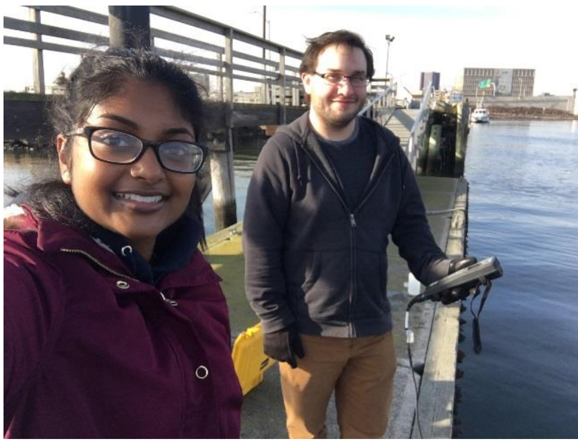
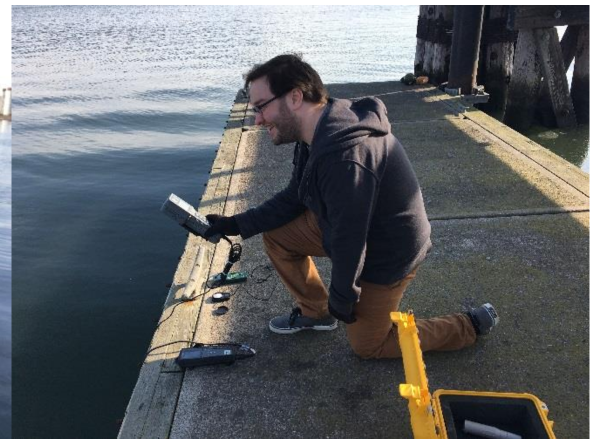
I. Research Projects

Water Quality Monitoring in New Haven Harbor

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

Student Participants

Summer 2016; Fall 2016; Spring 2017

Hollie Brandstatter, Graduate Student, Environment, Geography and Marine Sciences
Nick Devito, Undergraduate Student, Biology

Summer 2016; Fall 2016

Dylan Steinberg, Undergraduate Student, Environment, Geography and Marine Sciences
Lara Bracci, Undergraduate Student, Environment, Geography and Marine Sciences

Spring 2017

Nicole Woosley, Undergraduate Student, Biology
Cassandra Bhageloo, Undergraduate Student, Chemistry

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

WCCMS students have now completed four years of water quality monitoring at the Long Wharf Pier, New Haven, CT. A new development this year is our participation in the Long Island Sound Unified Water Study: Long Island Sound Embayment Monitoring coordinated by Save the Sound (http://www.ctenvironment.org/uws). The overall goal of the study is to standardize data collection methods and to better coordinate the embayment monitoring efforts among citizen and university researchers examining LIS water quality. This year focused on developing standard practices for monitoring water quality and developing a network for communicating the results of various water quality monitoring programs. Graduate student Hollie Brandstatter and Dr. Breslin attended the Unified Water Study: Long Island Sound Embayment Research, January 11, 2017 at the Bridgeport Public Library, Bridgeport, CT.

Results of our monitoring show that water temperature (-0.8 to 26.8°C) at the pier at Long Wharf, New Haven displays a seasonal trend. Dissolved oxygen concentrations (1.65 to19.18 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 (8/16/12, 7/24/13 and 9/11/15) when the dissolved oxygen level measured below the threshold suitable to sustain marine life (3 mg/L). Salinity at this location at high tide varies within a narrow range (9.8 to 30.5 ppt). Water clarity, as measured using a secchi disk, varies from 0.30 to 2.5 meters. Chlorophyll-a concentration measured using UV/Vis spectrophotometry and fluorescence range from 0.13 to 80.6 µg/L. The ranges of these values for these water quality parameters are typical for similar parameters reported for other Long Island Sound coastal embayments. Undergraduate Biology student Nick Devito was recently added (Summer 2017) to the team and is working with Biology Professor Elizabeth Roberts on determining fecal coliform bacteria concentrations at the Long Wharf pier. Coliform bacteria are used as an indicators of possible sewage contamination because they are commonly found in human and animal feces.

