SEA Fellows Summer Science Symposium

August 7th, 2018 * University of Maine Darling Marine Center, Walpole, Maine

Welcome to the 3rd annual symposium! Darling Marine Center Director Dr. Heather Leslie and UMaine President Dr. Joan Ferrini-Mundy will open the symposium at 2 PM. Dr. Brian Beal, University of Maine at Machias professor and DEI Director of Research, will offer closing remarks at 4 PM. Waterfront tours are available at 4:05 PM, departing from Brooke Hall.

Session A (2:15 to 3 PM)

#	Presenter(s)	Title	Authors & Affiliations
1	Emma Newcomb	Classifying human harassment of seals in Maine state waters, 2013 to 2015	Emma Newcomb & Kristina Cammen, University of Maine

From 2013-2015, there were 1,100 marine mammal strandings reported in Maine, of which 166 involved human interaction with pinnipeds, as reported by the stranding networks Marine Mammals of Maine and Allied Whale. Human interaction is broadly classified as harassment, entanglement, boat strike, or shot. The harassment category is vague and often requires further classification. In this project, I evaluated human interaction cases from 2013-2015 in Maine to create a classification system for harassment. I analyzed the frequency of interactions for harbor, gray, and harp seals, and determined the types of interaction with each. I formulated and applied a classification system to these cases and determined harbor seal weanlings in southern Maine were most often harassed. The most frequent type of interaction was approach. By classifying human interaction and analyzing frequency, stranding networks gather information to educate the public of what to do during a stranding, and prevent future human interaction.

2	Isabella Grasso	Shellfish toxicity forecast in the Gulf of Maine using neural networks	Isabella Grasso, Southern Maine Community College; Nick Record, Bigelow Lab for Ocean Sciences; Steve Archer, Bigelow Lab for Ocean Sciences; Craig Burnell, Bigelow Lab for Ocean Sciences; Ben Tupper, Bigelow Lab for Ocean Sciences

Currently, there are no site-specific forecasts of paralytic shellfish poisoning outbreaks in Maine. Recent mechanistic models operate on larger time and geospatial scales. Given the impacts of paralytic shellfish poisoning and harmful algal blooms on Maine communities and the marine economy, site-specific forecasting tools could aid both harvesters and regulatory agencies. Neural networks is an extremely powerful predictive machine learning tool for complex dynamic systems such as ecosystems. We used the Keras neural network algorithm along with Maine Department of Marine Resources toxicity data to forecast paralytic shellfish poisoning outbreaks in coastal Maine. The predictions were made for each harvesting site and used four classification levels, the highest indicating a closure. The 2014-2016 data was used to predict 2017 outbreaks, which was then compared with the in known 2017 closures. We also conducted a variety of tests with various metrics and time frames to determine the predictive power of the neural network. The algorithm was predicting with 95.6% accuracy with zero false predictions at the closure level; the variability in predictive power was largely in the lower two levels of toxicity. The neural network outperformed simpler statistical methods, suggesting this algorithm is worth analyzing for other ecological forecasts.

3	David Gauld	Developing a methodology to assess embryonic and larval lobster heart response to thermal stress under a microscope	David Gauld, University of Maine; Alex Ascher, University of Maine; Carolyn Tepolt, Woods Hole Oceanographic Institution; & Richard Wahle, University of Maine

Temperature is a key driver of biological processes, but it is challenging to measure responses to controlled environmental change in individual micro-organisms under a microscope. In this study we developed a new methodology to study the heart rate of pre-larval, embryonic lobsters. Lobster eggs and larvae are relatively large and translucent, making it easy to view internal organs under a dissecting microscope. Using pre-larvae, not yet hatched from the embryonic membrane, we side-stepped the problem of immobilizing swimming larvae. Our on-stage flow-through system gave us a microscopic view of the embryonic heart while maintaining a continuous flow of well oxygenated, temperature-controlled, seawater over the embryo while remaining undisturbed on the microscope stage. We used an ocular-mounted video camera and TrackerTM video analysis software to measure changes in heart rate. Here we demonstrate a temperature ramping protocol to determine the heart failure temperature in the unhatched pre-larvae. This experimental setup and methodology can be widely used to assess the environmental determinants of larval performance in other marine and aquatic organisms.

