POSTER PRESENTATION

ABSTRACTS
Aquaculture

P1-LOBSTER GROWER: EXPLORING MARICULTURE OF HATCHERY EUROPEAN LOBSTERS FOR FISHERIES AND AQUACULTURE

Charlie Ellis (charlie.ellis@nationallobsterhatchery.co.uk), Jacob W.S. Scolding, Carly L. Daniels
National Lobster Hatchery, UK

Hatchery-reared European lobsters (*Homarus gammarus*) have shown promising growth and survival when on-grown through post-planktonic life stages in oyster spat baskets in the sea. Building on these encouraging trials, a collaborative UK project – Lobster Grower – has designed a novel sea-based rearing container to overcome impracticalities of the oyster system, and is now testing both designs on a semi-intensive scale at an offshore shellfish farm. During 2016, over 13,000 juveniles have been deployed into containers and 900 animals reared in hatchery aquaria facilities as controls, with similar deployments scheduled for 2017 and 2018. Through a combination of biological, ecological, histological, pathological, environmental and oceanographic monitoring, the project is collecting an array of data relevant to the upscaling and optimization of clawed lobster mariculture, including information on semi-wild *H. gammarus* throughout life stages which remain largely unstudied in nature. A number of practical aspects associated with operation are also under consideration, including juvenile life stage at deployment, container depth and position, loading and handling processes, deployment time and season, mooring mechanism, the characterization of settlement community and juvenile diet, and economic factors. Preliminary results suggest that early juvenile growth rates are comparable in both sea-based containers, and surpass those of hatchery controls. The novel container design has yielded survival across the first 50 days post-deployment that far exceeds that among hatchery controls (83% vs 56%), with comparable survival across the following 50 days (98% vs 100%). Lobster Grower research is laying the foundations for semi-intensive culture of juvenile lobsters at sea. The lack of supplemental feeds and effects of this enriched environment on lobster development suggest that the method has considerable potential for (i) cost-effective and ecologically-conditioned on-growing to improve the effectiveness of releases enhancing capture fisheries, and (ii) the advent of sustainable aquaculture of this prized seafood species.

P2-GROWTH OF LOBSTERS *PANULIRUS INFLATUS* AND *P. GRACILIS* POSTLARVAE CULTURED IN OYSTER BOXES AT SOUTHEAST GULF OF CALIFORNIA

Raúl Pérez González (raulp@uas.edu.mx), Jesús Audomar Landeros Armenta, Luis Miguel Valadez Manzano, Martín Ignacio Borrego, Guillermo Roíguez Domínguez
Universidad Autónoma de Sinaloa, México

The growth of lobsters *Panulirus inflatus* and *P. gracilis* postlarvae cultured in oyster boxes was determined using postlarvae collected in the southeast of the Gulf of California, using Sandwich-type manifolds for later stocking into growth modules (oyster boxes). Measurements of cephalotorax length (CL) and weight (TW) were performed. The best model to describe observed growth was selected using Schnute model, modified by Montgomery, to apply it to the follow-up of mean lengths by time intervals and the two types of additive and multiplicative errors, as well as the Akaike index. In addition, relationships between CL and TW were made to determine the type of growth present in collected postlarvae. Relative growth was compared with the Student-t test. In the Mazatlán Bay case 1 of the Schnute model with additive error was selected and estimated values for \( k = 5.7 \) and \( \varepsilon = 24.9 \text{ mm CL} \) were obtained for *P. inflatus*. In the growth curve, an increase of 9.5 (0.8 g) to 24.1 mm CL (12.0 g) was observed over 9 months. In the Cospita estuary the model that was most adjusted was case 2 for *P. inflatus* and *P. gracilis* postlarvae, with values of \( k = 3.4 \) and \( \varepsilon = 44.6 \text{ mm} \) and \( k = 3.8 \) and \( \varepsilon = 44.2 \text{ mm CL} \), respectively, also showed isometric growth (\( b > 3; p > 0.05 \)). On the other hand, both in Mazatlán Bay and in the Cospita estuary, the associated fauna available to the lobster postlarvae is composed mainly by crustaceans and mollusks. In the analyzed periphyton, the main groups found were diatoms, dinoflagellates, cyanobacteria, and crustaceans. Therefore, it can be concluded that the associated fauna, periphyton, and temperature can influence the growth of lobster postlarvae stocked in oyster boxes.
Behavior, Neurobiology, & Behavioral Ecology

P3-MICROHABITAT SENSING BY THE PUERULI OF THE CARIBBEAN SPINY LOBSTER *PANULIRUS ARGUS*: TESTING THE IMPORTANCE OF RED ALGAE, JUVENILES, AND THEIR INTERACTION.

J. Antonio Baeza (baeza.antonio@gmail.com), Michael J. Childress
*Clemson University, Clemson, SC*

Although our knowledge about the early life of the Caribbean spiny lobster *Panulirus argus* has increased considerably during the last decades, little is known about chemical sensing used by pueruli during settlement. Considering previously reported benefits of inhabiting red algae *Laurencia* spp. (e.g., increased growth rate) and costs of living in close proximity to early benthic juveniles (e.g., increased mortality rate), we predicted that the settling pueruli of *P. argus* will be attracted and repulsed by metabolites produced by red algae and early benthic juveniles (EBJ), respectively. We also expected that any preference for *Laurencia* will cease if this cue was presented together with metabolites produced by conspecific given the reported costs of associating with them after settlement. Our results disagree with the expectations above. Pueruli did not display any preference or avoidance of red algae and EBJs, respectively. Unexpectedly, settling stages were attracted to water with metabolites produced by both red algae and EBJs. We also examined the influence of conspecific and red algae abundance on pueruli settlement in Florida Bay, the most important nursery ground of *P. argus* in the USA. In partial agreement with our experiments, field data indicated that juvenile lobster density had a positive influence on pueruli settlement as did a synergistic effect of juvenile lobster density and *Laurencia* algae cover. Altogether, our field and laboratory data suggest that the interplay of various environmental cues drives settlement of the Caribbean spiny lobster and is more complex than originally thought. Additional studies on the settling behavior of *P. argus* pueruli are needed to improve our understanding of the relationship between recruitment and fishery stocks in this heavily exploited species.

P4-VISUAL RECOGNITION OF FAMILIAR DOMINANT OPPONENTS IN THE LOBSTER, *H. AMERICANUS*

Maggie A. Bruce¹ (*mabruce@umass.edu*), Chris Sutherland¹, Anya Battaglino², Marzie Wafapoor², Sara Freed², Jelle Atema²
¹*University of Massachusetts – Amherst, Amherst, MA*, ²*Boston University Marine Program, Boston, MA, USA*

American lobsters can recognize familiar individual opponents. Blocking olfactory information greatly reduces this ability, and suggests that it is mediated primarily by odor. However, visual cues are suspected to play an additional role. In this study, lobsters were blindfolded to test their ability to visually recognize familiar dominant opponents. After a first fight between un-manipulated, equally sized males, losing lobsters blindfolded in second fights displayed more aggression towards known dominants that control animals with normal vision, indication that animals with blocked vision had an impaired ability to recall the identity of a familiar opponent. However, the dominance relationship remained intact in most cases, suggesting that vision is coupled with olfaction in the process of individual recognition. This raises questions about which morphological traits lobsters use as visual signals.
P5-THE AMERICAN LOBSTER, *HOMARUS AMERICANUS*, USES VISION TO EVALUATE RELATIVE OPPONENT SIZE
Tara Doherty (dohertyt@bu.edu), Jessica Kaplan, Jelle Atema
Boston University Marine Program, Boston, MA 02215 USA

Previous research has shown that claw size and carapace length affect the outcome of agonistic engagement in *H. americanus*, but it remains unknown how lobsters can assess size differences to reduce or avoid physical damage in a fight they are likely to lose. This study looks to determine if the American Lobster can use vision to assess its opponent’s difference in crusher claw size. Until recently, the role of vision in social interactions was not critically examined because its resolution was considered insufficient in a subtidal environment. Following up on the discovery that lobsters can recognize familiar conspecifics solely with vision, we staged fights between two random lobsters of various crusher claw sizes to see at which size difference they would back off. Then in one set of fights, the lobster of larger crusher claw size was blindfolded and in a second set the lobster of smaller crusher claw size was blindfolded. We recorded (1) if the lobsters engaged with one another, (2) the latency of the losing lobster’s first retreat, and (3) if the lobster with the greater crusher claw size won. Visually intact lobsters from each data set retreated at a similar range of latencies. Blindfolded smaller lobsters retreated significantly later than the blindfolded larger lobster group. There was no significant difference in retreat latency between the control group and the blindfolded larger lobster group. These results suggest that visual cues affect the retreat time of relatively smaller lobsters, causing them to fight significantly longer when blindfolded than when intact. The typical “meral spread” threat display could provide the significant size information by showing the bright yellow underside of the claws. The result suggests that lobsters can (visually) evaluate opponent size compared to its own size and that the “meral spread” signal evolved for this assessment function.

P6-CAN AMERICAN LOBSTERS DETECT LIGHT WITHOUT THEIR EYES? EVIDENCE FOR EXTRAOCULAR PHOTORECEPTORS
Benjamin C. Gutzler¹ (bg1067@wildcats.unh.edu), Colleen O'Dowd¹, Cody White¹, Steven H. Jury², Winsor H. Watson III¹
¹University of New Hampshire, Durham, NH, ²Saint Joseph’s College, Standish, ME

Although there have been multiple reports of extra-ocular photoreceptors in a number of crustaceans, it is not clear if American lobsters have this ability. In order to address this question, we conducted three different experiments and all of them strongly suggest that American lobsters can detect changes in light intensity using extra-ocular photoreceptors, either located in their ventral nerve cord or distributed throughout their body. First, we painted the eyes of juvenile lobsters and then recorded their movements to determine if they could still entrain their daily activity rhythms to a light:dark cycle. In most cases, they did so, suggesting they could sense the light in some other manner. Next, we covered different body parts and used a cardiac assay to determine if they could detect a shadow passing over them. Animals with everything covered but their abdomen would still respond with a change in heart rate, suggesting the presence of photoreceptors in that area. Covering the abdomen appeared to reduce, but not eliminate, this response, raising the possibility of additional photoreceptors distributed elsewhere in or on their body. We are also testing the effect of different wavelengths of light (blue, red, white) using the same assay, to provide insight into the type of photopigment that might be involved. Finally, we used immunohistochemistry to identify about 2-8 neurons in each abdominal ganglion containing the light sensitive protein, cryptochrome. Taken together, these data suggest that American lobsters do, in fact, have the ability to sense changes in light levels with extra-ocular neurons and that these photoreceptors can influence lobster behavior.
P7-AVOIDING DISEASED CONSPECIFICS VERSUS AVOIDING PREDATION RISK: TESTING THE TRADE-OFF HYPOTHESIS IN PANULIRUS ARGUS
Enrique Lozano-Álvarez (elozano@cmarl.unam.mx), Leslie Cid-González, Fernando Negrete-Soto, Cecilia Barradas-Ortiz, Patricia Briones-Fourzán
Universidad Nacional Autonoma de México

