strengthening links between industry and academia through transdisciplinary action research: A collaborative water quality, biodiversity and aquaculture initiative. *Blue Economy: People and Regions in Transitions*.

Baumann, H., Jones, L. F., Murray, C. S., Siedlecki, S. A., Alexander, M. & Cross, E. L. (accepted). Impaired hatching exacerbates the unusual CO<sub>2</sub> sensitivity of embryonic sand lance, *Ammodytes dubius*. *Marine Ecology Progress Series*.

Axon, S., Bertana, A., Graziano, M., Cross, E. L., Smith, A., Axon, K. & Wakefield, A. (2022). The U.S. Blue New Deal: What does it mean for just transitions, sustainability and resilience of the blue economy? *The Geographical Journal*. <https://doi.org/10.1111/geoj.12434>

Concannon, C. A., Cross, E. L., Jones, L. F., Murray, C. S., Matassa, C., McBride, R. S. & Baumann, H. (2021). Temperature-dependent effects on fecundity in a serial broadcast spawning fish after whole-life high CO<sub>2</sub> exposure. *ICES Journal of Marine Science*, 78: 3724-3734. <https://doi.org/10.1093/icesjms/fsab217>

## Grants

Sean Grace of the SCSU Department of Biology will work with Colette Feehan of the Montclair State University Department of Biology to pilot the use of “green gravel”—small granite rocks seeded with kelp spores—in the restoration of kelp forests in Long Island Sound. Three sites in eastern Long Island Sound will be seeded with kelp in partnership with local kelp farmers. The purpose of the project is to develop cost-effective and scalable restoration techniques for this key native seaweed that supports a highly diverse marine ecosystem. Many kelp forests have been lost or degraded due to various human impacts. The project will receive \$36,844 in CTSG funding, supplemented with \$20,734 in matching funds some of which will be used for Werth Center Fellows.

Breslin, V.T. 2021. Temporal Trends in Sediment Metal Contamination in New Haven harbor (2001-2021). 2021-2022 Faculty Creative Activity Research Grant. June 1, 2022-May 30, 2023. PI- V.T. Breslin. Total Funds \$2,500.

Breslin, V.T. 2022. Temporal Trends in Sediment Metal Contamination in New Haven harbor (2001-2021). 2021-2022 CSU-AAUP Research Grant. Project Duration: June 1, 2022-May 30, 2023. PI- V.T. Breslin. Total Funds \$5,000.

Cross, E. L. 2022. Quantifying the impact of co-culturing seaweed and shellfish on water quality and biodiversity to build environmental resilience for the shellfish aquaculture industry. 2022-2023 CSU – AAUP Faculty Research Grant. PI: Emma Cross (\$5,000, under review, submitted January 2022).

Cross, E. L. 2022. Does shipping traffic impact marine biodiversity and water quality in Seydisfjörður fjord, Iceland? 2022-2023 Faculty Creativity Activity and Research Grant (FCARG). Funded for 07/01/22-06/30/23. PI: Emma Cross. Total Funds \$2,500.

Cross, E. L. 2021. Enhancing Multi-Species Ocean Farming in the Northeast U.S. by Incorporating Summer-Growing *Gracilaria tikvahiae* to Create Year-Round Co-Cultivation of Shellfish and Seaweed. National Oceanic & Atmospheric Administration (NOAA) FY22 Saltonstall-Kennedy Competition PI – Emma Cross, co-PIs – Annette Govindarajan (Woods Hole Oceanographic Institution), Patrick Heidkamp (SCSU), Dan Martino (Cottage City Oysters) and Greg Martino (Cottage City Oysters). (\$299,990, pre-proposal highly encouraged to submit a full proposal, full proposal submitted November 2021, not funded).

Cross, E. L. 2021. Exploring the potential of climate change mitigation strategies for the shellfish aquaculture industry whilst increasing retention and broadening career prospects of underrepresented groups in marine biology. SCSU's Proposal Incentive Program (PIP). Funded for Spring 2022. PI: Emma Cross. Total Funds \$3,000.

Gerckens, S. 2021. The Impact of Sugar Kelp on Lower Trophic Biodiversity in a Multi-Species Ocean Farm in Martha's Vineyard. Undergraduate Research Grant, Southern Connecticut State University. Funded for Spring 2022. Total Funds \$3,000.

