

PROCEEDINGS OF THE GREEN CRAB WORKING SUMMIT

JUNE 6-7, 2018, O'Maine Studios, Portland, Maine



Fishery and market development
to mitigate the impacts of an invasive species

Co-hosted by Manomet and New Hampshire Sea Grant

Steering Committee:

Dr. Marissa McMahan (Co-lead, Manomet)
Dr. Gabriela Bradt (Co-lead, NH Sea Grant and UNH Cooperative extension)
Mary Parks (Green Crab R&D Project)
Roger Warner (Green Crab R&D Project)

<https://www.manomet.org/green-crab-summit-proceedings/>

Session One: Population Monitoring and Ecological Impacts

Understanding Green Crab Population Dynamics: Results of Systematic Green Crab Trapping in Freeport

Brian Beal, University of Maine Machias/Downeast Institute, presented results from a systematic study in the Harraseeket River. The results revealed a connection between crab abundance and warming ocean water as crab densities increased with water temperatures through summer and fall. Larger crabs were also observed in the warmer months. The results also indicate that green crab population control is impractical in open systems and green crabs should be approached as permanent inhabitants of the marine coastal environment.

Abstract: In 2014 and 2015 the Downeast Institute conducted systematic green crab trapping at 10-12 locations in the Harraseeket River — a highly productive clamming area — from May 1 through September/October. Researchers hauled 0-60 specially designed green crab traps three times a week (2014) or every 4 days (2015). The crabs that were caught were counted and measured to determine spatial and temporal variability in abundance, size-frequency distribution, sex ratios, best trap soak times, and bait preferences. DEI's trapping program followed a volunteer trapping initiative by the Freeport Shellfish Conservation Commission in 2013, and these results combined with the 2014 and 2015 trapping data show the connection to warming ocean water as crab densities increased with water temperature through the summer and fall, especially in the intertidal zone, and crabs were bigger after warmer vs. colder winters. Results indicate that it is not possible to reduce green crab populations locally through trapping in open systems, including rivers, and that green crabs should be thought of as part of the permanent inhabitants of the marine coastal environment.

Presentation Link: Contact mmcmahan@manomet.org

Green Crabs and Soft-Shell Clams: Results from Large-Scale Field Studies Examining Measures to Mitigate Predator Effects on Clam Survival and Growth

Sara Randall, Downeast Institute, focused on the results from a large-scale field study that examined measures to mitigate predator effects on clam survival and growth. Major findings in this study revealed that predation is the single most important factor regulating soft-shell clam populations and that 99% of settling clams are lost to predators.

Abstract: In the past decade soft-shell clam, *Mya arenaria*, landings in Casco Bay communities have declined dramatically by nearly 70%. To determine the cause of the clam decline, from 2014-2017 the Downeast Institute, in collaboration with the Maine Clammers Association, conducted the largest intertidal field research project in the history of the state. Experiments were conducted at 78 field sites, with 2 years of green crab trapping, and the operation of 2 large upwellers to produce soft-shell clams for the experiments. The effort tested the effectiveness of different methods to protect shellfish from green crabs and other predators. At the end of the field season for each experiment, clam survival and growth were measured. Major findings showed that predation is the most important factor regulating soft-shell clam populations and up to 99% of settling clams are being lost to clam predators from flats each year.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/08/Randall_900_session1.pdf

Measuring Impacts of Invasive European Green Crabs on Maine Salt Marshes: A Novel Approach

Jeremy Miller, Wells National Estuarine Research Reserve, showed that environmental data collected from different sites inferred crab numbers may be related to water temperature and dissolved oxygen signals. The results also suggest that marsh creek banks impacted by crab burrowing were more susceptible to erosion than vegetated creek banks.