Caribbean spiny lobsters are known to avoid shelters harboring PaV1 (Panulirus argus Virus 1) diseased conspecifics, yet in locations where “casitas” (large artificial shelters) are used, cohabitation between healthy and diseased lobsters is common. Because casitas work better where natural shelters are scarce, two hypotheses (not mutually exclusive) have been raised to explain this counterintuitive finding: A) that in shelter-poor habitats, healthy lobsters make a trade-off between avoiding diseased conspecifics and avoiding predation risk, or B) that the large shelter space of casitas allow healthy and diseased lobsters to cohabitate without physical contact. To test these hypotheses, we conducted four experiments (Exp1-4) using seawater mesocosms fitted with two casitas each. Exp1: one casita empty and one harboring either a diseased (treatment) or a healthy (control) tethered conspecific; Exp2: both casitas harboring either a diseased (treatment) or a healthy (control) tethered conspecific; Exp3 and Exp4: same as Exp1 and Exp2, respectively, but with a predatory triggerfish present. We then introduced six free-ranging healthy lobsters into each tank (3 replicates per each treatment and control) and checked the casitas for lobsters after 48 H. In the absence of triggerfish, free-ranging lobsters used empty casitas and those harboring healthy conspecifics, but avoided casitas harboring diseased conspecifics, with all lobsters remaining in the open in the Exp2 treatment. In contrast, in the presence of triggerfish, lobsters used empty casitas and those harboring healthy and diseased conspecifics, with few remaining in the open in the Exp4 treatment. Thus, whether lobsters share casitas harboring diseased conspecifics depends to some degree on availability of alternative shelter and immediacy of predation risk. However, in casitas harboring diseased lobsters, snapshots taken with an underwater camera showed that free-ranging lobsters were usually in the opposite side. Therefore, the results support both the trade-off and the large shelter space hypotheses.

P8-IF YOU CAN’T BEAT THEM, EAT THEM: THE DOCUMENTATION OF AMERICAN LOBSTER PREDATION ON THE INVASIVE EUROPEAN GREEN CRAB IN CANADA
Gemma Rayner (g.rayner@mun.ca), Iain J. McGaw
Memorial University of Newfoundland

The European green crab (Carcinus maenas) first invaded the east coast of North America in the 1800s and has been found in the diet of the American lobster (Homarus americanus) in some areas. Green crabs are used as bait in lobster fisheries in Nova Scotia, Canada but predation has not yet been quantified in Newfoundland, where crabs were first reported just 10 years ago. The aim of the current study was to determine if lobsters from Newfoundland would recognize and prey upon this new species, and if so did the green crabs reach a size refuge where they became too big to handle. Lobsters from Newfoundland were compared with those from Nova Scotia which have coexisted with green crabs for over 60 years. An individual juvenile (~40mm), sub-adult (40-65mm) or adult (~65mm) carapace width (CW) green crab was introduced into a tank with a single lobster. There was no significant effect of lobster origin on crab predation, and that sub-adult crabs were the favored size range. The lobsters consumed some adult crabs, but very large crabs (> 72mm CW) were injured and not eaten. The experiments were repeated adding a shelter as a potential refuge for green crabs and adding an alternative food source (fish flesh). When a shelter was added to the experimental tank lobsters consumed more, or inflicted more damage to the crabs, probably due to an increase in antagonistic interactions over acquisition of the shelter. When fish was added fewer crabs were consumed, and those that were consumed were the smaller juveniles. The present results suggest that green crabs can be an important prey item for lobsters and have the potential to be used as bait in the Newfoundland lobster fishery.
P9-AN UPDATE TO THE ICWL BOOK OF WORLD LOBSTER RECORDS
Winsor H. Watson III\(^1\) (win@unh.edu), Jason S. Goldstein\(^2\)
\(^1\)University of New Hampshire, Durham, NH, \(^2\)Wells Research Reserve, Wells, ME

At the 8th ICWL, a repository of lobster records was first established (Lobster Newsletter, Vol. 21(1), 2008). Approximately 30 entries were received, ranging from the culinary career award “the most species eaten in lifetime” (Ehud Spanier) to “the most lobsters captured in a single trap” (Sara Ellis, 117). We also learned that Carl Wilson recaptured the same lobster 7 times, Cindy Lewis went on 210 collecting dives in one year and Peter Lawton captured a 217 mm CL male lobster while diving. A few lobsters also made the Record Books such as a 32 mm CL spiny lobster egger and an American lobster that traveled 800 km. This year our goal is to share more records with the lobster community and update the ICWL Book of Lobster Records. Please come visit this poster prepared to enjoy previous entries, share your own record(s), and perhaps get a place in the Record Book (be prepared to provide any data (graphic or otherwise) to substantiate your claim(s). If you want to get a head start, and maybe have one of your records included in the poster, send it to us.
Climate Change

P10-DEVELOPMENT OF AMERICAN LOBSTER EMBRYOS EXPOSED TO OCEAN ACIDIFICATION
Tammy Blair¹ (Tammy.Blair@dfo-mpo.gc.ca), Julien Gaudette¹, Vicky Merritt¹, Piero Calosi², Erin Miller¹, Nicole Leavitt¹, Helen Gurney-Smith¹
¹ St Andrews Biological Station, Fisheries and Oceans Canada, ² Université du Québec à Rimouski, Canada

Global change drivers such as ocean acidification (OA) have been shown to impact the growth and physiology of larval and juvenile European lobster (Homarus gammarus) and settled American lobster (H. americanus). However, the effects of OA on embryonic development have not yet been studied. This is a critical knowledge gap, as shifting environmental conditions may affect embryo development rates, and subsequently impact the timing, rates and patterns of larval release, as well as larval quality, survival, dispersion and settlement.

To explore the effects of OA on embryos development, thirty ovigerous female American lobster were exposed to five pCO₂ levels ranging from current average atmospheric/sea-surface water conditions (~400 µatm) to 100-year projected conditions (~1500 µatm) and ambient temperatures from February 2016 until the embryos hatched (between June and August 2016). Newly hatched larvae were then transferred to ambient seawater and larval growth was measured from Stage I to Stage IV. Clutch fullness was measured prior to the onset of pCO₂ exposure and near-hatch in June to assess changes in fecundity. Lipid composition of the embryos, size of the yolk, and Perkins’ eye index were measured on a monthly basis in an attempt to correlate metrics of energy utilization and a developmental proxy with time of hatch. Metabolomics and lipidomics fingerprinting were also measured prior to the onset of pCO₂ exposure and near-hatch in June to acquire a mechanistic understanding of the impact of OA on embryos metabolism. Results of these analyses and potential application to lobster population and fishery management will be discussed.

P11-EFFECTS OF REGIONAL TEMPERATURE CYCLES ON LARVAL AMERICAN LOBSTERS (HOMARUS AMERICANUS): IS THERE A TRADE-OFF BETWEEN GROWTH AND DEVELOPMENTAL STABILITY?
Amalia M. Harrington (amalia.harrington@maine.edu), Makaila Kowalsky, Scarlett Tudor, Heather J. Hamlin
University of Maine, Orono, ME, USA

The American lobster (Homarus americanus) sustains the most economically valuable fishery in the Gulf of Maine and Atlantic Canada. Lobster biology and distribution are influenced by ocean temperature, which has increased rapidly and exhibited more frequent abrupt warming events in recent decades. Warming events are linked to mass mortality and disease in Southern New England, resulting in a dramatic population decline. There is concern that this decline may spread northeastward into the Gulf of Maine lobster population, as this region continues to warm faster than 99% of the global oceans. Here, we explore how altered seasonal temperature regimes affect the growth, survival, and development of larval lobsters.

We collected egg-bearing females and reared lobsters from hatch under one of three seasonal temperature regimes corresponding to Southern New England, Southern Maine, and Northern Maine. These regimes were further broken down into four nominal temperature categories: 14, 16, 18, and 22°C. We recorded the rate of development across the three larval stages (I-III) and the postlarval stage (IV). Survival was estimated as the proportion of initially stocked larvae that successfully metamorphosed to the postlarval stage. Postlarvae were photographed, and ImageJ software was used to measure morphological differences across treatments. Finally, we assessed total hemocyte count in a subset of postlarvae across treatments. Larvae in the 18 and 22°C treatments grew significantly faster than larvae of 14 and 16°C treatments, and survival was positively correlated with temperature. All larvae exhibited some degree of asymmetry in morphology, and total hemocyte counts were significantly lower in larvae raised in the 18°C compared to all other nominal temperature categories. Together, these data suggest that warmer temperatures may facilitate faster growth in larval lobsters at the expense of developmental stability.