Perry, M. 2021. Seasonal Changes in Marine Biodiversity in West Haven. Undergraduate Research Grant, Southern Connecticut State University. Funded for Spring 2022. Total Funds \$3,000.

Holland, M. L. Using environmental DNA (eDNA) to Quantify Biodiversity Changes Associated with Multi-Species Ocean Farming in Long Island Sound. National Science Foundation (NSF) 2022 Graduate Research Fellowship Program (GRFP) (\$114,000, not funded).

Cross, E. L. 2021. Project Blue @ SCSU - Engaging the Long Island Sound Blue Economy through Transdisciplinary Action Research. CTNext Higher Education Entrepreneurship and Innovation Fund. PI: Patrick Heidkamp (SCSU), Co-PIs: Colleen Bielitz (SCSU) and Emma Cross. Funded for 01/01/2022 – 12/31/2022. Total Funds \$180,000.

Cross, E. L. 2021. Graduate Studies Graduate Assistantship (GSGA) AY2021-2022. Awarded for graduate assistance with my ongoing research project investigating the environmental impacts of multi-species ocean farming in Martha's Vineyard. Graduate Assistant for Fall 2021 – Ian Bergemann. Graduate Assistant for Spring 2022 - Miranda Holland. PI: Emma Cross. Total Funds \$17,434.

Holland, M. L. 2021. The Impact of Regenerative Ocean Farming on Biodiversity. Undergraduate Research Grant, Southern Connecticut State University. Funded for Summer/Fall 2021. Total funds \$3,000.

Cross, E. L. 2021. Exploring the potential of multi-species ocean farming to build environmental resilience for the shellfish aquaculture industry. Joan Finn Junior Faculty Research Fellowship (9 hours of reassigned time for Spring 2022). PI: Emma Cross.

Cross, E. L. 2021. Does multi-species ocean farming improve meat and shell quality of farmed shellfish compared to shellfish-only aquaculture? 2021-2022 CSU – AAUP Faculty Research Grant. PI: Emma Cross. Funded for 07/01/2021-06/30/22. Total Funds \$3,747.

Cross, E. L. 2020. Does multi-species ocean farming improve the quality of shellfish aquaculture products? 2021-2022 Faculty Creative Activity and Research Grant (FCARG). PI: Emma Cross. Funded for 07/01/2021-06/30/22. Total Funds \$2,500.

Cross, E. L. 2020. Engaging the Long Island Sound Blue Economy. CTNext Higher Education Entrepreneurship and Innovation Fund. PI: Patrick Heidkamp (SCSU), Co-PI Colleen Bielitz

(SCSU), Named researcher – Emma Cross. Funded for 01/01/2021 – 12/31/2021. Total Funds \$118,337.

### **Presentations**

Kenneth Hamel, Sophia Kelly, Carla A. Narvaez, Sean P. Grace, and Colette J. Feehan. Sea Urchin Preference for Algal Turf Over Kelp in a Degraded Kelp Forest Ecosystem the 50th Annual Benthic Ecology *Meeting* will be held in Portsmouth, *NH*, from March 29-April 2, 2022. This poster has researchers from SCSU, Werth Center Fellow Sophia Kelly and Dr. Sean Grace. Researchers from Montclair State University, Kenneth Hamel and Dr. Colette Feehan and a researcher from University of Washington's Friday Harbor Research Laboratories Dr. Carla Narvaez.

*Astrangia Working Group Co-Organizer. Astrangia poculata* as a research model for all reefs. August 2016, 2017, 2018, 2019, 2021. Roger Williams University, Bristol, RI. *Astrangia* Research and Literature: historical perspective & context. Co-organizer with Drs. Koty Sharp (RWU) and Randi Rotjan (BU).

Dr. Grace was the keynote speaker at the Coral Reef Live Project on April 19, 2021. His talk was entitled: Global Climate Change, Coral Bleaching and Range Enhancements. This was the culminating event of a year-long coral biology project and seminar series held at Capital Community College. (see poster below)

Cross, E. L. Govindarajan, A. F., Heidkamp, C. P., Martino, D., Martino, G., Brideau, L. E., Holland, M. L., Gerckens, S. M., Rourke, M. C., Bergemann, I. M., Frates, E. & Stover, S. Strengthening Links Between Industry and Academia Through Transdisciplinary Action Research: A Collaborative Initiative to Build Environmental and Economic Resilience to the Shellfish Aquaculture Industry in the Face of Climate Change. Virtual Conference, Ocean Sciences Meeting 2022 (March 2022).