Abstract: Invasive European green crab (*Carcinus maenas*) populations have exploded state-wide and threaten Maine's valuable coastal resources, including soft-shell clam flats, sub-tidal eel grass beds, and salt marshes. Recent studies indicate that intertidal crabs contribute to substantial changes in marsh morphology, including plant dieback, erosion, and marsh loss through foraging and burrowing activities. We carried out a two-year (2014-2015) sampling effort to examine green crab abundance in salt marshes at three locations, Damariscotta, Yarmouth, and Wells, using fyke nets and modified baited eel traps. Concurrent sampling in June and August revealed much greater green crab activity in the tidal channel compared to the marsh surface. Crab densities in the marsh ranged from 0-0.5 crabs/m² with greater densities observed during the day for most sites and the lowest densities at Yarmouth. Trapping data from the summer revealed that Yarmouth had fewer crabs (0.2-3.0 crabs/hour) compared to Damariscotta (24-30 crabs/hour) or Wells (26-46 crabs/hour). The greatest sampling event to-date was at Wells in August 2014, where 1,110 crabs were captured in one 24 hour period. We also investigated green crab impact to these marshes by measuring marsh stability through replicate shear vane torque measurements along marsh creek banks and including CT scans of geologic cores which revealed clear images of crab burrows and the absence of live coarse roots and rhizomes in impacted samples. Our measurements also suggest that marsh creek banks impacted by crab borrowing were more susceptible to erosion than vegetated creek banks. We are currently working with a local commercial green crab fisherman in Wells, Maine to access crab reproduction on a seasonal basis within the estuary, as well as differences in gear type, effects of water temperature, and the presence and timing of gravid females

Presentation Link: Contact mmcmahan@manomet.org

Coastal Restoration in Nova Scotia: Resilience to an Invasive Species

Gabrielle Beaulieu, Kejimikujik National Park Seaside Parks Canada, presented results of the observed success of a coastal restoration project conducted in Nova Scotia at Kejimikujik National Park Seaside over the last 10 years. Over 2 million green crabs were trapped and removed from Little Port Joli estuary resulting in a 38% increase in eel grass beds and a positive increase in soft-shell clam populations.

Abstract: Parks Canada Conservation and Restoration program mandate is to achieve measurable conservation gains in a manner that engages and benefits society through effective and enduring restoration of ecological integrity, recovery of species at risk and enhancement of marine environments. Kejimikujik National Park Seaside (KNPS) protects the single most significant amount of undeveloped sandy shore, dunes, estuaries and mudflats in Nova Scotia, Canada. We present the challenges and successes of a Conservation and Restoration project at KNPS which controls green crab impacts through intensive trapping as a means of restoring ecological health to a coastal estuary. We chose green crab relative abundance, eelgrass distribution, and soft shell clam size-class distribution as measures of ecological integrity and thresholds were established as ecosystem recovery targets. Over the last ten years, staff and volunteers with little previous trapping experience have removed over 2 million green crabs from this remote estuary, with minimal operational footprint (no motorized watercraft or permanent infrastructure) and no significant incidental mortality to native by-catch. Once recovery

targets were reached, positive responses from eelgrass and soft shell clam populations were observed. This project has since served as a case-study for conservation groups nationally and internationally who are challenged by similar marine invasive species, and has provided unique opportunities for public and industry engagement in affecting meaningful and innovative coastal recovery action.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/08/GreenCrabSummit_2018_Beaulieu.pdf

Attributes of the European Green Crab (*Carcinus maenas*), a Nonindigenous Species in Massachusetts, USA

Jimmy Elliot, University of Maine Orono, described the results of multiple studies pertaining to green crab attributes. Some major findings within these studies included an observable increase in juvenile green crab hormone levels as the color on the ventral carapace changed from the green to red. Also, a yellow-phase category is proposed as a distinct intermediate between red and green phases due to the differences in size and physiology.