Ivan A. Hinojosa\(^1\) (ivanht@ucn.cl), Bridget S. Green\(^2\), Caleb Gardner\(^2\), Andrew Jeffs\(^3\)

\(^1\)Universidad Catolica del Norte – Chile, \(^2\)University of Tasmania, Australia, \(^3\)University of Auckland

Understanding settlement and recruitment may assist management and conservation of economically important species. The rock lobster, *Jasus edwardsii*, supports valuable fisheries in Australia and New Zealand. Settlement levels of pueruli have been monitored on artificial collectors with a long-term program in both countries. Patterns in settlement at some sites appear to be driven by environmental processes. However, a lack of correlation with environmental variables at other sites and the strong swimming ability of the pueruli, suggested that settlement may be influenced by the pueruli’s ability to orient onshore in combination with other environmental processes. However, no behavioral experiments have been reported on pueruli of this species, nor have broad scale settlement data analysis been conducted. Also, climate-change has led to loss of kelp habitats in some regions raising the concern of this change. Here we used a combination of broad scale data analyses, and laboratory and field experiments to assess the influence of environmental variables and puerulus behavior on settlement and post-settlement survival. Settlement was found to be affected by regional scale oceanic processes measured by the SOI, DMI, and SAM, although outcomes varied among regions. At a local scale, waves, wind, and current have some influence on settlement, with SST being less important, but these trends were not consistent among sites. Experiments showed that pueruli were attracted to chemical cues from coastal waters. Underwater reef noise attracted pueruli during calm seas. Kelp habitats increased settlement and survival. These results highlight the complexity of settlement and survival where larval behavior and oceanographic process interact at different scales. Overall, environmental conditions that reduce settlement strength in one region often increase settlement in other suggesting resilience to climate change at the scale of the entire fishery. However, local habitat changes are expected to affect future recruitment at a local scale.
P13-DEVELOPMENT AND HIERARCHICAL ARCHITECTURE OF CALCIUM CARBONATE STORAGE STRUCTURES (GASTROLITHS) IN AMERICAN LOBSTER

Jaroslaw Stolarski1, Marta Potocka1, Robert C. Bayer2, Timothy Bowden3, Ismael Coronado1, Maciej Mazur4, Gilles Luquet5

1Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland, 2Lobster Institute, University of Maine, Orono, ME USA, 3Aquaculture Research Institute, University of Maine, Orono, ME USA, 4Department of Chemistry, University of Warsaw, Warsaw, Poland, 5Muséum National d’Histoire Naturelle, Paris, France

The complete renewal of the exoskeleton (cuticle) in a hormonally regulated molting cycle is essential for the growth and survival of arthropods. Most crustaceans harden this exoskeleton by calcification, mainly with CaCO3. Different groups (amphipods, isopods and decapods) develop distinct strategies to store calcium ions and to make them instantly available to start the process of calcification after molting. For example, crayfish, lobsters, and land crabs form unique carbonate structures called gastroliths in the cardiac stomach walls during premolt. Although various mineralogical, structural, and chemical aspects of gastroliths were documented in crayfish and land crabs, detailed information about the lobster gastroliths is still missing. Herein, using X-ray microcomputed tomography, we show that in contrast to crayfish compact gastroliths, the mature gastroliths of American lobster (Homarus americanus) have composite, columnar organization. Individual columnar units (few millimeters long) show ca. 3 µm fine-scale increment bands suggesting sub-daily calcification activity, taken that the examined gastroliths developed within less than two months (ultrasound imaging documentation). The mineral bands are composed of amorphous calcium carbonate (ACC), which after gastrolith dissection often transform into calcite. Both ACC and secondary calcite have nanocomposite organization (Raman spectroscopy and FE-SEM analyses, respectively) consistent with crayfish gastroliths. In a preliminary experiment, effects of seawater acidification (pH 7.2 vs. 8.1 in control) were assessed on gastrolith development: only in normal pH conditions, cultured lobsters developed mature gastroliths, whereas none were fully formed in animals cultured in acidified conditions. Assuming that similar shifts in timing of gastrolith formation may result from the worst-case scenario for anthropogenic ocean acidification, the lobster molting cycle, and consequently the lobster survival might be threatened.

P14-THE POTENTIAL EFFECTS OF ACIDIFIED SEAWATER ON AMERICAN LOBSTER CHEMSENSORY-MEDIATED BEHAVIORS

Winsor H. Watson III1 (win@unh.edu), Stephanie L. Sykes1, Jason S. Goldstein2

1University of New Hampshire, Durham, NH, 2Wells Research Reserve, Wells, ME, USA

Ocean and coastal acidification (OCA) changes the carbonate chemistry of seawater, leading to a decreased pH, and is a measureable trend that has been increasing in recent years. While OCA has been shown to have an influence on several different aspects of crustacean physiology, and development the goal of this study was to determine if, and how, OCA might affect chemosensory-mediated behaviors in American lobsters. In the first experiment we measured the time it took for juvenile lobsters (45-60 mm CL) to find bait in a modified Y-maze, both in ambient seawater and in seawater with a reduced pH (produced by bubbling carbon dioxide. Reducing the pH (~7.4) did not have an impact on the movements of lobsters but, after bait was added, it took these animals significantly more time to move into the area containing the bait than when they were in ambient seawater (pH= ~8.1). These findings suggest that OCA might alter the way odorants interact with lobster olfactory receptors. To address this hypothesis we recorded the responses of chemoreceptors on lobster claws to a variety of substances in both normal and low pH saline. We found that lowering the pH reduced the responses to several potential odorants, such as hydroxyproline. These data, taken together, indicate that OCA may have a pronounced impact on lobster behaviors that rely on their chemosensory system, such as foraging for food and mating.
P15-MECHANISTIC UNDERSTANDING OF CLIMATE DRIVEN RANGE SHIFTS: USING THERMAL TOLERANCES OF ROCK LOBSTER TO PREDICT FUTURE RANGE SHIFTS

Samantha Twiname\textsuperscript{1} (Samantha.Twiname@utas.edu.au), Quinn Fitzgibbon\textsuperscript{1}, Alistair Hobday\textsuperscript{2}, Chris Carter\textsuperscript{1}, Greta Pecl\textsuperscript{1}

\textsuperscript{1}Institute for Marine and Antarctic Studies, University of Tasmania, \textsuperscript{2}CSIRO Oceans and Atmosphere

Ocean warming is affecting marine species worldwide, with one of the most observed changes being alterations to species geographical distributions. Understanding what drives these range shifts is key to predicting what may happen with future warming. This study takes a mechanistic approach to understanding climate-driven range shifts, looking at the metabolic and escape responses of spiny rock lobster and how they may change under different temperature scenarios. We examined the metabolic physiology and escape response of the puerulus and juvenile stages of \textit{Jasus edwardsii}, a common Tasmanian species of spiny rock lobster, and \textit{Sagmariasus verreauxi}, a species of spiny rock lobster extending its range into and further south in Tasmania. The puerulus stage of the spiny rock lobster life cycle is an important transitional stage between the larval and juvenile stages and understanding how ocean warming may affect its aerobic and swimming capacity allows us to better predict future scenarios of population dynamics. \textit{Jasus edwardsii} individuals of both life stages were tested at 16, 18, 20, 22, 24, and 26 °C, and \textit{S. verreauxi} individuals were tested at 22, 24, 26, 28 and 30 °C. Intermittent flow respirometry was used to determine aerobic scope (AS), excess post-exercise oxygen consumption (EPOC), and recovery times. Escape velocities were determined from high speed stereo-video footage. The comparison between the physiologies of the two species indicates that \textit{S. verreauxi} has higher thermal tolerances than \textit{J. edwardsii}, and this may facilitate further expansion of this range-shifting species into Tasmanian waters with future ocean warming.
Idiopathic blindness is a condition with an unknown etiology that afflicts ~50% of the lobsters in Long Island Sound (LIS). The condition has been described from LIS and Narragansett Bay, but not from Maine. Grossly, the condition presents as patches of cloudy grey-colored regions in the eyes of afflicted animals. Histologically, the ommatidia (the complex of photoreceptors and optic nerve fibers) show signs of altered pigment distribution, necrosis of the optic nerves and rhabdoms, and hemocyte infiltration through the protective basement membrane. Severe lesions show areas with no remaining ommatidia, and nearly complete loss of associated optic nerves. The purpose of this study is to assess a rapid, non-destructive, diagnostic technique for assessing blindness in lobsters. We compared the use of an otolaryngoscope (oscope) with stereomicroscopy on live, frozen, and histologically fixed eyes. Live lobsters from Narragansett Bay, RI, and off southern MA were assessed with the o-cope and categorized as having zero, light, moderate, or severe blindness. Right eyes were analyzed via standard histological procedures. Left eyes were frozen and stored at -80 °C and then later thawed and reassessed for blindness. Comparisons among the methods were made using correlation and regression analysis. In addition, we examined inter-observer variance in the use of the o-cope among staff and fishermen. Initial results indicate that the etiological agent of idiopathic blindness is present throughout a large portion of the Sound, and that lobsters are probably continually exposed to it. The results of these investigations will help us better understand the prevalence and distribution of idiopathic blindness in lobsters. [We thank Lanny Dellinger and Al Eagles for lobsters from RI, and Aaron Cebula and Mike Trainor for eyes from lobsters from southern MA.]
P18-CHARACTERISTICS OF RECENT INCREASES OF EPIZOOTIC SHELL DISEASE IN THE AMERICAN LOBSTER (HOMARUS AMERICANUS) FOR THE INSHORE GULF OF MAINE
Kathleen M. Reardon (kathleen.reardon@maine.gov), Carl J. Wilson
Maine Department of Marine Resources

The epizootic shell disease (ESD) that has persisted in southern New England since the mid-nineties appears to be increasing with higher incidences observed in recent years in the Gulf of Maine. The Maine Department of Marine Resources Sea Sampling Program has been monitoring for shell disease since 2003 in the commercial catch. Until 2010, the observed levels of ESD were consistently below 0.1 percent of the sampled catch but then peaked in 2013 at 2.25% in certain areas. We explore the spatial and biological characteristics of the affected catch in the Gulf of Maine.

P19-MOLECULAR AND ULTRASTRUCTURAL CHARACTERIZATION OF A MICROSPORIDIAN PARASITE INFECTING THE CARIBBEAN SPINY LOBSTER PANULIRUS ARGUS FROM FLORIDA
Hamish Small1 (hamish@vims.edu), Grant D. Stentiford2, Donald C. Behringer3, Kimberly S. Reece1, Kelly Bateman2, Jeffrey D. Shields1
1Virginia Institute of Marine Science, 2Centre for Environment, Fisheries, and Aquaculture Science, 3University of Florida

The Caribbean spiny lobster (Panulirus argus) supports the most economically valuable fishery in the Caribbean. Previous studies have documented the discovery of a rare microsporidian parasite infecting two spiny lobsters from southeast Florida. Histopathology and limited transmission electron microscopy revealed spore characteristics that were consistent with the genus Ameson, whose members are known to infect marine crustaceans. However, the parasite was never identified to species level. In 2014, an additional spiny lobster from southeast Florida (Key Largo) displaying abdominal muscle tissues with an apparent 'cooked' appearance was discovered. This lobster was confirmed to have an advanced infection of ovoid-shaped microsporidian spores (~ 1.6 × 1.1 µm in size) within the host muscle cell cytoplasm. Transmission electron microscopy revealed multiple life stages of a monokaryotic microsporidian closely resembling the previously identified specimens. Mature ovoid spores were observed to have 7-8 turns of a polar filament arranged mainly in one rank but occasionally in two. Molecular analysis of partial SSU rRNA sequence data from the 2014 sample and from one of the earlier cases showed that both sequences were identical and indicated a close affiliation with other Ameson species, placing the parasite from the spiny lobster in a clade with Ameson michaelis, Ameson pulvis and Nadelspora cancri.
P20-A STATISTICAL MODEL FOR MONITORING SHELL DISEASE IN INSHORE LOBSTER FISHERIES: A CASE STUDY IN LONG ISLAND SOUND
Kisei R. Tanaka (kisei.tanaka@maine.edu), Samuel L. Belknap, Jared J. Homola, Yong Chen
University of Maine, Orono, ME