Holland, M. L., Govindarajan, A. F., Heidkamp, C. P., Martino, D., Martino, G., Brideau, L. E., Cross, E. L. Biodiversity impacts of a potential climate change mitigation strategy for the shellfish aquaculture industry, Virtual Conference, Ocean Sciences Meeting 2022 (March 2022).

Cross, E. L. (Invited), Panel Speaker, Pathways to Success: Reflecting on Careers in Coastal, Aeolian, and Marine Science, American Association of Geographers Annual Meeting, Virtual Conference (March 2022).

Cross, E. L. (Invited) Impacts of future climate change on marine organisms. Guest Lecture for GEO 290 Research Methods, Southern Connecticut State University, New Haven, CT, USA (February 2022).

Cross, E. L. Strengthening links between academia and the aquaculture industry provides different perspectives to address topical environmental issues. Fall 2021 Annual Faculty Tapas, Southern Connecticut State University, New Haven, CT, USA (November, 2021).



Cross, E. L., Govindarajan, A. F., Heidkamp, C. P., Martino, D., Martino, G., Brideau, L. E., Holland, M. L., Gerckens, S. M., Rourke, M. C., Bergemann, I. M., Frates, E. & Stover, S. (Invited) Kelp Save the World! Strengthening Industry and Academia Relationships to Build Environmental and Economic Resilience to the Shellfish Aquaculture Industry. Project Blue Entrepreneurship Day, Southern Connecticut State University, New Haven, CT, USA (November 2021).

Holland, M. L., Govindarajan, A. F., Heidkamp, C. P., Martino, D., Martino, G., Brideau, L. E., Gerckens, S. M., Rourke, M.C., Bergemann, I. M., Frates, E., Stover, S. & Cross, E. L. Building environmental and economic resilience for the shellfish aquaculture industry through transdisciplinary action research involving industry and academia. New England – St. Lawrence Valley Geographical Society Annual Meeting, Virtual Conference (October 2021).

Cross, E. L. (Invited) Resilience of marine organisms to future climate change, Biology Seminar Series, Western Connecticut State University, Danbury, CT, USA. Virtual Seminar (September 2021).

Cross, E. L. (Invited) Project Blue at Southern Connecticut State University. Project Blue Innovation Bootcamp, Southern Connecticut State University, New Haven, CT, USA (July 2021).

Brideau, L. E., Heidkamp, C. P., Holland, M. L., Martino, D., Martino, G. & Cross, E. L. *Quantifying the Environmental Impacts of Regenerative Ocean Farming through Industry and Academic Partnerships*, Ocean Visions 2021 Summit, Virtual Conference (May 2021).

Cross, E. L. (Invited) Resilience of marine organisms to future climate change, SCSU's Geography, Environment and Marine Sciences (GEMS) Club seminar. Virtual Seminar (March 2021).

Breslin, V.T. Seminar (Invited). Microplastics in Long Island Sound: From Emerging Contaminant to Potential Threat. Y's Women, Branson Hall of Christ and Holy Trinity Church. Westport, CT. November 8, 2021

Breslin, V.T. Seminar (Invited). Microplastics in Long Island Sound. Schiller Shoreline Institute for Lifelong Learning. St. George Church Hall, Guilford, CT. October 20, 2021.

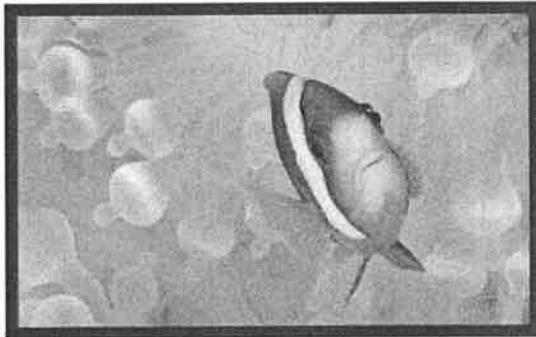
Breslin, V.T. Seminar (Invited Zoom Presentation). Microplastics in Long Island Sound: From Emerging Contaminant to Potential Threat. North Fork Environmental Council, Mattituck, NY. September 15, 2021.