Abstract: A synopsis of multiple green crab (*Carcinus maenas*) related studies are presented. The population of the nonindigenous green crab in Salem Sound, Massachusetts, USA, was studied over a three-year period from July 2013 through June 2016 using baited traps deployed monthly at five sites. Seasonal catch per unit effort, sex, size, and color were determined and the role of habitat variables, including temperature, salinity, water depth, and substrate, were evaluated. Seasonal catch per unit effort was highest in the fall (October-December), followed by summer (July-September), spring (April-June) and winter (January-March). Few crabs were captured when water temperature dropped below 5 °C. Crabs captured at sites with very fine sand were larger than those captured on other sediment types. Females comprised 73% of the total catch of 7,822 crabs. Only 57 individuals exceeded 70 mm carapace width. Females were larger (mean = 51.7 mm) than males (mean = 48.8 mm). Green-phase crabs comprised 56.8% and red-phase crabs 43.2% of the catch. Green-phase crabs were significantly smaller (mean = 48.1 mm) than red-phase crabs (mean = 53.6 mm). Red-phase females were most common in the spring and green-phase in the fall, whereas red-phase males were most common in the spring and fall and green-phase in the summer. Merits of various types of traps and of bait were also evaluated based on different trapping requirements and goals. Additionally, a study was conducted in which crabs were kept in controlled conditions to observe the relationship between molting, hormone levels and color on the ventral carapace. Juvenile hormone levels were observed to increase as the color on the ventral carapace progressed from the green to red phase. A yellow-phase category is proposed as a distinct intermediate between red and green phases due to differences in size and physiology. This is the first investigation of multiple aspects of a population of *C. maenas* in Massachusetts. The findings should prove useful for researchers, as well as for commercial crab fishers or others trapping green crabs for bait. Future research directions will also be presented, involving habitat suitability modeling to reinforce our understanding of *C. maenas* behavior in New England.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/07/Elliott_1000_Session1_PDF-for-public.pdf

Interaction between Carcinus and Hemigrapsus

Christopher Baillie, Marine Science Center, Northeastern University, presented results found from a study conducted on the interactions between the green crab and the Asian shore crab. The results indicated that when green crab recruits are abundant their densities may be limited by predation or displacement of the Asian shore crab. Conversely, when Asian shore crab recruits are abundant, predation by larger conspecifics may regulate their densities.

Abstract: As ecosystems are increasingly inhabited by multiple invasive species, interactions among exotic species have the potential to negatively impact native communities and habitats. In rocky intertidal and shallow subtidal habitats along southern New England, the recently introduced Asian shore crab, *Hemigrapsus sanguineus*, has been implicated in the displacement of the more established invasive European green crab, *Carcinus maenas*. Using both faunal surveys and manipulative experiments, we investigated how densities of *C. maenas* have changed as *H. sanguineus* populations have become established and whether *H. sanguineus* is also displacing *C. maenas* in the Gulf of Maine. By comparing our faunal sampling data with published densities from both pre- and early post-*H. sanguineus* invasion timepoints, we found that *C. maenas* densities in the low intertidal have declined by nearly ~90% compared to their pre-invasion densities. Furthermore, compared to early-post invasion densities, the compared to their pre-invasion densities. Furthermore, compared to early-post invasion densities, the average density of *C. maenas* has decreased by ~66% concurrent with 23-fold increases in *H. sanguineus* densities. Results from our manipulative experiments provide insights into the potential mechanisms behind this replacement. Specifically, our results indicate that when newly recruited *C. maenas* are abundance, their densities may be limited by predation or displacement by *H. sanguineus* adults and juveniles. Conversely, when *H. sanguineus* recruits are highly abundant, predation by larger conspecifics may regulate their densities. Cumulatively, our work suggests that the pattern of *C. maenas* displacement from rocky intertidal habitats observed in studies from Southern New England has continued as *H. sanguineus* populations have expanded northwards, which, given their high abundances, could result in greater disturbance to native communities.

Presentation link: https://www.manomet.org/wp-content/uploads/2018/08/Baillie_1015_Session2.pdf

Session Two: Green Crab Products

Food Chain

Roger Warner, Green Crab R & D Project, discussed green crab's flavor adding properties and the potential for use in gourmet food recipes. Roger also discussed the need to help the green crab's natural predators, specifically striped bass. He proposed that outlawing commercial striper fishing may increase the natural predation on the green crab by increasing numbers of stripers; in turn, leading to a rebound of clam and mussel populations.