The American lobster (Homarus americanus) fishery is being threatened by the expansion of shell disease. Species Distribution Models (SDMs) designed to improve the efficiency and precision of monitoring programs have been advocated as an important tool in mitigating the harmful effects of the disease. The objective of this study was to develop a SDM to enhance existing shell disease monitoring efforts in the US lobster fishery that could (1) identify potential disease-associated biotic and abiotic factors, and (2) estimate the spatial variation in shell disease prevalence. In this case study, a delta-generalized additive modeling (GAM) approach was applied to existing bottom trawl survey data collected from 2001-2013 in Long Island Sound. The spatial distribution of shell disease prevalence was strongly influenced by interactive effects of latitude and longitude, supporting previous work that suggested a geographic origin of the disease in eastern Long Island Sound. Bottom salinity, bottom temperature, and depth were also influential factors in determining the spatial variability of shell disease prevalence. The delta-GAM projected high disease prevalence in locations with low sampling efforts. Moreover, a spatial discrepancy was found between modeled disease hotspots and survey-based disease gravity centers. This research provides a modeling frame that can be applied to more effectively monitor the spatial extent and spread of shell disease into the future.
Environmental Stressors

P21-AN ASSESSMENT OF STRESS AND POST RELEASE MORTALITY IN ATLANTIC COD (GADUS MORHUA) CAPTURED IN THE COMMERCIAL LOBSTER FISHERY
Riley S. Austin (raustin3@une.edu), Brett B. Sweezey, James A. Sulikowski
University of New England, Marine Science Center, Biddeford, ME USA

Atlantic cod (Gadus morhua) populations, once one of the most important commercial species in the Gulf of Maine (GOM), have been decimated by overfishing in our recent history. In order to restore these populations we must consider all of the ecological, environmental, and anthropogenic influences that have an impact on their populations. This study focuses on the stress associated with capture in lobster gear and how it relates to subsequent mortality of cod. Sampling trips with a commercial lobster fisherman from Cape Porpoise, ME were taken beginning in the summer of 2016. One mL of blood was awn from each of the 11 cod that were captured in lobster gear. The secondary blood stress parameters glucose, hemoglobin, lactate, and hematocrit were tested on board the fishing vessel. Mean values for these parameters were 42.8 ±20.9 mg dL⁻¹, 1.265 ± 0.41 mmol l⁻¹, 6.145 ± 0.53 g/dL, and 30% ± 4.15% respectively. When compared to baseline values from other studies, results herein revealed that cod were relatively non-stressed.

Throughout the spring of 2017, I will also be using blood radioimmunoassay to determine concentrations of cortisol, a primary indicator of stress, which will then be compared to secondary blood parameters to establish relationships between stress and mortality. Sampling will continue throughout the summer of 2017 to increase sample size to further quantify the effects of capture in lobster trap gear.

P22-THE EFFECT OF CASITAS ON PANULIRUS ARGUS MORTALITY, GROWTH, AND SUSCEPTIBILITY TO DISEASE IN THE BAHAMAS
Lester Gittens (lestergittens@yahoo.com), Mark J. Butler IV
Old Dominion University, Norfolk, VA

The fishery for Panulirus argus in The Bahamas - which is the largest in the Caribbean - was historically trap-based, but in the 1990s casitas surpassed traps as the primary type of fishing gear. Yet, casitas are unregulated in The Bahamas (i.e., neither permitted or banned) and their effects on fishery sustainability are unknown. Concerns about whether overcrowding of lobsters within casitas detrimentally alters lobster growth, disease, or mortality prompted our study in which we compared these attributes in lobsters within traps versus casitas. Tethering and videography were used to compare lobster mortality and predation risk at casitas and in the natural environment. We also compared the nutritional condition, growth, injury, and prevalence of disease in lobsters within casitas and traps. We found no difference in predation on subadult and adult lobsters in casitas compared to natural areas, although predators were far more abundant near casitas. Lobsters in casitas were in better health than those in traps, with higher blood protein indices and lower prevalence of shell disease; the PaV1 virus was absent in our samples. Starvation experiments in which lobsters were held in traps for time periods similar to those when traps were left underwater during the closed season, revealed significant health problems after three weeks, with dire health afflictions after 6-12 weeks. In summary, we found no evidence that casitas negatively affect subadult and adult P. argus in The Bahamas, but our study revealed that traps pose a risk to the fishery if not properly managed.
P23-INTERACTIVE EFFECTS OF pCO₂ AND TEMPERATURE ON THE PHYSIOLOGY, BEHAVIOR, AND SURVIVAL OF EARLY LIFE STAGE HOMARUS AMERICANUS: COMPARING SUBPOPULATIONS OF NEW ENGLAND
Maura Niemisto¹ (maura.niemisto@maine.edu), Richard A. Wahle¹, David Fields², Jesica Waller², Spencer Greenwood³
¹University of Maine School of Marine Sciences, ²Bigelow Laboratory for Ocean Sciences, ³University of Prince Edward Island

Anthropogenic carbon released into the atmosphere has led to the warming and acidification of the world’s oceans, most prominently in the northern latitudes, and including the Northwest Atlantic. This phenomenon will have important implications for commercial fisheries within the region. As an important species culturally, economically, and ecologically, the American Lobster (*Homarus americanus*) is one of the many valuable species that is exhibiting a northward range shift as a result of changing ocean conditions. Understanding the interactive effects of ocean warming and acidification on this species’ most vulnerable early life stages is important to predict its response to climate change on a stage-specific and population level. Our study will be the first to compare the responses of lobster larvae to the joint effects of elevated pCO₂ and temperature across three sub-populations spanning New England’s steep north-south temperature gradient (Rhode Island, Midcoast Maine, and Eastern Maine, USA). Using a common garden experimental design, we will subject pre-settlement larval and post-larval stages to different combinations of ambient, end-century projected, and extreme pCO₂ concentrations (400 ppm, 750 ppm, 1200 ppm), as well as ambient and projected end-century temperatures (16°C and 19°C). We will measure important components of larval performance including survival, growth, oxygen consumption, carbon-to-nitrogen ratio, swimming speed, feeding behavior, and gene expression.

P24-EFFECTS OF THE ORGANOPHOSPHATE CHLORPYRIFOS ON SURVIVAL OF THE AMERICAN LOBSTER (*HOMARUS AMERICANUS*)
Laura J. Taylor¹, Dounia Daoud², K. Fraser Clark³, Michael R. van den Heuvel¹, Spencer J. Greenwood¹
¹University of Prince Edward Island, ²Homarus Inc., ³Mount Allison University

American lobster (*Homarus americanus*) harvests from the Northumberland Strait within the southern Gulf of St. Lawrence, Canada, have been in decline since the 1990s. Larval lobster life-stages exist in the pelagic zone of the Northumberland Strait and are therefore vulnerable to agricultural runoff of pesticides. The organophosphate chlorpyrifos, a pesticide that targets arthropodic pest insects, has been shown to affect the survival of some larval decapod crustaceans, yet no data exists on the impacts to *H. americanus*. Using 48-hour acute exposures, with concentrations ranging from 0.03 – 2.01 µg/L, the 48 hr median lethal concentration of chlorpyrifos was established to be 1.56 ± 0.50 µg/L for stage IV American lobster. During sublethal exposures, biological parameters such as intermolt period, specific growth rate, molt increment, and gene expression were also measured. General linear model analysis (α = 0.05) determined that intermolt period was significantly increased and both specific growth rate and molt increment were significantly decreased in the 0.82 µg/L chlorpyrifos treatment when compared to the control treatment (0.03 µg/L chlorpyrifos). RNA sequencing was performed using Illumina Hiseq 4000 PE100 and subsequent confirmation of expression of genes of interest was performed via RT-qPCR. In the current study, gene expression was used to determine pathways being affected by sublethal chlorpyrifos exposures. Unique patterns of gene induction may serve as a potential diagnostic tool to further examine the impacts of pesticides on lobster.
P25-EFFECTS OF THE ORGANOPHOSPHATE AQUACULTURE PESTICIDE AZAMETHIPHOS ON STAGE I AND STAGE IV AMERICAN LOBSTER (HOMARUS AMERICANUS) LARVAE

Laura J. Taylor\textsuperscript{1} (lataylor@upei.ca), Dounia Daoud\textsuperscript{2}, K. Fraser Clark\textsuperscript{3}, Michael R. van den Heuvel\textsuperscript{1}, Spencer J. Greenwood\textsuperscript{1}

\textsuperscript{1}University of Prince Edward Island, \textsuperscript{2}Homarus Inc., \textsuperscript{3}Mount Allison University

Salmon aquaculture and the American lobster (\textit{Homarus americanus}) industry are two economically important industries in Atlantic Canada. Both industries exist in the marine ecosystem and have potential to interact. Salmosan\textsuperscript{®} (active ingredient azamethiphos) is an organophosphate aquaculture pesticide used to treat Atlantic salmon for infestations of parasitic sea lice (\textit{Lepeophtheirus salmonis}). Crustaceans such as the American lobster have been shown to have a low tolerance to contaminants when compared to other aquatic organisms. Salmosan\textsuperscript{®} is known to be lethal to adult lobster at relatively low concentrations (100 µg/L) and few studies have been carried out on the pesticide's effects on the health of larval lobsters. Three hour exposures using stage I and IV \textit{H. americanus} larvae were carried out using a range of azamethiphos (as Salmosan\textsuperscript{®}) concentrations between 0.04 – 71.11 µg/L. Median lethal concentrations at 3 hours were determined to be 5.87 ± 2.01 µg/L for stage I and 20.45 ± 12.77 µg/L for stage IV. Post-exposure, surviving stage IV larvae were raised to stage V and sublethal parameters including intermolt period, specific growth rate, molt increment, and global gene expression were determined. General linear model analysis ($\alpha = 0.05$) determined that intermoul periods were significantly increased in the 13.00 µg/L azamethiphos treatment when compared to the control (<0.05 µg/L azamethiphos). Molt increment and specific growth rate were not significantly affected. RNA sequencing was performed using Illumina Hiseq 2500 PE125 and subsequent RT-qPCR was performed to confirm expression of genes of interest. Gene expression was used to establish effects on biological pathways of \textit{H. americanus} in order to determine unique gene induction patterns. Established gene induction patterns may be used as a potential diagnostic tool for pesticide exposure in lobster.
Fisheries Management