Breslin, V.T. (Invited Zoom Presentation). Microplastics in Long Island Sound: From emerging contaminant to potential threat. Guest Virtual Seminar for the Friends of Outer Island, March 30, 2021.

Dr. Sean Grace gave a presentation on Climate Change and Coral Range Expansions to Dr. Kathleen Morrow, Ph.D. Honors Biology and Bioinformatics class at Thomas Jefferson High School for Science & Technology in Alexandria, VA on May 5, 2021.

*You are cordially invited to attend:*

## ***The Coral Reef Project Live Event!***



***Monday, April 19, 2021***

***1:30 - 3 pm Via Webex***

*This event is open to everyone in the Capital community!*

### ***Featuring:***

Keynote Speaker: Sean Patrick Grace, Ph.D. Professor of Biology at SCSU

Keynote Presentation: "Global Climate Change, Coral Bleaching, and Range Enhancements"

A Q&A Session

A Curated Exhibit with Capital Students' Artwork

***Brought to you by Capital Community College's Center for Teaching***



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## **Participation**

Grace, S. Co-Organizer with Drs. Koty Sharp (Roger Williams University) and Randi Rotjan (Boston University). 6<sup>th</sup> Annual Astrangia Working Group Conference on Temperate Corals. May 2021. Roger Williams University, Bristol, Rhode Island. Astrangia History; *Arbacia punctulata* opening space for temperate corals; Marine heatwaves and species distributions.

Breslin, V.T. Long Island Sound Science and Technical Advisory Meeting.

Cross, E. L. Ocean Sciences Meeting 2022, Virtual (International; 02/24/22-03/04/22)

Holland, M. L. Ocean Sciences Meeting 2022, Virtual (International; 02/24/22-03/04/22)

Cross, E. L. American Association of Geographers Annual Meeting 2022, Virtual (International; 02/28/22)

Cross, E. L. Fall 2021 Annual Faculty TAPAS, Virtual (Internal; 11/22/21)

Cross, E. L. SeaGrant Aquaculture Research Symposia, Virtual (National, 10/25/21 - 11/3/21)

Cross, E. L. New England – St. Lawrence Valley Geographical Society Annual Meeting, Virtual (Regional; 10/14/21 – 10/16/21)

Holland, M. L. New England – St. Lawrence Valley Geographical Society Annual Meeting, Virtual (Regional; 10/14/21 – 10/16/21)

Gerckens, S. New England – St. Lawrence Valley Geographical Society Annual Meeting, Virtual (Regional; 10/14/21 – 10/16/21)

Perry, M. New England – St. Lawrence Valley Geographical Society Annual Meeting, Virtual (Regional; 10/14/21 – 10/16/21)

Cross, E. L. Ocean Acidification Week, Virtual (International; 09/13/21 – 09/17/21)

Cross, E. L. 44<sup>th</sup> Larval Fish Conference, Virtual (International; 06/24/21 – 06/26/21)

Cross, E. L. Ocean Visions Summit 2021, Virtual (International; 05/18/21 – 05/20/21)

## **Workshop Attendance**

Cross, E. L. 2nd National Workshop on Marine eDNA, Virtual (National; 02/02/22)

Holland, M. L. 2nd National Workshop on Marine eDNA, Virtual (National; 02/02/22)

Cross, E. L. National Oceanic & Atmospheric Administration (NOAA) Northwest Fisheries

Science Center (NWFSC) Webinar, Virtual (National, 01/13/22)

Cross, E. L. National Seaweed Hub Marketing Opportunities Group Meeting, Virtual (National; 12/09/21)

Cross, E. L. Project Blue Entrepreneurship Day, Southern Connecticut State University, New Haven, CT (Regional; 11/05/21)

Cross, E. L. Project Blue Business Plan Presentations, Virtual (Regional; 08/27/21)

Cross, E. L. Maine Center for Coastal Fisheries, Lunch and Learn Talk Series Webinar, Virtual (National; 07/30/21)

Cross, E. L. Project Blue Internships Check In, Virtual (Regional, 07/23/21)

Cross, E. L. Blue Economy Innovation Bootcamp, Southern Connecticut State University, New Haven, CT (Regional; 07/16/21)