Seasonal Growth of the Temperate Coral *Astrangia poculata* from 1972 to 1981 Using Historical Photographs

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Summer 2015; Fall 2015; Continued with research through Spring 2016

Gabriella DiPreta, Biology, Undergraduate Student

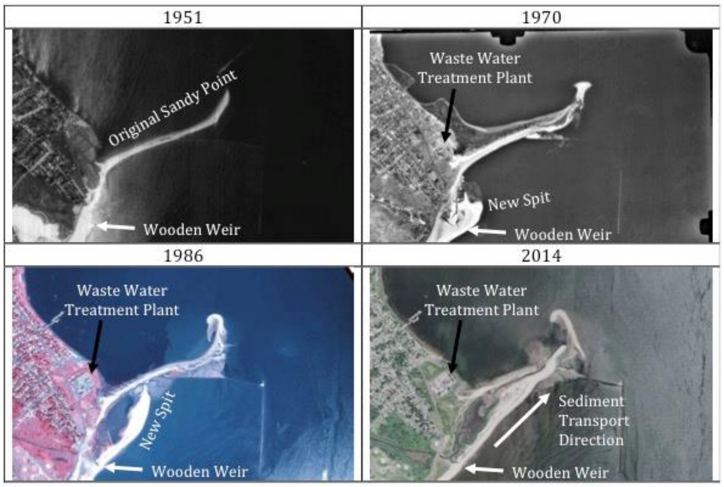
The purpose of this study was to examine historical photos taken with a Nikonos III underwater camera between the years 1972-1979 by Wes Pratt who worked as at the National Marine Fisheries Laboratory in Narragansett, Rhode Island. The photos were of the temperate coral *Astrangia poculata* and are unique in that growth measurements on corals world-wide were rare at that time. Pratt visited the same colonies over the course of 7 years and took photographs of them. The photos were given to Dr. Grace recently by Wes Pratt. Photos were digitized (moved from slide film to jpeg) and examined to count polyp number, a measure of coral growth over time. Each coral was identified by a clear marker and 47 corals were followed throughout the timeframe of the original photographic data-set. The number of polyps were counted and any other organisms that were over-growing the corals were also noted.

Results to Date/Significance

Results demonstrate that during the summer months, *Astrangia poculata* displayed a positive growth rate with an increase in polyp count. A negative growth rate or no change in polyp count was found when *Astrangia poculata* went dormant during the winter months. Competitive interactions between *Astrangia poculata* and the red boring sponge *Cliona celata*, as well as burial by sedimentation, displayed a negative growth or no change in polyp count. This study demonstrates an understanding of seasonal trends which initiate a positive or negative growth of polyps in the temperate coral, and the ecological and environmental factors which influence coral growth.

Sediment Transport on West Haven Beaches

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



Student Participant

Summer 2016

Jessica Brewer, Undergraduate Student, College of Environmental Science and Forestry, State University of New York. (Tait: FDCA Grant stipend)

Project Description

Extending the results from Ryan Orlowski's study (2014-2016) of the fate of a beach replenishment project, beach profile data was rendered into a time series of 3-D images of the beach as a whole. In addition, a beach sediment transport study of West Haven's northeastern beaches was conducted by Miller and Tait. Miller took and series of aerial photos from 1934 to 2014, geo-referenced to the same boundaries and animated them. Sediment transport patterns were clearly visible.

Results to date/Significance

The results of Brewer's study were consistent with the interpretations of beach sediment dispersal by Orlowski. Sediment is being lost from southwestern beaches and collecting in a shoal to the west of Bradley Point. In the study by Tait and Miller, transport history was also clear. 1) The sand spit know as Morse Point (sometimes confused by an older spit called Sandy Point) originated in the 1950s and has grown rapidly over time. 2) This growth has resulted in the creation of a new marsh but also resulted in sediment starvation of the Sandy Point spit. 3) The Morse Point spit has become a hazard to navigation a threat to the operation of the West Haven water treatment plant. Several beach replenishment episodes on the beaches updrift of the spit provided added sediment that was transported to the northeast by the same SW wavefield that transported sediments from the 2014 beach replenishment project to the shoal at Bradley Point. Construction of a wooden "weir" near the base of the spit acted like a groin diverting sand offshore and away from the original Sandy Point spit.