P26-NORTHEAST FISHERIES OBSERVER PROGRAM: OBSERVER COVERAGE, DATA COLLECTION AND BIOLOGICAL SAMPLING OF THE AMERICAN LOBSTER FISHERY, AN OVERVIEW 2012-2016
Glenn Chamberlain (glenn.chamberlain@noaa.gov), Sara Weeks, Amy Martins
NOAA Northeast Fisheries Science Center

All federally permitted vessels required to file federal vessel trip reports (VTRs) are eligible to carry an observer certified by the National Marine Fisheries Service (NMFS), as a condition of the permit. The federally permitted lobster fleet in the Northeast and Mid-Atlantic is unique among other federal fisheries as the majority of the fleet are not required to submit VTRs. As a result, observer coverage is directed toward federally permitted vessels that submit VTRs and report fishing lobster gear. The NMFS, along with state and regional partners, are working to modify the Standardized Bycatch Reporting Methodology (SBRM) omnibus amendment in order to provide more equitable coverage of the lobster fleet. The SBRM describes the methods and processes used to monitor bycatch for all fishery management plans as required by the Magnuson-Stevens Fishery Conservation and Management Act. Potential changes will include expansion of the sampling frame to include all federally permitted lobster vessels. Once amended, the NEFOP will be assigned seadays consistent with the SBRM process and data will be collected that further represent the fleet. The observer program collects an extensive suite of biological, gear, and other fishery dependent data during inshore and offshore lobster trips. These data are used by scientists and managers at NMFS, the Atlantic States Marine Fisheries Commission (ASMFC), industry members, and others. Biological sampling protocols are regularly updated based on feedback from industry members, observers, scientists, and managers to better match their data needs and the realities of working on a lobster vessel. Since 2012, the NEFOP has observed over 450 lobster trips and collected biological sampling data from over 300,000 lobsters and crabs in addition to important information for stock assessment and management purposes.

P27-SETTLEMENT INDICES AS PREDICTORS OF COMMERCIAL CATCHES OF THE EUROPEAN SPINY LOBSTER PALINURUS ELEPHAS IN THE NORTHWESTERN MEDITERRANEAN SEA
Anabel Muñoz (anabel.mcaballero@ba.ieu.es), David Díaz, Sandra Mallol, Raquel Goñi
Instituto Español de Oceanografía

Predictions of the size of the commercial catch based on settlement magnitudes have proven valuable in stock assessment and adaptive management of spiny lobsters all over the world. This study assesses the relationship between settlement strength (post-pueruli density) and recruitment strength (catch per unit effort of lobsters at first harvest) of the European spiny lobster Palinurus elephas in exploited fishing grounds from the Northwestern Mediterranean. Over the last 18 years, post-puerulus settlement has been monitored by scuba-diving in several locations of three NW Mediterranean regions. Recruitment strength data were obtained over the last 15 years from onboard sampling of commercial catches in the Balearic Islands lobster fishing fleet (Majorca and Menorca) and in the fleet operating in the Columbretes Islands fishing grounds (NW Mediterranean). Regression analyses were performed on the series of mean annual settlement and recruitment indices. Several delay periods between the series were tested to find the best-fit, and a highly significant correlation was found when using a 3-year time-lag (settlement index and catch of 3-year-old individuals). The results confirm that post-puerulus monitoring may be used as a robust indicator of recruitment strength and, hence, of future fishery performance. Therefore, settlement indices offer a valuable tool for the proactive management of this valuable but dwindling resource in the study area. An interesting next objective would be to expand this study to other regions in both the Mediterranean and Atlantic where decades ago P. elephas supported highly valuable fisheries. In the short term, our objective is to convince local fishery managers to adopt the European spiny lobster settlement index as a key tool for managing the fisheries for the future.
P28-EVALUATION OF *HOMARUS GAMMARUS* CATCHES AND POTENTIAL IN A MEDITERRANEAN SMALL-SCALE FISHERY

Anthony Pere¹ (anthopere@yahoo.fr), Michel Marengo², Pierre Lejeune³, Eric D.H. Durieux
¹No Affiliation, ²University of Corsica Pasquale Paoli, ³Station de Recherches Sous-marines et Océanographiques

The European lobster fishery is important for the fishing communities throughout its range. In the Mediterranean, *Homarus gammarus* (Linnaeus, 1758) is not targeted and is rather a by-catch from trammel net targeting the common spiny lobster. Given the equivalent high commercial value, it is nevertheless potentially interesting in order to diversify crustacean-fishing activities. In Corsica island (France, NW Mediterranean), the overall fleet is artisanal and fully representative of the Mediterranean small-scale fisheries. The aim of this study was to have a better understanding of the exploitation pattern and to obtain the first ecological information about the European lobster population around Corsica. We analyzed: (1) total annual production in the island; (2) size distribution; (3) the catch per unit of effort (CPUE); and (4) the potential abundance. Data were collected by scientific observers on-board fishing vessels for 8 consecutive years from 2006 until 2013, during a net monitoring program. Total annual catches were estimated to 6.7 tonnes, representing about 1.2% of total captures at the national level. Length frequencies indicated that exploitation focused on large individuals: 93% of lobsters sampled were beyond the MLS. CPUE varied significantly as a function of month, strata, and depth. Our spatial approach revealed a heterogeneous catch distribution and identified important catches in the south area, which could be due to locally more suitable habitats for adults coupled with important larval pool coming from the Bonifacio Strait Natural Reserve. A fishery independent survey was performed over 2013 and 2014 in West Cap Corse using a lobster specific trap; it displayed an extremely low catch rate, which confirmed the low abundance for this area. Such results showing an overall relatively low abundance (compared to the south) coupled with life history traits characteristics of the species highlight the low potential of *Homarus gammarus* as a targeted species for fisheries development.

P29-THE CHALLENGES OF THE MSC CERTIFICATION: A CASE STUDY USING A LOBSTER SMALL-SCALE FISHERY

Monica Perez-Ramirez (monicaypr@yahoo.com.mx)
Centro de Investigaciones Biologicas del Noroeste S.C.

The Marine Stewardship Council (MSC) certification is a market-based instrument recognizing sustainable fishing practices through a public, third-party assessment. MSC standards evaluate: (1) the target species, (2) the ecosystem impact of the fishery, and (3) the management system. The Mexican spiny lobster (*Panulirus argus* Latreille, 1804) small-scale fishery was MSC-certified in 2012. The annual catch is estimated at 280 t and its main market is domestic. Using a questionnaire survey among fishermen and in-depth, semi-structured interviews with fishery leaders, the study assesses socioeconomic issues, technical barriers, and perceptions regarding MSC certification. Increasing market-share was a main motivation to pursue certification. From the surveyed fishermen, a majority of the households were dependent on at least half of their monthly income from the fishery. Fishermen are organized into six cooperatives that have spatial property rights and self-management ability driven by strong social cohesion. Technical barriers involved: (1) lack of scientific-based information on specific issues (i.e., stock assessment and ecosystem structure); (2) absence of a formalized harvest strategy including harvest control rules; (3) high costs associated with certification; and (4) lack of long-term agreements with management bodies to meet certification conditions. MSC certification was negatively perceived by most fishermen since it may not offer economic incentives for the fishery, but it may increase management costs. However, certification may be a diagnostic tool to identify the improvements required to move the fishery toward better performance.
P30-DIRECTLY AGEING THE CARIBBEAN SPINY LOBSTER, PANULIRUS ARGUS, USING THE GASTRIC MILL

Gayathiri Gnanalingam1 (ggnan001@odu.edu), Mark J. Butler IV1, Thomas R. Matthews2, Emily Hutchinson2
1Old Dominion University, Norfolk, VA, 2Florida Fish & Wildlife Conservation Commission

Robust fisheries management of crustaceans has been hampered in part by our inability to directly age individuals. Like other crustaceans, lobsters grow through a process of ecdysis long believed to result in the loss and replacement of all calcified structures. As such, conventional ageing methods were thought to be inapplicable. However, Kilada et al. 2012 demonstrated that age could be accurately estimated in four temperate decapods by counting bands deposited in the eyestalk and ossicles of the gastric mill. The technique has since been applied to a few other crustaceans, but no tropical species. In the Caribbean, the tropical spiny lobster Panulirus argus supports one of the region’s largest and most economically valuable fisheries whose management would benefit if the age and size of individuals could be differentiated. Here we present the results of an ongoing study to verify use of the gastric mill and eyestalks to directly age P. argus. We have discovered clearly distinguishable bands in the meoscardiac and zygotic ossicles of the gastric mill that differ logically between animals of different sizes and known age. Lobsters tagged with calcein retain these tags through several molts and we are using marked bands in the gastric mill to validate band counts. In an ongoing experiment, we are also testing whether the deposition of bands is influenced by the frequency of ecdysis or temperature, or is simply a function of chronological age. Thus far, the results have been promising and suggest that a direct method for ageing P. argus could well be possible in the near future.

P31- USING DEGREE DAYS TO DEFINE YOUNG-OF-YEAR STATUS IN THE AMERICAN LOBSTER SETTLEMENT INDEX

Robert Russell (robert.russell@maine.gov)
Maine Department of Marine Resources

The American Lobster Settlement Index (ALSI) began in 1989 in midcoast Maine. Since then this survey has expanded to include more than 100 sites from Rhode Island to Newfoundland. Utilizing diver suction sampling and vessel deployed collectors the ALSI is currently the only survey looking at the initial benthic life stage of lobsters. A primary goal of the ALSI collaborative is to create a predictive model of future lobster recruitment to the fishery based on the relative strength of the settlement signal. The first step in determining the annual settlement signal is assigning sampled lobsters to a year class based on carapace length. This is done by looking at the upper size limit of the first mode in the size frequency histograms. Changing water temperatures and variations in sampling dates may confound the definitions of Young-of-the-Year (YOY) annually and regionally. For example, should some portion of the next mode be included in the size definition because a particular sample site was bathed in warmer water for a longer period of time? In order to standardize these different thermal regimes and determine potentially longer development times, we will calculate the number of degree days up until the time of sampling by individual site for the Maine subset of the broader index and make more targeted size definitions. Impacts of this method on defining YOY will be evaluated and presented for possible use in the ALSI collaborative.
Gene Expression

P32-NUCLEAR RECEPTOR INTERACTIONS AND THEIR ROLE IN CRUSTACEAN MOLTING AND METAMORPHOSIS
Cameron John Hyde¹ (cameron.hyde@research.usc.edu.au), Quinn Fitzgibbon², Abigail Elizur¹, Greg Smith², Tomer Ventura¹
¹University of the Sunshine Coast,²Institute of Marine and Antarctic Studies

Molting and metamorphosis are critical processes in arthropod development that often hamper crustacean aquaculture endeavors. Exposing the endocrine pathways leading to these events could resolve challenges encountered in larval culture. Solutions for commercially viable aquaculture of spiny lobsters have long been pursued due to their persistently unmet market demand and limited fishery. Recent advancement has successfully closed the lifecycle in three commercially relevant species in Australia. The elongated, well-defined progression towards metamorphosis presents spiny lobsters as a great model for studying molting and metamorphosis. It is known that ecdysone release triggers a molt, while metamorphosis is inhibited by the juvenile hormone. However, the molecular mechanism which links these two hormones remains obscure. What is known is that both hormones act through nuclear receptors that function as ligand-induced transcription factors. Interactions between nuclear receptors modulate their DNA-binding response, resulting in a multitude of transcriptional outcomes from relatively few inputs. By taking advantage of spiny lobsters as biological models, we have produced a transcriptome that spans metamorphic events and has led to hypotheses of receptor interactions. We present a prospective series of in vitro experiments that are aimed at unwinding the interplay between key nuclear receptors central to the ecdysone response and the role they play in this fundamental regulatory pathway. The great variability and adaptive potential of nuclear receptor interactions makes it a likely candidate for integration of ecdysone and juvenile hormone pathways, and could thus form a master key to manipulate metamorphosis.