Cross, E. L. Ocean Acidification North American Hub members meeting, Virtual (National, 05/20/21)

Cross, E. L. National Seaweed Hub Marketing Opportunities Group Meeting, Virtual (National; 05/06/21)

Cross, E. L. Northeast Coastal Acidification Network (NECAN) Webinar, Virtual (National; 04/20/21)

Cross, E. L. Global Ocean Acidification Observing Network (GOA-ON) Webinar, Virtual (International, 04/08/21)

Cross, E. L. CSI Oyster: a community science initiative on environment-oyster interactions in Chesapeake Bay Webinar, Virtual (National, 04/01/21)

Cross, E. L. Northeast Coastal Acidification Network (NECAN) Webinar, Virtual (National; 03/08/21)

Cross, E. L. Long Island Sound Seaweed Bioremediation Working Group Meeting, Virtual (Regional, 03/02/21)

## **Undergraduate and Graduate Research and Creativity Conference**

### **Southern Connecticut State University**

#### **Werth Center for Coastal and Marine Studies Participants**

May 1 and 3, 2021

Werth Center for Coastal and Marine Studies students were well represented at the fourth annual undergraduate research and creativity conference held at SCSU. The following students presented oral or poster presentations at the conference.

<b>Students</b>	<b>Presentation Title</b>
Maeve Rourke	The Presence of Microplastics in the Gills and Digestive Tract of Atlantic Menhaden ( <i>Brevoortia tyrannus</i> )
Renee Chabot	Spatial and Temporal Patterns in Norwalk Harbor Sediment Contamination
Nicole Woosley	The effects of depth, light, and orientation on the fluorescence of the symbiont <i>Breviolum psygmophilum</i> in the <i>Astrangia poculata</i>

### Student Theses and Reports/Advisors

Student	Thesis Title	Completion Date
Renee Chabot	Spatial and temporal patterns in Norwalk harbor sediment contamination	May 2021
Cassandra Bhageloo	Macroalgae as bioindicators for mercury contamination in Long Island Sound	May 2022
Rebecca Hedreen	Creation of a gamefish occurrence dataset from public-focused informational newsletters.	Dec 2021
Nicole Woosley	The effects of time, light and polyp orientation on the fluorescence of the symbiont <i>Breviolum psygmophilum</i> in the <i>Astrangia poculata</i>	May 2022
Miranda Holland	Biodiversity Changes Associated with Shellfish Aquaculture Equipment in Martha's Vineyard	Dec 2021
Sara Gerckens	The Impact of Multi-Species Ocean Farming on Mesozooplankton Abundance and Species Diversity in Martha's Vineyard	May 2022
Makenna Perry	Seasonal Changes in Marine Biodiversity in West Haven	May 2022

### Werth Center Fellows Alumni Update

Renee Chabot completed her undergraduate degree in Chemistry and completed her Honors Thesis research with Dr. Breslin with Werth Center support. Renee studied sediment metal contamination in Norwalk harbor and her work is an important contribution to the ongoing assessment of the Walk bridge replacement in Norwalk. Renee was recently accepted a fully funded doctoral program in the School of Marine and Atmospheric Sciences at Stony Brook University for studies in Atmospheric Sciences working with Professor Paul Shepson.

Brooke Mercaldi graduated in May 2020 *Summa Cum Laude* with a BS in Environmental Systems and Sustainable Studies working with Professor James Tait examining coastal processes. Brooke is currently a Juris Doctor Candidate at the Elisabeth Haub School of Law at Pace University. She was recently accepted into the Masters degree program at the Yale School of Forestry to study Environmental Policy for the 2022-2023 academic year. She will then return to Pace University to graduate with a Law degree and a Masters in Environmental Policy in spring 2024.

Lauren Brideau graduated in May 2020 *Summa Cum Laude* with a BS in Environmental Systems and Sustainability Studies and began her fully funded Ph.D. position at the University of Virginia in Fall 2021 where she is working with Dr. Max Castorani on biodiversity in seagrass beds. Lauren has just been awarded a National Science Foundation Graduate Research Fellowships Program (NSF GRFP) to support her Ph.D. research.

Gabriella DiPreta graduated in 2018 with an MS in Biology and currently works as a Biologist for RPS International, in Wakefield, Rhode Island, examining the benthic community structure of potential off-shore wind ventures on the east coast of the USA.