There is a larger significance relates to coastal resilience. In a time of rising sea levels and intensified storms, the need for beach nourishment will increase. This is not only becoming more expensive, sources of suitable sand are becoming scarce worldwide. One of the decisions made by the Town of West Haven, in part due to our results and recommendations, is the decision of the town in its Harbor Management Plan, its Coastal Resilience Plan and its Conservation and Development Plan is a commitment to sand management. This entails engaging in sand reclamation, an activity in which eroded sand is reclaimed and replaced in an ecologically sensitive manner. This differs from beach replenishment because replenishment depends on the import of sand from another source. Currently, the state D.E.E.P. discourages extracting sand from the nearshore for sand replacement projects (although it is allowed at state beaches). So this research may result in changes in state environmental policy.

<u>Werth Center for Coastal and Marine Studies Aquarium</u>

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

Student Participants

Summer 2016; Fall 2016; Spring 2017

Hollie Brandstatter, Graduate Student, Environment, Geography and Marine Sciences
Nick Devito, Undergraduate Student, Biology

Summer 2016; Fall 2016

Dylan Steinberg, Undergraduate Student, Environment, Geography and Marine Sciences
Lara Bracci, Undergraduate Student, Environment, Geography and Marine Sciences

Spring 2017

Nicole Woosley, Undergraduate Student, Biology

Werth Center facilities in the new science building 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 (coastal aquarium) and January 2016 (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 one year of water quality measurements on the aquarium system and the fish have been in the aquarium for one year. To celebrate this occasion, WCCMS hosted an Aquarium Open House on March 21st, 2017. The Open House allowed students throughout the campus an opportunity to tour the facilities and learn about LIS fish and invertebrates. Student posters displayed the water quality monitoring results for the past year and information concerning the fish and invertebrate species in the aquarium. We also recently added a second touch tank to the lab in SCI 111, separate from the original aquarium system. This touch tank serves as a true touch tank for invertebrate specimens for students to handle during visits. The lab also hosted a 6th grade student group from Fair Haven School, New Haven, on Friday March 3rd. WCCMS students led a tour of the lab and educational programming using the invertebrate specimens from the touch tank. Three additional school groups are scheduled to visit the laboratory during the Spring 2017 semester.

Testing for the Presence of Seasonal Beach Profiles on the Connecticut Coast

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

Student Participants

Fall 2016

Dylan Steinberg, Undergraduate Student, Environment, Geography and Marine Sciences
Lara Bracci, Undergraduate Student, Environment, Geography and Marine Sciences

Fall 2016; Spring 2017

Mathew Connors, Undergraduate Student, Environment, Geography and Marine Sciences
Shannon Bronson, Undergraduate Student, Environment, Geography and Marine Sciences

Project Description

Multi-year research focused on testing for seasonal beach profiles on the Connecticut coast continues. Profiles were measured in the summer and fall of 2016. The next measurements are scheduled for spring 2017.

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. The predominant model for annual beach behavior posits an annual equilibrium between a robust beach during fair weather waves and a smaller, eroded beach during periods of seasonal storminess. In this model, sand is transferred to offshore bars during storms and then returned to the beach by more moderate fair weather waves. Such changes in sand storage are referred to as seasonal beach profiles. The fair weather waves on most beaches are derived from distant storms. A process called velocity dispersion sorts these waves into highly coherent wave trains (or swell) that are moderate in height and long in period. Such waves transport sand shoreward and rebuild the beach. On the Connecticut coast such waves are filtered out by Long Island.

The current research involves testing the scenario above by measuring beach profiles at five Connecticut beaches on a seasonal (four times per year) basis in order to establish the presence or lack of seasonal beach profiles (i.e., does the beach ever accrete and, if so, is there ever full recovery after a storm?). The beaches included in the study include Sherwood Island State Park, Bayview Beach in Milford, Hammonasset Beach State Park, Rocky Neck State Park, and Ocean Beach in New London. Since the Race at the east end of Long Island Sound is a possible entry point for large ocean swell, it is possible that beaches at the eastern end of the Sound exhibit seasonal behavior while beaches further from the Race do not. The results of this study will provide key information concerning the state of vulnerability of Connecticut beaches.