Abstract: The vast majority of commercially-trapped green crabs are sold for bait, especially for tautog south of Cape Cod. But the bait business is high-volume, labor-intensive, low-margin, and uncertain due to state regulations. The question is, can profitable markets be developed to use green crabs as food for human consumption? We take a quick look at the crabs' umami or flavor-adding properties, and then at

the four main kinds of gourmet food recipe categories – stock or broth, soft-shell crabs, recipes derived from roe or crab eggs, and crab mince for crabcakes. For each category there are opportunities for higher-volume production but also obstacles that will need to be overcome. Finally, we consider the bigger question: Can the bait trade plus the use of crabs for human food reduce the crab population enough to make a significant difference ecologically? Maybe not! We look at a theoretical model for the island of Nantucket, at the use of crabs as fertilizer generally, and at the concept of “integrated pest management” with a particular eye on protecting indigenous fish species that prey on crabs, such as striped bass.

Presentation link: <https://www.manomet.org/wp-content/uploads/2018/08/Food-Chain.Warner-presentation.pdf>

The use of green crab extract as a food supplement, and as Bait, for commercially important invertebrates

Steven Jury, Biology Department, Saint Joseph’s College, talked about the benefit of feeding horseshoe crabs that have been bled for biomedical purposes, a nutritional supplement made partially from green crab extract. It was found that feeding them the supplement helped the horseshoe crabs rebound faster from the bleeding procedure, both behaviorally and physiologically. He also spoke about the potential for using green crabs as bait for various commercial fishing industries.

Abstract: We have tested green crab “extract” as a nutritional supplement to help horseshoe crabs, *Limulus polyphemus*, to recover from the biomedical bleeding process, as well as an ingredient in alternative baits for the lobster (*Homarus americanus*) and channeled whelk (*Busycotypus canaliculatus*) fisheries. Each year thousands of horseshoe crabs have 30% of their blood extracted and then LAL is extracted for use by the biomedical industry. There is a 10-30% mortality rate from this process, as well as some sublethal behavioral and physiological impacts, due, in part, to a large drop in the concentration of hemocyanin, their respiratory pigment, in their blood. We found that feeding them a food supplement, made in part from green crab extract, helped them rebound faster from the bleeding procedure, both physiologically and behaviorally. In the two other ongoing studies, we created alternative baits using green crab extracts as an ingredient and tested them in the field and the laboratory. Both whelks and lobsters were attracted to the bait in the laboratory, but while catch of lobsters was comparable to traditional baits, catch of whelks in the field was not as high. Our long-term goal is to demonstrate that green crabs have multiple uses and thus encourage fishermen to capture them and use them for alternative products. This approach may reduce the abundance of this invasive species, and provide an alternative to other species, such as horseshoe crabs and herring, for bait, and help maintain a healthy population of horseshoe crabs for biomedical uses.

Presentation Link: NA

Green Crab Uni Extraction: Maintaining the true form

Jamie Bassett, Green Crab Nation, spoke about the potential for green crab in the high-end culinary and specialty market, specifically utilizing the uni-like roe in sushi dishes. His presentation included a live roe extraction demonstration.

Abstract: As a large volume supplier of green crab, Green Crab Nation is committed to creating and strengthening global demand for Green Crab product for the high-end culinary and specialty markets.

Whether it be Soft Shell Green Crab, She Crab Soup Stock, Italian Manzanetta over Pasta, Asian Ganjang Gejang, or Sushi Grade Green Crab Uni, this unique seafood catch is finding its way onto plates around the world and Top Chefs, who are forever searching for a breakthrough and distinguishing product or ingredient, they are beginning to take notice. Today Green Crab Nation will demonstrate how to extract green crab uni roe from the crab carapace with the goal of having the uni roe maintain the actual true form of the crab shell. While a bit labor intensive, successful extraction and presentation produces a beautiful and elegantly formed end product that is well worth the effort, sure to please the most discerning and sophisticated sushi clientele. It is an artistic, flavorful, and impressive addition to any shop's menu. Normal appetizer serving size is approximately 6-8 pieces with each piece ranging in size from approximately nickel sized to quarter sized, weight in grams varies. Restaurant plate pricing is subject to market demand.