## **V. Accounting, Budget Expenditures and Grant Writing**

### **Academic Year 2021-2022 Itemized Budget Justification**

Funds totaling \$75,000 were requested for Year 16 (2021-2022) to support the research and educational mission of the Center (see attached budget spreadsheet). Three columns are shown in the budget sheet showing the Werth Foundation request, the Werth Foundation Fund Disbursement (how dollars were actually spent) and the SCSU Matching Funds (dollars committed by the University or obtained from other sources).

#### **Professional Salaries and Honoraria (\$11,800 expended)**

Werth Foundation funds were used in support of salaries for faculty mentoring students during the summer 2021. Professors Breslin (\$4,000), Cross (\$3,000) and Grace (\$3,000) were compensated for mentoring student research projects (\$1,800 fringe benefits). The SCSU Dean of Arts & Sciences provided faculty reassigned time (3 credits time each for Breslin, Grace and Cross) during the academic year in support of managing the CCMS activities and programs. Reassigned time (9 credits) for faculty in support of CCMS management totaled \$20,100.

#### **Student Research Fellowships (\$36,300 expended)**

A major portion of the Center budget consists of funds in support of undergraduate and graduate student research stipends. A major goal of the Center is to increase undergraduate student participation in the processes of “doing science” through participation in faculty guided research projects. The CCMS awarded fellowships during summer 2021 (7 students; \$16,800), Fall 2021 (8 students; \$9,600) and spring 2022 (9 students; \$9,900). Fellowship amounts per student ranged from \$500-\$2,400 per semester (50-200 hours @ \$10/hour). The CCMS has a system-wide mission to support student research. This past year, the CCMS supported ten different students in five different academic fields (Biology, Chemistry, Environmental Systems and Sustainability Studies, Marine Studies, and Honors) in support of faculty-directed research projects during this past year totaling \$36,300.

#### **Analytical Equipment Service Contracts (\$15,944 expended)**

Funds in the service contract budget category were used to purchase a service contract for fiscal year 2021-2022 for the PerkinElmer AAnalyst 800 Atomic Absorption Spectrophotometer (\$11,444). Werth funds were also used to purchase a one-year service contract (2021-2022) for the Milestone DMA 80 Direct Mercury Analyzer (\$4,500). The service contracts are essential for keeping the instruments operational and properly calibrated. Both analytical instruments are essential for the ongoing WCCMS harbor research programs.

#### **Ship Time (\$5,450 expended)**

Funds for chartering ship time were budgeted (\$4,500) to provide access to field sample sites for research and education along the Connecticut shoreline and in Long Island Sound. An easing of Covid restrictions in the summer and fall of 2021 allowed WCCMS researchers to once again



charter boats in support of their research and education programs. Six cruises were conducted in 2021-2022. Three were completed in support of the ongoing harbor research examining contaminant metals in sediments (6/17, 5/21 and 8/17). Three cruises were conducted in support of educational programming (10/27, 10/28 and 4/8). Students in undergraduate courses MAR 210 Coastal Marine Studies and MAR 460 Field Techniques in Marine Studies were able to conduct field research and environmental observations during the cruises.

### **Long Island Sound Seminar Series**

This year marked the 17<sup>th</sup> consecutive year that the Werth Center for Coastal and Marine Studies has hosted the seminar series. This past year two speakers participated in the seminar series virtually via Zoom and neither speaker requested an honorarium.

### **Travel and Conference Funds (\$200 expended to date)**

Travel funds totaling \$1,500 were budgeted to reimburse costs associated with travel in support of attendance at local, regional and national scientific meetings. Travel was largely restricted during the pandemic. One trip was made to Woods Hole, MA to the Marine Biological Laboratory specimen lab to pick up fish for the aquarium. We anticipate allocating additional funds for travel this spring as we will have several students participate in the Long Island Sound Research Conference, Bridgeport, CT May 18<sup>th</sup>, 2022.

### **Publication Costs (\$0 expended to date)**

A total of \$600 was budgeted for publication costs for FY 2021-2022. Funds are allocated primarily in support of printing large format posters (3' x 4') for student research posters for scientific meetings. All recent meetings have been virtual and printing large format posters for presentations has been unnecessary. However, funds will be used later this spring 2022 for the printing of large format posters for WCCMS students participating in the SCSU Undergraduate and Graduate Research Conferences.