Results to Date/Significance

This study is in an intermediate stage. Profiles have been measured at the five study sites in Fall of 2015, Winter of 2015, Spring of 2016, Summer of 2016 and Fall of 2016. Based on initial observations, profiles are mainly immobile with transport of sand offshore or alongshore during high-energy events. The main regime is erosive with only minor gains, those gains being likely the result of alongshore transport from other parts of the beach rather than recovery of sand lost to erosion by the action of fair weather waves.

***Cliona celata*, Bio-eroding and Changing Temperate Reefs from Mixed Highly Biodiverse Communities to Single Low Diverse Habitats**

Faculty Dr. Sean Grace
Biology

Student Participant(s)

Fall 2015; Spring 2016

Jennifer Lazor, Undergraduate Student, Biology
Todd Massari*, Graduate Student, Biology

Project Description

Competition between the temperate scleractinian coral *Astrangia poculata* and the Red Boring spring *Cliona celata* was examined *in situ* at Fort Wetherill, Jamestown, Rhode Island. Coral-sponge assemblages were examined using 3, 30m transects at 14m depth. Out of 2,758 corals examined, 21% were in association with the sponge. *Cliona celata* bores under the coral decreasing its attachment strength and ultimately leading to coral dislodgement. The attachment strength of corals alone and those in competitions with the boring sponge was examined.

Results to Date/Significance

Sponges significantly decrease the attachment strength of corals ($T=697$, $P<0.001$). Corals were three times likely to be dislodged when in an assemblage with sponges than alone. Though corals are not overgrown by sponges (not observed in this study), corals that were movable by simply pushing on them increased when in competition with the sponge. Like tropical reefs that may be moving to sponge dominance, temperate corals were negatively affected by boring sponges which decrease their attachment strength thus increasing the likelihood of dislodgement.

This summer (2016) was instrumental in determining the methods for removal to examine changes in attachment strength. Results are interesting for many reasons in this case as it is the first study to demonstrate that temperate reefs are similarly affected by sponges as tropical reefs.

Cove River Marsh Recovery

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

Student Participants

Summer 2016; Fall 2016; Spring 2017
Shannon Bronson, Undergraduate Student, Environment, Geography and Marine Sciences
Mathew Connors, Undergraduate Student, Environment, Geography and Marine Sciences

Student Participants (Volunteer, no stipend)

Scott Thibault, Graduate Student, Environment, Geography and Marine Sciences
Peter Broadbridge, Graduate Student, Environment, Geography and Marine Sciences
Darryl Nicholson, Graduate Student, Environment, Geography and Marine Sciences

Project Description

The town of West Haven recently undertook a salt marsh restoration project that involved replacement of a tide gate and removal via cutting and herbicide of invasive common reed (*Phragmites australis*). Unfortunately, recolonization by native marsh grasses has been very problematic. Studies of marsh elevations, characterization of the marsh surface, water level changes, sediment samples, and observations via drone have been conducted in order to understand current marsh dynamics and to develop hypotheses concerning the failure of the marsh to thrive.

Results to Date/Significance

Marsh elevation data, sediment samples, and extensive drone observations have been collected. The study is still in its initial stages. The study is significant in that coastal environments such as salt marshes, which are highly important coastal ecosystems, will come under increasing stress as a result of climate change. Specifically, with sea level rise, marsh surfaces will be subjected to increased periods of inundation by salt water. This will result, eventually, in losses of high marsh grasses such as *Spartina patens* and *Dystichlis spicata*, and eventually loss of low marsh grasses (*Spartina alterniflora*). The grasses are keystone species in the marsh ecosystem. The study is also significant in that it investigates a marsh that is completely surrounded by an urbanized environment. During sea level rise, marshes typically responded by migrating landward. In this case, there is no place for the marsh to go. The surrounding development presents a barrier to marsh migration.