P33-IMPACT OF WATER TEMPERATURE ON HOMARUS AMERICANUS GENE EXPRESSION
Louise-Marie D. Roux¹ (lroux@upei.ca), Philip J. Byrne², K. Fraser Clark³, Mark D. Fast¹, Spencer J. Greenwood¹
¹University of Prince Edward Island,²Fisheries and Oceans Canada,³Mount Allison University

The American lobster, Homarus americanus, inhabits almost the entirety of the North Atlantic East coast and is adapted to water temperatures that range between 0 °C to 20 °C. With increasing concerns for the impact of changing water temperatures, a controlled laboratory study was designed to begin to explore the impacts of temperature on gene expression. The present study used a lobster-specific oligonucleotide microarray containing 14592 genes to examine the transcriptomic profiles of H. americanus held at four different water temperatures 10 °C, 15 °C, 17.5 °C, and 20 °C. One-way ANOVA analysis (with α = 0.01 and the proportion of false significant genes < 0.05) identified 789 significantly differentially expressed genes. Hierarchical clustering of the significant genes revealed distinct transcriptomic profiles between H. americanus held at each temperature. Of the significantly differentially expressed genes only 46% were annotated; gene ontology analysis however revealed that temperature had significant effects on gene expression in a number processes including development, immunity and metabolism. Ubiquitin and DEAD box ATP-dependent RNA helicase showed increased expression with increasing temperature, whereas cathepsin A isoform B decreased in expression with increasing temperature. Several ribosomal proteins (S13, S3, L39) were also significantly differentially expressed. Microarray results were verified using RT-qPCR on a select number of genes. Results from this study begin to characterize how temperature influences H. americanus on a broad molecular level.
Functional Morphology

P34-LANDMARK ANALYSIS OF AMERICAN LOBSTER SHAPE IN THE GULF OF MAINE
Joseph G. Kunkel¹ (joe@bio.umass.edu), Melissa Rosa², Brian Tarbox³
¹University of Massachusetts – Amherst, ²University of New England, Biddeford, ME ³Southern Maine Community College

The American Lobster carapace shape is studied in 3-dimensions by Geometric Morphometrics. A Microscribe G2X 3D digitizer collects homologous landmarks recognizable in all specimens, chosen from suture convergences and muscle attachments on the carapace. Offshore sampling of lobster populations were made aboard NOAA Ship H.B. Bigelow cruise legs on Northeast Bottom Trawl Surveys and digitized at sea. Inshore population samples were obtained from day-trip lobster boats and digitized on land. Collected landmark coordinates were analyzed using the R Geomorph library as well as custom written R-scripts. Shape was found to vary depending on size, sex, and population location in the Gulf of Maine and Georges Bank. The multivariate matrix of aligned carapace landmarks were analyzed by multivariate ANOVA and fractions of the total shape variability were explained by quantitative covariates such as size and discrete factors such as sex and population membership. A relationship tree connects populations and sexes in a smooth manner.

P35-DESCRIPTION OF THE SETAE ON THE PEREIPODS OF SCYLLARID LOBSTERS, SCYLLARIDES AEQUINOCTIALIS, S. LATUS, AND S. NODIFER, WITH OBSERVATIONS ON THE FEEDING SEQUENCE DURING CONSUMPTION OF BIVALVES AND GASTROPODS
Kari L. Lavalli¹ (klavalli@bu.edu), Cassandra N. Malcom², Jason S. Goldstein³
¹Boston University, College of General Studies, Boston, MA, ²Educational Testing Service, Sacramento, CA, ³Maine Coastal Ecology Center, Wells National Estuarine Research Reserve, Wells, ME

The morphological and behavioral aspects of slipper lobster feeding have remained largely unexplored. Using Scanning Electron Microscopy (SEM), the gross morphological structure of all segments of the pereiopods were described for three species of scyllarid lobsters: Scyllarides aequinoctialis, S. latus, and S. nodifer. Five types of setae within three broad categories were found: simple (long and miniature), cuspidate (robust and conate), and teazel (a type of serrulate setae). Setae were arranged in a highly organized, row-like pattern on the ventral and dorsal surfaces. Cuspidate setae were found on all surfaces of all segments. Simple setae were found only on the dactyl, whereas teazel setae were concentrated on the lateral-most edge of the alate carina on the merus in S. aequinoctialis only. Comparisons among species demonstrate that S. nodifer bears the same setae and setal pattern as S. latus, but S. aequinoctialis differs. The setal patterns of slipper lobsters contrast with those of nephropid and palinurid lobsters, likely due to the more rigorous use of the pereiopods in accessing their food. Feeding sequences of S. aequinoctialis on bivalves were videotaped, analyzed as Markovian chains, and showed a complex suite of behaviors involving contact chemoreception by the antennules as part of an initial assessment of food items, followed by mouthpart and leg probing, and eventual wedging behavior as previously described for S. squammosus. Feeding sequences of S. latus on gastropods and bivalves also demonstrate extensive use of the pereiopods (instead of the mouthparts) first to pry these prey items from the substrate and then to remove the foot. Use of antennules for food assessment and recruitment of many of the pereiopods for food handling with minimal use of mouthparts also contrasts with the feeding sequences typical of nephropid and palinurid lobsters and may be an important adaptation.
P36-THE SLIPPER LOBSTER, *SCYLLARIDES LATUS*, USES APATITE AND FLUORAPATITE TO PROTECT ITS SENSORY ORGANULES

Kari L. Lavalli¹ (klavalli@bu.edu), Joseph G. Kunkel², Ehud Spanier³

¹Boston University, College of General Studies, Boston, MA, ²Biology Department, University of Massachusetts, Amherst, MA and Center for Land Sea Interaction, Marine Science Center, University of New England, Biddeford, ME, ³The Leon Recanati Institute for Maritime Studies & Department of Maritime Civilizations, The Leon H. Charney School for Marine Sciences, University of Haifa, Haifa, ISRAEL

The cuticle of arthropods has been intensely studied not only to better understand the properties of a natural composite material, but also to understand how structural properties and mineral contributions to this composite offer a durable protective covering from predator and microbial attack. Thus far, most marine cuticular studies have focused on the American lobster, *Homarus americanus*, or several crab species, but have largely ignored other types of lobsters, such as spiny or slipper lobsters that have exoskeletons differing in both structural properties (i.e., amount of trabeculae present in pits and spines) and resistance to structural failure. Using an electron microprobe, we analyzed various segments of the exoskeleton of the Mediterranean slipper lobster, *Scyllarides latus*, to determine the mineral content in discrete domains of cuticle. EMP analysis determined that the cuticle of *S. latus* is similar to that of *H. americanus* in that it contains carbonate apatite in canal linings and in the areas surrounding sensory organules (setae). The slipper lobster also uses a fluorapatite mineral that further adds strength to the shell. Results will be discussed in the context of what this means for defense against attack and differences in environmental water chemistry and resilience to climate change.

P37-LOBSTER’S LIVING BIOTOPE, MORPHOLOGY AND BEHAVIOR: CAN THESE CONNECTIONS BE USED TO LEARN MORE ABOUT REALLY CONCEALED LIFE STAGES?

Gro I. van der Meeren¹ (grom@imr.no), Astrid K. Woll²

¹Institute of Marine Research, Bergen, Norway, ²Woll Naturfoto, Midsund, Norway

The natural living biotope of all animals is reflected on their body shape and by their behavior. In European lobster (*Homarus gammarus*) it is well established that they are nocturnal predators and scavengers, can easily move both forwards and backwards, and shelter in caves and burrows. Their slender, long bodies are a perfect fit for life in rocky and complex bottoms, while the antennules and antennae provide them with excellent taste and touch senses, respectively, for navigating their dark world. Other decapod species, although mostly nocturnal, have other body shapes: heavy chelae and a wide and flattened body in the edible crab (*Cancer pagurus*); spiky carapace, long appendices, and slender claws in king crabs (*Paralithodes camtschaticus*); and something intermediate as reflected by squat lobsters (*Galatheidae*) that are elongated, but also flattened, with a flexible tail that is usually tucked underneath the body. These are all examples of functional morphology and habitat ecology. Still, in the European lobster early life stages, no documentation on the natural living biotope is known. Even with more than a century of hatchery reared lobsters, the present knowledge of the juveniles are all from lab-studies. We have some anecdotal information and observations of laboratory-hatched young-of-the-year juveniles in tanks, with various levels of habitat constructions provided. Searches in nature have been futile. These searches have been based on knowledge of the larger lobsters of more than 50 mm carapace length. We want to make some pure speculations on why we still cannot find the wild juveniles, and use what we know of their morphology and behavior to suggest where they may be and what may be alternative methods for looking for the missing link - small, juvenile European lobsters.
In American lobsters, *Homarus americanus*, inter- and intra-gender competition in lobsters is highly dependent on the animal’s ability to use its appendages, particularly its large claws, to gain access to resources. This may be particularly true for males competing with other males for access to females. Therefore, claw size may respond, over evolutionary and/or ecological time scales, to geographic variation in competition for mates. In this study, we measured the body (carapace length) and crusher claws of over 5,000 male and female lobsters from inshore water along the Atlantic coast. We found significant geographic variation in claw size in both genders, when standardized for body size, and this variation was markedly more pronounced in males than in the females. Variation in claw size was not simply related to water temperature, as the relation between body-size-adjusted claw size and latitude was opposite in male and female lobsters. For example, male lobsters in the Bay of Fundy and Gulf of Maine had smaller size-adjusted crusher claws than those in the Gulf of St. Lawrence, whereas the opposite pattern was true for females. Our findings support the hypothesis of geographically varying selection on claw size, and they suggest that sexual selection might be an important driver of this variation, given the greater variability in males than females. Future studies should investigate in greater detail the potential mechanisms underlying the small-scale patterns in variation in American lobster claw size revealed in this study.
Growth & Development