### **New Equipment/Software Purchases (\$6,240)**

The university purchased (\$14,831) an Aqua Logic MT9 Air Cooled water chiller 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. Werth Center funds were used to move (Walker Crane and Rigging Corp., \$2,740) the chiller unit to the basement of the Academic Science building and to integrate the chiller (Elite Aquarium, Inc, \$3,450) into the existing water flow of the aquarium. The installation was completed in January 2022.

### **Expendable Supplies (\$6,893 expended)**

Funds for laboratory and office supplies (\$5,000) were budgeted to allow the purchase of materials in support of the WCCMS research and educational initiatives. Supply funds were used to purchase laboratory chemicals, tank gas for instrumentation, cartridges for water

purification systems, standard reference materials for laboratory instrument calibration, supplies for the sediment metals research and laboratory and field supplies for the sediment grain size and beach surveying research. Additional funds were used for the purchase of chemicals, supplies and reagents for water quality and aquarium supplies and general office supplies. New this year was the purchase of personal protection equipment including hand sanitizer, facemasks and latex gloves. Supplies were also purchased to support educational and aquaculture activities in the Werth Center aquarium laboratory. Supplies include filter cartridges for 30-gallon aquaria, water quality test kits, and water quality meters.

WCCMS faculty purchased an additional site license for Sigma Plot 14 (\$599 per license). Sigma Plot software is used in support of statistical analysis of data and as a scientific graphing software package.

Supply purchases exceeded the budgeted amount as supply needs were increased due to new research initiatives.

### **Balance of Funds**

To date, CCMS has expended \$82,827 of the \$75,000 funds budgeted for FY 2021-2022. The overage is covered by funds carried forward from previous years.

### **Matching Funds**

Each of the following CSU-AAUP Research Grants, SCSU Faculty Development Grants, SCSU Undergraduate Research Grants and Fellowships listed have been used in support of WCCMS research and education activities.

### **Connecticut State University Research Grant Award 2020-2021**

Gerckens, S. The Impact of Sugar Kelp on Lower Trophic Biodiversity in a Multi-Species Ocean Farm in Martha's Vineyard. Undergraduate Research Grant, Southern Connecticut State University (\$3,000, funded for Spring 2022).

Perry, M. Seasonal Changes in Marine Biodiversity in West Haven. Undergraduate Research Grant, Southern Connecticut State University (\$3,000, funded for Spring 2022).

Cross, E. L. Graduate Studies Graduate Assistantship (GSGA) AY2021-2022 (\$17,434, funded). Awarded for graduate assistance with my ongoing research project investigating the environmental impacts of multi-species ocean farming in Martha's Vineyard. Graduate Student for Fall 2021 – Ian Bergemann. Graduate Student for Spring 2022 - Miranda Holland. PI: Emma Cross.

Grace, S. P. Graduate Studies Graduate Assistantship (GSGA) AY2021-2022 (\$8717, funded). Awarded for graduate assistance with ongoing research projects involving the temperate scleractinian coral *Astrangia poculata*. Graduate Student for Fall 2021 and Spring 2022 – Leah Hintz. PI: Sean Grace

Holland, M. L. The Impact of Regenerative Ocean Farming on Biodiversity. Undergraduate Research Grant, Southern Connecticut State University (\$3,000, funded for Summer/Fall 2021).

Cross, E. L. 2021. Does multi-species ocean farming improve meat and shell quality of farmed shellfish compared to shellfish-only aquaculture? 2021-2022 CSU – AAUP Faculty Research Grants (\$3,747, funded for 07/01/2021-06/30/22). PI: Emma Cross.

Cross, E. L. 2021. Does multi-species ocean farming improve the quality of shellfish aquaculture products? 2021-2022 Faculty Creative Activity and Research Grant (FCARG, \$2,500, funded for 07/01/2021-06/30/22). PI: Emma Cross.

Breslin, V.T. 2021. Temporal Trends in Sediment Metal Contamination in New Haven harbor (2001-2021). 2021-2022 Faculty Creative Activity Research Grant. (FCARG, \$2,500, funded for 07/01/2021-06/30/22). PI: V. T. Breslin.