Assessment of Plastic Microbead Contamination in Long Island Sound

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

Student Participant(s)

Summer 2016; Fall 2016; Spring 2017

Cody Edson, Graduate Student, Chemistry
Lela Jackson, Undergraduate Student, Chemistry

Plastic microbeads (< 5mm) in consumer cosmetic and skin care products bypassing municipal wastewater treatment systems may cause harm to marine ecosystems yet no systematic study has been conducted to confirm their presence in Long Island Sound. New Haven harbor, with two municipal wastewater treatment facilities discharging treated wastewater into the harbor, was selected for this study. Several commonly available consumer cosmetic products were first examined using optical microscopy to determine microbead particle morphologies (size, shape, and color).

The proposed study is designed to examine the temporal and spatial distribution of plastic microbeads in Connecticut coastal harbors. Harbor water was sampled by towing an 80 µm mesh plankton net at the water surface along four predetermined transects in New Haven (June) and Mystic (October) harbors in 2016. The collected water was filtered and the filter paper examined for the presence of plastic microbeads. Results will allow for a comparison of microbead concentrations in an eastern (Mystic) and central (New Haven) LIS harbor. The goals of this proposed study are to (1) repeat the plankton tow transects conducted in June 2015 in New Haven harbor to determine if microbead concentrations have changed over time; (2) examine the spatial distribution of microbeads in two coastal LIS harbors along the Connecticut coastline; and (3) correlate the measured microbead concentrations within each harbor with wastewater treatment and tributary river discharges in each harbor.

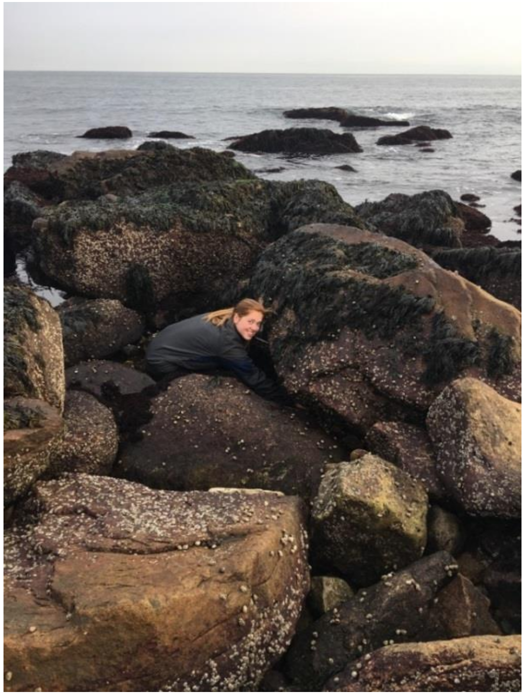
Results to Date/Significance

Five surface water plankton tows (64 and 80 micron mesh nets) were conducted along predetermined transects in New Haven harbor in June 2016 proximate to two municipal wastewater discharges to quantify plastic microbead concentrations in the harbor. Using a dissecting microscope (10-45x magnification) microbeads were photographed using a Ken-A-Vision PupilCAM camera and measured using Toupview digital imaging software. A total of 185 plastic microbeads were found in the harbor plankton tows. Plastic microbead diameters captured in New Haven harbor plankton tows were primarily in the 60-300 micron size range.

Microbeads were also sampled in Mystic harbor in October 2016. Two of the plankton tows were conducted in Mystic harbor and one tow was conducted in Long Island Sound. Final microbead counts and microbead imaging are still in progress.

Acquisition of DIVING-PAM Underwater Fluorometer

Faculty Dr. Sean Grace
Biology



Student Participant(s)