Presentation: visit <https://www.greencrabnation.com/>

Bait to Delicacy: Navigating and Redefining the Green Crab Market

Mary Parks, Green Crab R & D Project, spoke about the need to redefine and differentiate the green crab market as one of a culinary market versus a bait trade market. She also spoke about the challenge of connecting fishermen and wholesalers.

Abstract: The green crab was introduced to the Eastern United States in mid-1800s and has become one of the most destructive and widely spread invasive species of all time. In an effort to mitigate the green crab's catastrophic invasion, many environmental groups have poured assets into removal efforts, using harvested crab for compost or promoting a seasonal bait trade. The Green Crab R&D Project is a small nonprofit that has taken a different approach. The project aims to develop a culinary market for the invasive crab as a means to mitigate their destructive impact while providing a viable food source. Artisanal markets for the crab exist in Venice, Italy and other regions containing native populations. These established markets provide an excellent foundation for culinary market development in the Eastern United States. In Venice, there are established seasons for harvesting soft shell green crabs and green crab roe, known as Mazanetta. The Green Crab R&D Project aims to merge artisanal Venetian techniques with modern aquaculture technology while simultaneously developing a better understanding of the ecological and biological differences between native and invasive populations. However, the lack of an existing culinary market, current affiliation with the bait trade, and overall inconsistency with supply and demand have proved challenging. By working with fishermen, wholesalers, processors, and food vendors to differentiate food grade green crab processing and supply from the bait trade, the Green Crab R&D Project hopes to seed the development of an invasive, culinary fishery. Future initiatives include outreach, sampling events, caviar and soft-shell processing development and wholesale pilot studies with university based consumers and local chefs.

Presentation Link: Contact mmcmahan@manomet.org

Toward Full Utilization of the Green Crab Biomass: Food and Feed Ingredients

Denise Skonberg, University of Maine, spoke about several projects being conducted and tested to utilize green crabs as food and feed ingredients.

Abstract: The invasive European Green Crab (*Carcinus maenas*) has become an important predator along the New England coast, contributing to a decline in the soft shell clam fishery and damaging important ecosystems. Green crabs have not been targeted by the crab picking industry because of their

small size and low meat yield. However, their abundance, relative ease of capture, and the compelling motivation to reduce their populations, make them a potential resource for a commercial fishery. At the University of Maine, multiple avenues of research have been underway to examine the feasibility of producing various food and feed ingredients from the harvested green crab biomass. Potential products include crab meat mince for incorporation in seafood recipes, functional isolated proteins for the formulated food industry, crab meals for animal feeds, carotenoid pigments for salmon aquaculture, and bioactive ingredients for nutraceuticals. This presentation will give an overview of ongoing research and will emphasize the need for full utilization of the green crab resource through the generation of multiple product streams.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/08/Skonberg_130_Session-2.pdf

Potential Health Benefits of Green Crab Peptides Produced with Commercial Enzymes

Bouhee Kang, University of Maine, spoke about the potential health benefits of green crab peptides produced with commercial enzymes. Results indicate that the peptides found in green crabs have antioxidant activity and the potential to aid in the control of blood glucose levels. Addition of green crab peptides added to food products could be utilized as a health promoting ingredient.

Abstract: Invasive green crabs (*Carcinus maenas*) have negatively affected economically important marine resources and marine habitats in the U.S. However, despite the fact that green crabs contain essential amino acids, healthful fatty acids, and minerals, they have been hardly commercialized by the food industry due to their small size. Our primary aim is to develop health-promoting food ingredients from underutilized green crabs. This study was designed to evaluate the antioxidant and anti-diabetic effects of green crab protein derivatives (peptides). Enzymatic digestion (hydrolysis) of proteins is an effective method to obtain peptides that have health benefits. In order to collect peptides, mechanically separated crab mince was hydrolyzed with commercially available enzymes; Alcalase, Protamex and a Combination of both enzymes. Then, the extent of digestion and level of antioxidant activity were determined. The anti-diabetic effects of peptides also were evaluated by several methods. During hydrolysis, protein was digested similarly over time among Alcalase, Protamex, and Combination treated samples. Preliminary results indicate that Protamex treated samples had the highest antioxidant activity. Similarly, anti-diabetic effects were highest in Protamex treated samples. Results indicate that these peptides have antioxidant activity and the potential to aid in the control of blood glucose levels and that enzyme type affects these bioactivities significantly. Also, our study suggests that green crab peptides could be applied in food products or dietary supplements as a potential health-promoting ingredient. Further research will be conducted to evaluate whether the health benefits of these peptides are changed during an in vitro simulation of human digestion.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/08/Kang_145_Session2.pdf