4	Brianna Desoto	Field and laboratory trials of culture methods of the Atlantic razor clam (*Ensis leei*)	Brianna DeSoto, University of Maine; Brian Beal, University of Maine at Machias and Downeast Institute

Since 1990, soft-shell clam *(Mya arenaria*) landings in Maine have decreased by approximately 75%. Clammers now are beginning to harvest razor clams (*Ensis leei*), especially in the fall and winter, to supplement their livelihoods. We examined various methods to grow cultured razor clam juveniles successfully in the hatchery and field to encourage both public enhancement and farming enterprises. In the hatchery, sand can be cumbersome to work with, but using water flow or porous (reticulated) foam to provide the pressure against razor clam shells may be important to hatchery production. In the lab, effects of flow on survival and growth of clams (< 10 mm SL) was investigated in a downweller system without substrate. Animals in units receiving slow (12 L/min) vs. fast (6 L/min) flow rate had higher survival and growth rates, regardless of initial stocking density. In the field, interactive effects of sediment (present vs. absent) and reticulated foam (large vs. small pores) were tested on juvenile clam growth and survival in two habitats (benthic, intertidal; floating, subtidal) over 4 weeks. Juvenile clam survival averaged nearly 50% in intertidal trays both with and without sediment, but less than 25% in treatments with foam substrate. In floating trays, survival was highest in sediment (ca. 55%), and < 10% in the other treatments.

5	Jessica Lindsay	Alternative methods to growing razor clams: Reticulated foam vs. sediments as a substrate for razor clam growth and survival	Jessica Lindsay, Maine Maritime Academy; Brian Beal, University of Maine at Machias and Downeast Institute

Atlantic razor clams (*Ensis lee*i) are an intertidal and shallow subtidal benthic filter-feeder. This species has largely been ignored by aquaculturists and fishers, but due to recent declines in soft-shell clam landings in Maine, interest exists in new markets for razor clams. Our work focused on how best to produce them under hatchery conditions, and then grow the cultured juveniles in the field. We manipulated sediment substrate types and measured growth and survival of juveniles (< 10 mm in shell length) in both the field and laboratory. In the laboratory, clams grown in three types of reticulated foams with varying pore sizes were compared to treatments with and without sediment. Foam, in combination with predator exclusion netting, also was tested in the field to determine the interactive effects on razor clam survival and growth. In the hatchery, clam survival was best in sediment (ca. 45%), which was significantly higher than the control and three foam treatments that each yielded mean survival rates < 20%. Clams also grew faster in sediment than any other treatment. In the field, substrate (foam & sediment vs. sediment) did not have a significant effect on growth or survival; however, the effect of predator deterrence (netted vs. unnetted experimental units) on survival was highly significant ($P < 0.001$). No live clams were recovered in experimental units without netting. Survival rate in units protected from predators was about 16% over a 4-week period. Protected clams grew similarly across substrates.

6	Brynn Yarbrough	Warming Eggs: temperature effects on fish egg energy production	Brynn Yarbrough, University of Maine; Bradlyn McEttrick, University of Maine; Andrea Grossmann, John Bapst High School; Nishad Jayasundara, University of Maine

Aquatic organisms, including fish are often exposed to temperature changes in their environment. However, we know very little about thermal stress responses during fish embryo development. We focused on zebrafish *Danio rerio* to examine effects of temperature during embryonic development. We specifically focused on mitochondria, the energy producing organelles of cells, as they play a critical role in optimum embryo development. We exposed embryos to 28˚C, 32˚C and 36˚C at different stages of development. Following thermal exposure, we quantified their mitochondrial function based on a high-throughput assay. Post-stress heart rates and hatching rates were also quantified. Data showed little differences in heart rates and hatching rates across treatment groups. However, mitochondrial function was significantly compromised depending on the magnitude and duration of the thermal stress. These findings suggest that characterizing mitochondrial function may provide key insights into optimum growth conditions for fish and other aquatic species during early development.

7	Rebecca N. Lopez-Anido	The effects of ocean acidification on the hemolymph chemistry of subadult American lobsters	Rebecca N. Lopez-Anido, Wesleyan University; Amalia M. Harrington, University of Maine; Heather J. Hamlin, UMaine

Research investigating the direct effects of climate change on the American lobster (*Homarus americanus*) has grown rapidly as this economically influential species continues to make headlines. However, little is known about the sublethal effects of ocean acidification (OA) on subadult lobster physiology. We exposed subadult lobsters to either acidified or control conditions (pH of 7.6 or 8.0, respectively) for 65 days and analyzed hemolymph chemistry using commercially available assay kits. We found no significant effect of treatment on the concentrations of ecdysone (a molting hormone), calcium, or total protein content in lobster hemolymph. However, L-lactate levels were significantly higher in control versus acidified lobsters. Additionally, acidified lobsters had lower hemocyte counts than control lobsters, suggesting that OA may be immunosuppressive. These results suggest that exposure to acidified conditions alters some components of subadult lobster physiology, which may compromise their ability to adapt to a changing environment.