Julie Honan, Undergraduate, Biology

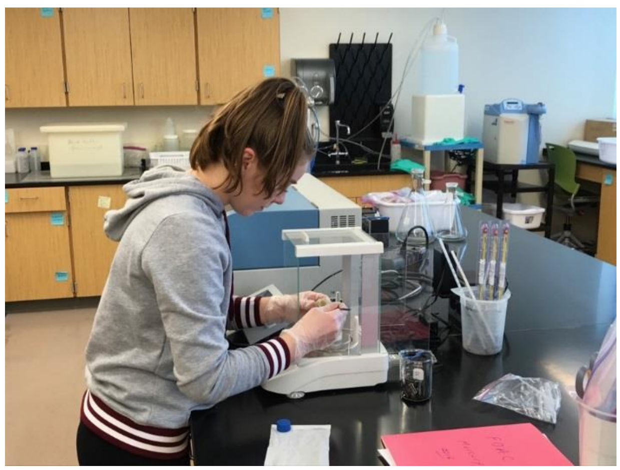
The DIVING-PAM Underwater Fluorometer is a unique instrument for studying *in situ* photosynthesis of underwater plants, including sea grasses, macroalgae, and zooxanthellae in corals. Based on the large experience with chlorophyll fluorescence analyses of terrestrial plants, investigations using the DIVING-PAM have shaped a clearer understanding of underwater photosynthesis under natural conditions. The Diving-PAM underwater fluorometer was recently purchased (Spring 2017) by Werth Center co-coordinator Dr. Sean Grace (Biology) and will be used to study *in situ* photosynthesis by chlorophyll fluorescence analysis. This unique instrument is one of only a few available regionally and represents a significant advance in our ability to conduct underwater photosynthesis studies. It can be used in underwater studies of sea grass, underwater plants, macroalgae and coral. The Diving-PAM is rated to a depth of 50m, has an external fiber optic sensor and multiple sample holders. All necessary underwater commands are via a touch sensitive keypad. The instrument automatically displays and records fluorescence yield (F), maximal yield (Fm) and photosynthesis yield (Y=deltaF/Fm'). The fluorometer stores up to 4000 datasets in internal memory for later transfer to a PC. Further, the Diving-PAM fluorometer determines the basic health measurements for any photosynthetic animal (corals, anemones), all macroalgae, and sea-grasses. Essentially, this instrument can be used to compare the ‘health’ of photosynthetic organisms in one area of Long Island Sound to other areas and since it is a hand-held device, it is easily transportable and students can use it easily when properly trained.

Results to Date/Significance

Dr. Grace and others will utilize this instrument to determine the photosynthesis/respiration rates for temperate corals with (zooxanthellate) and without (azooxanthellate) the endosymbiont *Symbiodinium psygmophilum*. Additionally, this equipment will be utilized to examine kelp and other macroalgal photosynthetic rates in Long Island Sound.

An Analysis of Mercury Sorption in Macroalgae across the Long Island Sound East-West Gradient

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



Student Participants

Fall 2016; Spring 2017

Lela Jackson, Undergraduate Student (Chemistry)

Seaweeds have been used worldwide as bio-indicators and to evaluate the quality of the surrounding environment. A macroalgae bio-indicator, especially for mercury, would be of great utility in LIS. Differences in sediment and dissolved mercury concentrations in LIS coastal harbors provides an opportunity to assess the resultant spatial trends in macroalgae tissue mercury concentrations along this gradient. This study will examine the mercury sorption capacity of two common macroalgae across an east-west gradient in Long Island Sound, the brown alga *Fucus spiralis* (Flatwrack) and the red alga *Chondrus crispus* (Irish Moss). To our knowledge, this is the first systematic analysis of algae mercury concentrations in Long Island Sound. We propose to collect macroalgae (N=10 of each species) from the five Connecticut harbors spanning an East to West gradient in LIS. Freeze-dried algae tissue samples (0.100-

0.250 g) will be analyzed directly for mercury by thermal decomposition amalgamation and atomic absorption spectrophotometry using a Milestone DMA-80 direct mercury analyzer.

Results of this study will be critical in the systematic analysis of mercury concentrations in these two macroalgae species in Long Island Sound. Results of this study will also be useful in assessing the utility of these two common macroalgae species as bio-indicators of mercury pollution in estuarine waters.

Results to Date/Significance

Chondrus specimens were collected from six Connecticut embayments in November 2016 by Dr. Grace for analysis in this study. These specimens were prepared and analyzed for mercury in spring 2017. Results show that mercury concentrations in *Chondrus* varied and ranged from 10.6 ng/g in New Haven harbor to 21.3 ng/g in Groton. We are currently analyzing *Chondrus* tissues from herbarium mounted, archived specimens collected in past years (2000-2014) for comparison to recently collected *Chondrus* specimens. These analyses may provide an indication of temporal changes in *Chondrus* tissue mercury concentrations in Long Island Sound.