Session Three: Soft-shell Crab

Soft-shell green crab production: adapting traditional Venetian production techniques

Jonathan Taggart spoke about soft-shell green crab production and adapting traditional Venetian production techniques.

Abstract: Soft-shell green crabs have been produced for hundreds of years in the Venetian Lagoon. Deep-fried, they are a rare delicacy that has been reserved for Venetians, or for those who know to ask if they are available at select restaurants. The art of the Venetian fishermen is their ability to recognize the signs of a crab that is 2-3 weeks away from molting. These crabs are held and checked regularly leading up to the molting event. Though there is a slight difference between the crab in the Venetian Lagoon and the crab on the east coast of the United States, the difference is insignificant for our purposes. Working with, and studying from Venetian fishermen, techniques, equipment, and methods were adapted to utilize existing fishing gear and to conform to laws and regulations in Maine. Abandoned shrimp traps and eel traps were modified and repurposed for green crab fishing, in place of the traditional Venetian fyke net. Lobster crates with inserts made from oyster bags were used for holding crabs until they molted, in place of the traditional Venetian handmade Live Well. Working with a team of volunteer fishermen, researchers, and citizen scientists, we produced soft-shell green crabs in sufficient quantities to supply restaurants in the summer of 2017, and to evaluate their flavor and appeal to the dining public.

Presentation Link: [Part 1](#), [Part 2](#), [Part 3](#)

Investigating the viability of a soft-shell green crab industry in New England

Marissa McMahan, Manomet, discussed ongoing research pertaining to the viability of a soft-shell green crab industry in New England.

Abstract: The European green crab (*Carcinus maenas*) is a harmful invasive species that has been linked to the decline of the soft-shell clam industry in New England, as well as the degradation and loss of critical eelgrass and salt marsh habitat. Compounding these issues is the link between increasing green crab abundance and increasing ocean temperature, which has had severe ecological and socio-economic consequences in areas such as the GOM, where warming is occurring faster than 99% of the world's oceans. Developing a lucrative green crab fishery may be a viable way to control population abundance and derive value from this invasive species. We are investigating the adaptation of techniques from the Venetian soft-shell crab fishery, which targets a closely related species, the native Mediterranean green crab (*Carcinus aestuarii*). In 2017, we successfully learned to identify pre-molt green crabs and produce soft-shell (i.e., newly molted) product. During restaurant trials, chefs and consumers responded positively, comparing the flavor and quality of the product to soft-shell blue crabs. As a featured menu item, soft-shell green crabs were priced at roughly \$40/lb, and sold out immediately. We have also established long-term monitoring sites in several areas of midcoast Maine, and preliminary results indicate synchronized spring molting in male crabs. Ongoing research aims to increase production of soft-shell crabs, as well as determine the economic viability of this fishery.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/08/McMahan_300_Session3.pdf

Determining peak molting periods for European green crabs in New Hampshire

Gabriela Bradt, NH Sea Grant, UNH Cooperative Extension, spoke about her work in determining the peak molting periods of green crabs in New Hampshire and results obtained.