8	Olivia Joyce	Temporal variation in parasite dynamics of the European green crab	Olivia Joyce, Juli Silver, Cassandra Srauch, Megan Dunnock, Tyler Van Kirk, Emma Taccardi, Ian Bricknell, Katie O'Brien, Liza Gallan, all of University of Maine

The parasite Profilicollis botulus is an acanthocephalan worm that uses the European green crab, Carcinus maenas, as its intermediate host and the eider duck, Somateria mollissima, as the definitive host. *The green carb* is an invasive species in the Gulf of Maine and are fed on by the lobsters that support Maine's economy. Because of this concern, a survey was carried out look at the baseline infection dynamics. Green crabs were collected from June to August 2018 and processed for parasites. Earlier data has suggested variance among bioregions and between crabs of different color and sexes. The crab biometrics were recorded such as carapace width, chellae width, carapace color, teste weight, and sex of each crab to examine any differences in prevalence rates or intensity. The seasonal findings for 2018 will be presented and compared to previous years.

9	Dylan Schlichting	Mechanisms controling salinity structure in a broad, shallow, unsteady estuary	Dylan Schlichting, University of Maine; Robert Hetland, Texas A&M University

Estuarine salinity structure is primarily influenced by the input of freshwater and exchange flow at the mouth. Understanding processes influencing salinity structure has applications in estuarine management. The Regional Oceanic Modeling System (ROMS) was used to hindcast six years of salinity structure in Copano Bay: a broad, shallow, unsteady estuary along the Texas Gulf Coast. Salinity concentrations averaged between 5 g kg-1 and 40 g kg-1 during high and low river discharge events, respectively. When river discharge is high, it controls the salinity structure. Vertical stratification patterns up to 15 g kg-1 were common at the boundaries, despite an average depth of 2.7 m. During periods of low river discharge, the exchange flow is more important in controlling salinity structure. The mouth becomes less saline than the rest of the estuary as freshwater forcing decreases. Copano Bay is considered partially-mixed during periods of high river discharge and well-mixed otherwise.

10	Erynn Mills	Changes in lipid bioavailability of Sugar Kelp through degradation	Erynn Mills, Carrie J. Byron, Adrianus Both, all of University of New England

Detritus plays an important role in nutrient flow within ecosystems and is an untapped resource for the aquaculture industry. Additional research on detritus digestibility and nutrient content could improve how farmers utilize this resource for optimal shellfish production. To address the question "Does the bioavailability of lipids in kelp detritus change throughout degradation?" we are using chemicals found in digestive tracts to imitate the stomach of bivalves. We degraded sugar kelp into detritus for three weeks. The detritus was then placed with digestive chemicals for 15 hours, and analyzed for lipid content. Preliminary results suggest lipid dissolution does occur within the digestion cocktail; however, the methods still need refining. These results are important because many farms are limited by the availability of phytoplankton for bivalves to eat. Knowing the lipid content bioavailable from detritus for farmed bivalves helps us understand what food resources additional to phytoplankton are available to them.

Session B (3:15 to 4 PM)

Poster	Presenter	Title	Authors & Affiliations
11	Kim Kusminsky, Cassandra Leeman	Viability of lobster pounds as oyster aquaculture sites	Kim Kusminsky,Eckerd College; Cassandra Leeman, Eckerd College; Damian Brady, University of Maine

The oyster market has rapidly grown in the past decade, leading to a large increase in oyster aquaculture throughout Maine. However, most of this growth has occurred in the Damariscotta River, resulting in a need to identify new sites for the expanding industry. Lobster pounds, man-made structures along the coast of Maine, are sheltered and isolated during part of the tidal cycle, resulting in elevated water temperatures. It is well established that oysters thrive in environments with high temperature, salinity, and chlorophyll (Wallace, 2001). Eight weeks of growth measurements and surface temperatures were recorded from oysters grown inside and outside of a lobster pound in Bremen, Maine. Continuous measurements of biotic and abiotic factors were recorded in situ inside the pound by a multiparameter sonde. We will explore the influence of the pound on the environmental conditions conducive to oyster growth and determine if growth rates are indeed enhanced in these structures.