P39-THE USE OF ENERGY STORES IN THE TRANSITION FROM FINAL LARVAL STAGE TO FIRST-_STAGE JUVENILE OF THE CARIBBEAN SPINY LOBSTER, PANULIRUS ARGUS
Ali Espinosa-Magaña1 (disarm22@hotmail.com), Patricia Briones-Fourzán1, Andrew Jeffs2, Enrique Lozano-Alvarez1
1Universidad Nacional Autonoma de Méxco, 2University of Auckland

Panulirus argus has 10 phyllosoma stages that develop in oceanic waters. The final stage (FX) metamorphoses into a non-feeding (lecithotrophic) postlarva, the transparent “nektonic puerulus” (NP), which actively swims towards the shore and settles in shallow coastal vegetated habitats. After settlement, “transparent benthic pueruli” (TBP) become “pigmented pueruli” (PP) and eventually molt into “first-stage juveniles” (J1), which resume feeding. To determine the amount of energy stores used in the development from FX to JI, we examined the content of total proteins, total lipids, and lipid classes in multiple individuals of each stage in two different seasons corresponding to the primary (autumn) and secondary (spring) peaks in coastal pueruli settlement. We collected FX and NP during two oceanographic cruises in the Mexican Caribbean in autumn (November 2012) and spring (April 2013). During the same seasons, we obtained TBP, PP and J1 from artificial collectors permanently deployed in two Mexican coastal locations. On average, the percentage of total lipids (relative to the dry weight of individuals) decreased progressively with development, from 26% in FX to 7% in J1 in the autumn (a 73% decrease), and from 25% to 6% in the spring (a 76% decrease), with the greatest decrease occurring between FX and TBP in both seasons (~ 45% in autumn 2012 and ~ 53% in spring 2013). In all stages, phospholipids accounted for ~80–87% of total lipids. Unlike lipids, the percentage of proteins did not decrease progressively with development, exhibiting higher and similar levels in NP, TBP and PPB, and lower levels in FX and J1. However, total lipids and proteins decreased significantly between PP and JI, reflecting the high energy demand required to fuel the molting process as found in other palinurids and underlining the importance to JIs of resuming feeding soon after the molt.

P40-OXYGEN CONSUMPTION AND CRITICAL POINT IN THE CARIBBEAN SPINY LOBSTER, PANULIRUS ARGUS, LATREILLE 1804
Gerardo Suarez Alvarez1 (gerardo650@hispavista.cl), Ocampo Lucia2
1Centro de Investigaciones Pesqueras, Havana, CUBA, 2Centro de Investigaciones Biologicas del Noroeste, CIBNOR, Havana, CUBA

The metabolic rate of the spiny lobster Panulirus argus was estimated at 49.4 mg O₂ kg⁻¹ h⁻¹ at 20 °C for specimens of 520 g of average weight. Studies on the water replacement required for its normal functioning and survival indicate that each lobster needs between 20 to 60 liters of sea water per hour to metabolize normally. Research on the metabolic rate indicated that the habits of lobster are nocturnal, and if they are fed, the respiratory metabolism increases by 3.5 times its standard value. This report indicated that for aims of storage of unit in cages or pools, without affecting its survival, the following model will be used: mgO₂.kg⁻¹.h⁻¹ = -9.209849+1.160395*(L.h⁻¹)-6.782791*(L.h⁻¹)²+1.326459*(L.h⁻¹)³-8.225767. We found that decreases in salinity affect the respiratory behavior making it decrease. The lethal limit of oxygen was determined experimentally between 0.70 and 0.80 mg O₂ L⁻¹ as the critical value.
Population Dynamics & Connectivity

Elizabeth Baker (elizabeth.baker@dfo-mpo.gc.ca), Jessica Cosham, Shannon Scott Tibbetts
Fishermen and Scientists Research Society

The Lobster Recruitment project began in the spring of 1999. The goal of the project is to provide an index of the number of lobsters that will molt into the legal sizes in the coming seasons. The project was initiated by the Fishermen and Scientists Research Society (FSRS) in cooperation with the Invertebrate Fisheries Division (currently named Population Ecology Division), DFO at the Bedford Institute of Oceanography (BIO). The initial phase of the project was planned for five years; however, after reviewing the project’s usefulness, it is scheduled to continue for the foreseeable future. This project involves over 130 volunteer fishermen from LFAs 27-35 who fish standardized traps and take measurements of the lobster caught. These measurements are recorded in a logbook using a specially designed gauge with 15 different size increments. Participating fishermen also monitor bottom temperatures with a mini-log temperature gauge in one of the standard traps. These bottom water temperatures are forwarded to the oceanographers at BIO and are a great addition to their coastal temperature monitoring database. The lobster information gathered has been used by Fisheries and Oceans Canada (DFO) in their lobster stock assessments and has helped to greatly understand the lobster populations around the Scotian Shelf area of Nova Scotia.

P42-DO LOBSTER LARVAE RELEASED OVER THE GULF OF MAIN AND GEORGES SUBSIDIZE THE LOBSTER STOCK OFF SOUTHERN NEW ENGLAND?
James H. Churchill1 (jchurchill@whoi.edu), Geoff Cowles2, Robert Glenn3, Richard Wahle4, Tracy Pugh5, Burton Shank6
1Woods Hole Oceanographic Institution, 2University of Massachusetts – Dartmouth, MA, 3Massachusetts Department of Marine Fisheries, 4University of Maine, Orono, ME, 5Massachusetts Department of Marine Fisheries, and 6NOAA Northeast Fisheries Science Center

The lobster harvest off the southern coasts of Rhode Island and Massachusetts (in Lobster Management Area-2; LMA-2) experienced a significant decline in the early 2000’s and has been at historically low levels since 2003. This decline has been accompanied by a sharp decrease in the settlement and early-stage survival of post-larval lobsters. A concern is that the supply of juvenile lobsters to suitable settlement habitat in LMA-2 may have shrunk due to temporal and spatial shifts in egg release within LMA-2 associated with warming ocean temperatures. To better understand factors that control and limit juvenile lobster recruitment in LMA-2, we have conducted bio-physical modeling of the development and transport of lobster larvae released from points distributed over LMA-2 as well as over Georges Bank and the Gulf of Maine coastal region. A goal was to determine the extent to which the juvenile lobster stock in LMA-2 may be subsidized by the delivery of lobster larvae released in other regions. Our results indicate a small, but potentially important, delivery of juvenile lobsters to LMA-2 from release locations on southern Georges Bank and in the western Gulf of Maine. This source of juveniles appears to vary seasonally, being greatest in the late summer and early autumn. It also exhibits significant interannual variability associated with both variations in the large-scale regional circulation and in the local wind-driven flow in LMA-2. As a cautionary note, we find that the model results are highly sensitive to variations of the parameters representing larval growth as a function of temperature. The uncertainty in the estimates of larval delivery from remote release locations is largely due to uncertainty in these parameters.
P43-UNDERSTANDING SETTLEMENT DYNAMICS OF THE EUROPEAN SPINY LOBSTER (PANULIRUS ELEPHAS) IN THE MID-WESTERN MEDITERRANEAN
David Díaz1 (david.diaz@ba.ieo.es), M. Leduc2, M. Patrissi2, A. Abadi2, Anabel Muñoz1, Sandra Mallol1, Raquel Goñi1, C Pelaprat2
1Instituto Español de Oceanografía, Centro Oceanográfico de Baleares, Palma de Mallorca, Spain, 2Station de Recherches Sous-marines et Oceanographiques, STARESO,Pointe Revellata,Caldvi, France

It is generally accepted that the dispersal capacity of lobster larvae is directly linked to the duration of their pelagic phase. During the 5-month long dispersal phase of Palinurus elephas phyllosomas, both dispersion and survival are shaped by environmental and hydrographic conditions. Ongoing studies of spatial and temporal patterns of puerulus settlement in the NW Spanish Mediterranean indicate temporal synchrony at a 100 km scale. To shed light on the scale of drivers of settlement success, we expanded the study area to the Mid-northwestern Mediterranean and during four years (2013 to 2016) surveyed locations around islands separated up to 750 km (Mallorca Is – Corsica Is) by scuba diving. To integrate small-scale spatial variability, in each location we sampled three sites separated by < 500 m. Settlement indices at the two islands were similar in both magnitude and temporal pattern, lending weight to the hypothesis of a common larval pool in the NW Mediterranean basin and of a negligible effect of local environmental conditions. The similarity of the magnitude of the settlement indices in the two regions also suggests similar settlement habitat or cues for habitat selection. These results highlight the need of coordinated management efforts at a larger scale than anticipated.

P44-PANULIRUS PASCUENSIS LARVAL CONNECTIVITY BETWEEN MOTU MOTIRO HIVA MARINE PARK AND EASTER ISLAND: IMPLICATIONS FOR MANAGEMENT
Erika I. Meerhoff1,2 (ilikameerhoff@gmail.com), Beatriz Yannicelli1,2,3, David Veliz2,4, Caren Vega-Retter4, Boris Dewitte1,2,5,6, Marcel Ramos1,2,5, Luis Bravo2,5, Freddy Hernandez7
1Centro de Estudios Avanzados en Zonas Arides (CEAZA), Coquimbo, Chile, 2Millennium Nucleus for Ecology and Sustainable Management of Oceanic Islands (ESMOI), Universidad Católica del Norte, Coquimbo, Chile, 3Centro Universitario Región Este, Universidad de la Republica, Rocha, Uruguay, 4Departamento de Ciencias Ecológicas, Facultad de Ciencias, Universidad de Chile, 5Departamento de Biología, Facultad de Ciencias del Mar, Universidad Católica del Norte, Coquimbo, Chile, 6Laboratoire d’Etudes en Géophysique et Océanographie Spatiale, Toulouse, France, 7Dirección de oceanografía naval, Instituto oceanográfico de la armada, Guayaquil, Ecuador