Abstract: As a result of investigations into the development of a fishery and of soft-shell green crab markets as a mechanism for controlling these out of control invasive crustaceans in New England, determination of peak molting periods for green crabs is crucial. Knowing when green crabs molt in large numbers will help streamline potential fishery efforts. Preliminary studies of male and female crabs indicate that male and female crabs have two separate and distinct molting peaks which could have significant implications for a successful fishery and consistent supply for markets. 2017 data for male crabs caught in Hampton-Seabrook estuary between June 1 and July 15th suggested that peak molt for these crabs was between the last week in June and the first week in July and optimal salinity and temperature ranges were 18-21°C and 22-27 ppt. Female crabs caught in Hampton-Seabrook estuary between July 26th and Sept 3rd, had peak molting period throughout the month of August into the first week of September with optimal temperature and salinity ranges of 18-24°C and 27-30 ppt.

Presentation Link: <https://www.manomet.org/wp-content/uploads/2018/08/GCWS-Talk-Bradt.pdf>

Soft-Shell Green Crab in Prince Edward Island: New Strategies and Techniques

Luke Poirier, Fisheries and Oceans Canada, presented results from several studies conducted in Prince Edward Island investigating molting rates and pre-molt indicators. He also spoke about the future potential of utilizing fyke nets for green crab fisheries.

Abstract: One of the world's most successful marine invaders, the European green crab (*Carcinus maenas*), continues to spread and invade the coastlines of Atlantic Canada. In Prince Edward Island, populations have continued to expand since the late 1990s. There is a distinct need to document this species' expansion into new habitats, to monitor its impacts on important native species, and to develop innovative mitigation strategies to control some of its effects. With the recent implementation of a fishery for green crab as a potential mitigation strategy, there is a need for a marketable product to prompt fishermen to harvest green crabs. A soft-shell green crab product modelled after the Venetian "moleche" is expected to provide a lucrative incentive beyond the existing hard-shell bait market. The examination of the timing and characteristics of molting revealed that synchronized "molting windows" or times of increased molting occur in the early summer for male green crabs. Recorded molting rates in the laboratory and the field were as high as 75% and 60%, respectively. External physical characteristics such as the presence of a "halo" on the episternites of the carapace, were deemed a reliable indicator that a crab would molt within 3 weeks. Although these results were preliminary in nature, they were promising and suggested that further studies be performed on the potential scaling up of these results. Fyke nets are a natural choice for a directed fishery of green crabs, as this type of gear is readily available and used locally, primarily for American eel (*Anguilla rostrata*). These nets are also a variant of the fyke net used in Italy to fish for a similar species of crab (*Carcinus aestuarii*) during its molting season. However, before fyke nets can be used in a directed fishery for green crab in Atlantic Canada, bycatch must be reduced. A novel Bycatch Reduction Device (BRD) for fyke nets was therefore developed and evaluated. Bycatch numbers and diversity, including three key commercial species, were significantly lower in the BRD equipped nets. Overall, these results advanced green crab research in the region, especially with regards to the development of mitigation measures.

Presentation Link: https://www.manomet.org/wp-content/uploads/2018/08/Poirier_330_Session3.pdf

Poster Session

Green invaders: Early-life stages of the European green crab in a southern Maine estuary.

Blair Morrison and Jason Goldstein, Wells National Estuarine Research Reserve

Using Green Crab to Produce Nutritious Dog Treats.

Angela Myracle and Anna Smestad, University of Maine

Population Trend of the Invasive Green Crab in Great Marsh, Massachusetts.

Alyssa Novak, Boston University and Peter Phippen, Massachusetts Bays National Estuary Program

Using Citizen Science to determine hotspots and distribution of European Green Crabs in New Hampshire.

Gabriela Bradt, NH Sea Grant, UNH Cooperative Extension

Green crab culinary uses.

Marissa McMahan, Manomet

Green crab outreach and education.

Marissa McMahan, Manomet

Breakout Groups

Monitoring protocols/mitigation methods

Session Leads: Marissa McMahan and Gabriela Bradt

Participants: Carrie Culver (CA Sea Grant), Sarah Kirn (GMRI), Emily Molden (Nantucket Land Council), Anita Wray (Colorado College), Nicole Twohig (Quahog Bay Conservancy), Erika Ferrelli (USM and Manomet), Meggie Harvey (GMRI), Brian Beal (UMM and DEI), Ashley Taylor (MDI Biological Laboratory), Denis-Marc Nault (ME DMR).