12	Aubrey Szoke	An assessment of trematode infection in farmed blue mussels	Aubrey Szoke, University of New England (UNE); Carrie Byron, UNE; Adam St. Gelais, UNE; Connor Jones, UNE

As part of a two-year long, ongoing histopathological survey, trematode presence in farmed blue mussels is being monitored using both PCR and histological methods. Genetic analysis of trematode infected mussels provides a means of confirming the hypothesized Northern migration of subtropical species *Proctoeces maculatus*. Determining when and where these parasitic flatworms are most likely to habit Maine's coast, regardless of the species, we can assist shellfish farmers in taking preventative measures against trematode infections.

13	Everett Pierce	Ensuring kelp is safe to eat - assessing the bacteria associated with kelp processed for human consumption	Everett Pierce, University of New England; Carrie Byron, UNE, Adam St. Gelais, UNE, Gretchen Grebe, University of Maine, Olivia Barberi, UNE

The commercial variant of kelp aquaculture is still in development, with many potential regulations still being tested, including aspects of food safety through both harvest and preparation. Our project is based upon the preparation aspect of this, with methods involving drying freshly harvested kelp, then rehydrating and testing this kelp for harmful bacteria such as *V. cholera and E. coli*. This project is an extension of previous works using similar methods, in which fresh kelp was immediately processed and compared with water samples from the harvest site. The previous projects discovered that kelp retains a hardy resistance to harmful bacteria, with the colony forming units of the surrounding water greatly exceeding those found on the kelp. I expect my project to yield similar results, with minimal bacteria found. The results of this project will further the potential accuracy of kelp aquaculture safety and regulation.

14	Michele Condon	Interannual analysis of reproduction and energy investment within a population of farmed Blue Mussels	Michele Condon, University of New England (UNE); Adam St. Gelais, UNE; Carrie Byron, UNE; Connor Jones, UNE

Blue mussel aquaculture is a growing industry in the Gulf of Maine. With a changing environment due to climate change, understanding the current health of these farmed blue mussel populations is helpful information. Through the use of histological techniques, the reproduction of the mussels was analyzed to help understand their health. This research gives an indication of when the mussels are most developed and when possible spawning events are occurring. This research also helps to explain when mussels are most vulnerable to environmental stress due to a higher investments in reproduction than storage tissues. All of this information can be used by farmers now to improve their practices and can be used in the future by farmers and scientists to explain changes in the health of the mussels.

15	Nicholas Houseman	Land-based inputs' contributions to estuarine resilience: a study of the drivers of buffering capacity in the Damariscotta River Estuary	Nick Houseman, University of Rhode Island; Kate Coupland, University of Maine; Damian Brady, UMaine

Total Alkalinity (TA) is often used to measure buffering capacity of a body of water. In the open ocean nearly all of the TA comes from carbonate species with organic material being nearly absent and therefore negligible part of alkalinity. However, in nearshore and estuarine environments there is Colored Dissolved Organic Matter (CDOM), that runs off from the terrestrial environment and can contribute to Alkalinity. CDOM tends to be higher in areas with more freshwater input, and also in watersheds that pass through heavily wooded areas. The goal of this study is to determine how much of the TA in the Damariscotta river estuary is contributed by the carbonate species and how much is contributed by CDOM, in order to better understand our estuary system and potentially predict how it might react to ocean acidification.

16	Dory Freeman	Vertical migration of diatoms in the Damariscotta River Estuary	Dory Freeman, Union College; Sean O'Neill; UMaine; Julia Mackin-McLaughlin, UMaine; Jeremy Rich, UMaine

The driving force behind diatom migration in marine sediments is poorly understood. Previous research indicates that migration of benthic diatoms follows rhythms of day:night light conditions. Our lab has found that subtidal benthic diatoms have high concentrations of intracellular nitrate, but why they have these high concentrations is not known. We hypothesize that diatoms migrate into the sediment anoxic boundary layer and perform nitrate reduction there. To test this hypothesis, I have designed an experiment for fine scale sampling of sediments (<1mm) to track diatom migration along oxygen gradients measured with oxygen microsensors. This will hopefully tell us whether or not diatoms are in fact migrating into the anoxic layer, as we hypothesize. This research aims to answer questions pertaining to the hypothesis that benthic diatoms conduct nitrate metabolism at the anoxic boundary layer, which could have large implications for understanding the nitrogen cycle in marine ecosystems.