Panulirus pascuensis is the endemic lobster from Easter Island that is also present in Pitcairn Island and Salas y Gómez Island where a 150,000 km² no-take Motu Motiro Hiva Marine Park has recently been created. It is an important fishery resource for inhabitants of Easter Island. However, harvesting has affected its abundance and the size of individuals has been reduced, suggesting possible overexploitation. In order to investigate the larval connectivity between Easter Island and Motu Motiro Hiva Marine Park, we evaluated the genetic connectivity and a bio-physical model (IBM) has been implemented based on outputs of the Regional Oceanic Modelling (ROMS) at the resolution of ~3 km over the period 2000-2015. As a first step, some aspects of the simulated circulation is validated from satellite observations highlighting the larger level of mesoscale activity in the model compared to observations. We then evaluated the sensitivity of the distribution of the adults to the bathymetry and depth (depth of larval liberation: 0-50 m and 50 to 200 m depth), planktonic development length (PDL, 6, 8, 10 and 12 months). We also studied how the interannual variability affects the degree of self-recruitment and connectivity between these areas. The genetic analysis showed largest effective population sizes in Salas y Gómez Island when compared with Easter Island, and asymmetric connectivity, with more migrants from Salas y Gomez to Easter Island (5 fold). From the oceanographic modelling, an asymmetric connectivity also was observed, with more larvae being transported from Motu Motiro Hiva Marine Park to Easter Island at both strata. At the surface, we observed a peak in connectivity in 2008 and 2012 for 6 months PDL. Our results support the importance of Motu Motiro Hiva Marine Park in the seeding of P. pascuensis larvae to Easter Island.
P45-IS EVERYTHING ALWAYS THE SAME? TEMPORAL GENETIC STABILITY OF EASTERN ROCK LOBSTER PUERULUS WITHIN AND BETWEEN COHORTS
Laura N. Woodings¹ (17869067@students.latrobe.edu.au), Nicholas P. Murphy¹, Geoffrey W. Liggins², Jan M. Strugnell³
¹La Trobe University, ²NSW Department of Primary Industries, ³James Cook University, Australia

Settlement of post-larvae is often geographically and temporally variable in the marine environment. This variability can be observed in terms of changes in abundance and within the genetic structure of settling individuals. Variability in settling individuals is commonly observed for species, such as the commercially important Eastern Rock Lobster, Sagmaria verreauxi, which exhibits high fecundity, high early mortality, and long pelagic larval durations. On-going monitoring of S. verreauxi puerulus settlement has shown that lower abundance of settlers occurs at sites of the northern limits of S. verreauxi settlement, while higher abundance occurs at southern sites. There is also temporal abundance variance within the settlement window, which occurs from August to December, with peak abundance generally observed in October. While the patterns of settler abundance is well resolved for S. verreauxi, the genetic structure for the settling puerulus is unknown. By assessing the genetic structure of the puerulus, a better understanding of whether events such as sweepstake reproductive success and natural selection are occurring and whether they occur consistently within a cohort and across cohorts from different years. The aim of this study was to determine the genetic structure and its temporal stability of S. verreauxi puerulus that recruit into the New South Wales Fishery in eastern Australia. Samples were collected monthly from 4 locations along the NSW coast across two consecutive years. The locations included two northern sites with low abundance and two southern sites with higher abundance. SNPs were obtained via double digest Restriction Associated DNA Sequencing (dAD Seq). Population structure will be determined through bioinformatic examination of the differences in the relative frequencies of alleles from each location, as well as within a settlement period and between settlement periods of the two years. The geographic structure and temporal stability of the S. verreauxi puerulus will be presented and the possible causes of these patterns will be discussed.

P46-EVALUATING LONG TERM ESLSI (EUROPEAN SPINY LOBSTER SETTLEMENT INDEX) IN THE WESTERN MEDITERRANEAN
David Díaz¹ (david.diaz@baieo.es), Anabel Muñoz¹, Ben Stobart², Mikel Zabala³, Diego K. Kersting³, Cristina Linares³, Sandra Mallol¹, Raquel Goñi¹
¹Instituto Español de Oceanografía, ²SARDI Aquatic Sciences, ³Universitat de Barcelona

The European Spiny Lobster Settlement Index (ELSI) is a component of annual monitoring program of the European spiny lobster Palinurus elephas that quantifies the arrival of postpuerulus in three Western Mediterranean locations separated by +100Nm. Long term monitoring of early benthic juveniles helps understand the variability of the recruitment process and to predict year-class strength from a 3-year vantage point. This predictive capability of the ESLSI allows a proactive management of the fisheries for this valuable, but overfished species in the region. Also, this data set encompassing the NW Mediterranean basin and a series of +10 years, allows us to investigate correlations between settlement success and oceanic and atmospheric variables. In 1997 the first post-settlers of P. elephas were found in the coast of the NE Iberian Peninsula and the monitoring program was initiated in 1998. Three regions were surveyed every summer: coastal NE Iberian Peninsula (Catalonia) and the archipelagos of the Columbretes and Balearic Islands. In the last 18 years, a total of 24 locations and more than 60 sites have been surveyed. The complete series encompasses 16 years (2000-2016), 12 locations and 38 sites, sampled routinely by underwater visual censuses (UVC) to estimate settlement index strength. In 2004, a spiny lobster artificial collector was successfully designed to complement the UVC estimates. Stations of artificial collectors have been in operation experimentally in the Balearic Islands since 2009 and in Corsica since 2016. The collectors remain underwater year-round and are surveyed during summer peak settlement months (June-August). The next step for the ESLSI team members will be to consolidate the artificial collector stations and expand UVC censuses to other regions in both the Mediterranean and Atlantic where P. elephas is, or was, an important species ecologically and economically for the local fisheries.
Reproductive Biology

P47-A NOVEL METHOD FOR CHARACTERIZING AMERICAN LOBSTER SPERMATOPHORE COMPOSITION AS A MEASURE OF POTENTIAL REPRODUCTIVE OUTPUT
Benjamin C. Gutzler1 (bg1067@wildcats.unh.edu), Jason Goldstein2, Tracy L. Pugh3, Winsor H. Watson III1
1University of New Hampshire, Durham, NH, 2Wells National Estuarine Research Reserve, Wells, ME, 3Massachusetts Division of Marine Fisheries

Changes in the thermal environment of inshore Southern New England (SNE), in combination with a number of diseases including a high incidence of shell disease, have been implicated in the decline and recruitment failure of the SNE lobster stock. We hypothesize that sub-lethal effects of physiological stress resulting from high water temperatures have resulted in reduced reproductive output in SNE lobsters. One indicator of this decline might be insufficient or low quality sperm being passed to females. As climate change is expected to persist, stressful environmental conditions could spread northwards into the highly productive Gulf of Maine (GOM) lobster stock, making it critical to understand how physiological stress induced by a changing climate might affect reproductive output. As a first step towards examining this question, we have developed two methods for quantifying the number of sperm in a spermatophore. The first method involves homogenizing spermatophores, removing an aliquot, staining sperm with acridine orange, and then using ImageJ to quantify the number of sperm from images obtained from a fluorescent microscope. The second method involves quantifying the amount of DNA in a spermatophore, using a Qubit fluorometric system, after determining the amount of DNA in each sperm. The advantages and disadvantages of each method will be discussed.

P48-TESTING THE AUTODIAMETRIC METHOD TO QUANTIFY OVARIAN FECUNDITY IN AMERICAN LOBSTERS
Julien Gaudette1 (julien.gaudette@dfo-mpo.gc.ca), Feng Tang2,3, Brent Wilson1,2, Rémy Rochette2
1St Andrews Biological Station, Fisheries and Oceans Canada, St Andrews, Canada
2University of New Brunswick, Saint John, Canada

A core objective in any fishery management plan is to maintain reproductive capacity of the stock to avoid recruitment overfishing. Typically, stock assessments use proxies of reproductive capacity such as abundance indices and spawning stock biomass as they are easier to quantify. Work conducted by the Lobster Node and Bay of Fundy Lobster Assessment Program has revealed processes (sperm limitation, egg loss, massive resorption) that challenge the paradigm that stock reproductive capacity is necessarily proportional to spawning stock biomass or abundance indices. A better understanding of processes involved in stock reproductive output would help identifying effective harvest control rules to mitigate limiting factors for reproduction, and reduce the uncertainties surrounding reproductive stock status. This requires first an ability to effectively evaluate reproductive potential such as ovarian fecundity. However, ovarian fecundity in lobster is rarely quantified directly, as traditional approaches such a gravimetric method are tedious. We tested autodiametric method to quantify ovarian fecundity in the American lobster more easily. This method is based on a relationship between oocyte density (i.e. number of oocytes per gram of ovary) and mean oocyte diameter and was initially developed for groundfish. Once the relationship is known, ovarian fecundity is simply estimated by measuring the average oocyte diameter and the ovary wet weight. Primary results show a tight relationship between oocyte density and diameter. Estimated fecundity based on both methods are well correlated (R²~0.9). This method shows great potential to quantify ovarian fecundity in lobster, and could be easily used in conjunction with size-at-onset-maturity studies that are based on ovary development.
P49- TRACKING THE DEVELOPMENT OF INDIVIDUAL AMERICAN LOBSTER EMBRYOS TO MORE ACCURATELY PREDICT TIME OF HATCH

Tammy (Sha) Bo¹ (m4edq@unb.ca), Julien Gaudette², Rémy Rochette¹

¹University of New Brunswick, Saint John, ²Fisheries and Oceans Canada

Connectivity among American lobster populations influences stock structure and recruitment dynamics, knowledge of which is important to the management of lobster fisheries. Connectivity via larval drift is generally estimated using dispersal models, which are sensitive to variation in the timing of larval hatch. This study will develop and test a technique to estimate the development of individual embryos (separated from a female’s clutch) in order to improve our ability to predict hatch time of lobster embryos and connectivity estimates over large geographic areas. We will raise ovigerous female lobsters (n=6) and individual embryos (n=20/female) in two separate labs located in southwest New Brunswick, Canada, one at ambient (7–13 °C) and the other at constant (12 °C) temperature, from February to August 2017. Every week until all larvae hatch, we will measure the Perkins Eye Index (PEI) and yolk area of 20 randomly selected embryos from each female and of all 120 individually-raised embryos. We will (i) determine whether embryos isolated from a female’s brood develop at same rate and hatch at same stage as embryos raised in a brood attached to a female; (ii) quantify the contribution of intra- and inter-brood variability in development rates and stage at hatch to the temporal distribution of hatch to assist future sampling programs; (iii) determine whether PEI or yolk area provides the better metric of embryonic development and “stage” at hatch; and (iv) determine the extent to which our ability to predict observed hatch is improved by randomly allocating to different embryos, through simulations, the variability in development rates and stage at hatch observed during the study. Improving predictions of American lobster embryonic development and time of hatch can be used to improve estimates of larval release time in nature, thereby improving modelled connectivity between lobster stocks via planktonic dispersal.