Topics:

- Streamlining data collection for easy data sharing (share protocols)
- Site selection
- Incorporating Northeast Coastal Stations Alliance (NeCSA)
- Tagging/movement studies
- Who are end users of data
- Engage fishers and public in data collection
- What has already been done and by whom
- Create repository of shared temperature and field data
- Utilize technology

Transitioning from bait fishery to culinary industry

Session Lead: Mary Parks

Participants: Dana Morse (ME Sea Grant/CE), Kate Masury (Eating With the Ecosystem), Nelle D'Aversa (NY Dept. of Environmental Conservation)

Topics:

- Use restaurants to reach local consumers
- Product development—create things people want to eat
- Consistent, compelling narrative—why it's good to eat green crabs

Culinary group

Session Lead: Ali Waks-Adams

Participants: Colles Stowell (One Fish Foundation), Thanh Huibers (Green Crab Café), Dana Morse (ME Sea Grant), Marissa McMahan (Manomet), Robert Russell (ME DMR)

Topics:

- Potential for fermented crab is massive
- Roe market has good potential
- Free crab program
- National trade shows
- Use social media to highlight new dishes
- Compelling narrative for eating green crab
- Try to reach celebrity chefs

Outreach, education and citizen science

Session lead: Gabriela Bradt

Participants: Carrie Culver (CA Sea Grant), Sara Randall (DEI), Ashley Taylor (MDI Biological Laboratory), Meggie Harvey (GMRI), Sara Kirn (GMRI)

Topics:

- Standardize data collection methodologies
- Recruit and retain citizen science volunteers
- Develop communication tools
- Create a green crab festival to raise awareness, share results, recruit volunteers

Pre-molt crab identification and obstacles to soft-shell fishery development

Session lead: Jonathan Taggart

Participants: Zachary Whitener (GMRI), Gabrielle Beaulieu (Parks Canada), Luke Poirier (UPEI), Roger Warner (Green Crab R&D), Scott Jeffrey (Dalhousie), Thanh Huibers (Green Crab Café), Brian Beal (UMM and DEI)

Topics:

- Venetian fishery methods
- Individual housing display/trap display
- Pre-molt indicators
- Soft-shell production
- Marketing

Roe extraction demo

Session lead: Jamie Bassett

Participants: Zachary Whitener (GMRI), Gabrielle Beaulieu (Parks Canada), Luke Poirier (UPEI), Roger Warner (Green Crab R&D), Scott Jeffrey (Dalhousie), Thanh Huibers (Green Crab Café), Brian Beal (UMM and DEI)

Student Presentation

West Bath Elementary School

- Summary of research on green crabs
- Mock interview of Maine industry members impacted by green crabs
- Sharing of green crab information/recipe cards
- Green crab trivia

Panel discussions:

Panel 1: Population monitoring and ecological impacts

Panelists: Brian Beal, Sara Randall, Jeremy Miller, Gabrielle Beaulieu, Jimmy Elliot, Chris Baillie

Panel 2: Green Crab Products

Panelists: Roger Warner, Steve Jury, Jamie Bassett, Mary Parks, Denise Skonberg, Bouhee Kang

Panel 3: Soft-shell Crab

Panelists: Jonathan Taggart, Marissa McMahan, Gabby Bradt, Luke Poirier, Robert Russell

Cooking Demonstrations

Green Crab Rangoon & Popcorn Green Crab

Ali Waks-Adams, owner of Butter and Salt Pop Up and the executive chef at the Brunswick Inn, Brunswick, Maine

Video & Recipe: https://www.youtube.com/watch?time_continue=37&v=vLJQ8EX78Z0

Green Crab Pozole & Green Crab Arancini

Matt Louis, owner of Moxy and the Franklin Oyster House in Portsmouth, NH and Chris Hayes, chef de cuisine

Video & Recipe: <https://www.youtube.com/watch?v=x-WAOe44VW0>

*For photos, videos, and other details visit: [Green Crab Summit Proceeding Page](#)