17	Emma K Ober	Green crab population dynamics and fishery development	Emma Ober, College of the Atlantic; Marissa McMahan, Manomet; Rachel Lasley-Rasher, University of Southern Maine

The invasive European green crab came to the Gulf of Maine in the 1900s and quickly established a large and ever-growing population. This species is of particular concern as it threatens Maine's lucrative soft-shell clam industry and destroys ecologically important eelgrass beds and salt marshes. One possible mitigation strategy is the development of a green crab fishery. In Europe, softshell green crab is a delicacy, and a number of restaurants in Maine are beginning to experiment with including softshell green crab on their menu. To fully develop a softshell green crab fishery in Maine, ecological data is needed on the population, molt cycle, and pre-molt indicators so fishermen know how to best fish this species. This study collected population data on green crabs in the Damariscotta river and monitored premolt green crabs to observe molt indicators and quantify growth.

18	Josephine Roussell	Designing a cost-effective oyster sorter for small-scale growers	Josephine Roussell, UMaine; Joshua Stoll, UMaine and Maine Center for Coastal Fisheries; Heather Leslie, UMaine; John Belding, UMaine; Dana Morse, Maine Sea Grant and UMaine Cooperative Extension

Aquaculture serves as a major economic opportunity for coastal communities in the United States, providing the potential for fishermen to diversify their employment. Small-scale aquaculture businesses (400 - 1600 sq ft) are the fastest growing subset of aquaculture farms in Maine. In 2017, the Maine Department of Marine Resources issued more than 400 limited purpose aquaculture (LPA) permits to over 150 independent operators. For small-scale aquaculture businesses to be profitable in the long-term, there is a need for cost and scale appropriate tools that facilitates efficient operations. This equipment, however, largely does not exist. This poster highlights the design, development, and field-testing of a small, low-cost oyster sorter. If successful at increasing aquaculture farm operational efficiency, this equipment could be a key part of a larger suite of scale appropriate equipment for aquaculture start-up companies and small-scale farmers in the future.

19	Kaitlyn Raffier	Developing a data capture and sharing platform for Maine and ocean data	Kaitlyn Raffier & Heather Leslie, University of Maine

There are many reasons data are not managed, shared, or communicated effectively. These barriers can inhibit research, education and the application of knowledge. The goal of this project is to design a metadatabase (i.e., a database about data) that DMC-based scientists and students can use to manage and communicate about environmental and socioeconomic data collected at the DMC and in Maine coastal areas more broadly. We began by interviewing individuals with knowledge of DMC and Maine environment-related data. We then developed a survey to canvas a broader set of scientists and other data users regarding their willingness to share data and metadata and some potential attributes of those data. In parallel, we investigated current standards for managing metadata and datasets like those generated at the DMC. Next steps include continued collection of metadata and identification of a long-term, publicly accessible repository for DMC metadata.

20	Maggie MacMahon	Determining environmental conditions for successful oyster growth in the Damariscotta River Estuary	Maggie MacMahon, Maine Maritime Academy; Damian Brady, University of Maine; Struan Coleman, Dartmouth College

The Damariscotta River Estuary produces 73% of Maine's aquacultured American oyster, Crassostrea virginica (Maine DMR, 2016). Due to increasing demand, farm site selection is crucial for this expanding industry. Biogeochemical factors across sites play a significant role in the time required for oysters to reach market size. Temperature, salinity, chlorophyll, and other environmental drivers make the Damariscotta River Estuary an ideal location for successful growth. The goal of this project was to monitor the change in shell height weekly at two different sites to determine favorable factors for expedient growth. Bags of C. virginica spat were deployed at Mook Sea Farm and the Darling Marine Center. MSF is located on the upper Damariscotta and experiences warmer temperatures, while the DMC is located mid-estuary with lower temperatures. Growth will be compared to hourly temperature, salinity, chlorophyll, and turbidity monitored in situ with a CTD and Land Ocean Biogeochemical Observatory (LOBO) buoy.

21	Genevieve Wilson	Axial rod growth and age estimation of the sea pen Pennatula aculeata	Genevieve Wilson, University of Maine; Rhian Waller, UMaine; Richard Langton, NOAA and University of Maine

This project focuses on the age structure of sea pens, particularly *Pennatula aculeata*, a species found primarily in cold, deep-water environments. Using an isometric saw to cut the axis of each individual sea pen, samples can be observed for growth bands which can be related to the length of an individual in order to make estimates on the annual growth of *Pennatula aculeata*. Axial rod growth and age estimation of the sea pen can help us to make estimates on sea pen populations, which make up a large amount of mega faunal communities in the deep sea. Sea pen populations have also been recognized as nurseries for fish larvae, in particular the red fish (*Sebastes spp.*). An increase in anthropogenic activity has caused a global decline in numerous commercial fish populations and it is important for appropriate assessments to be made for fisheries management.

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