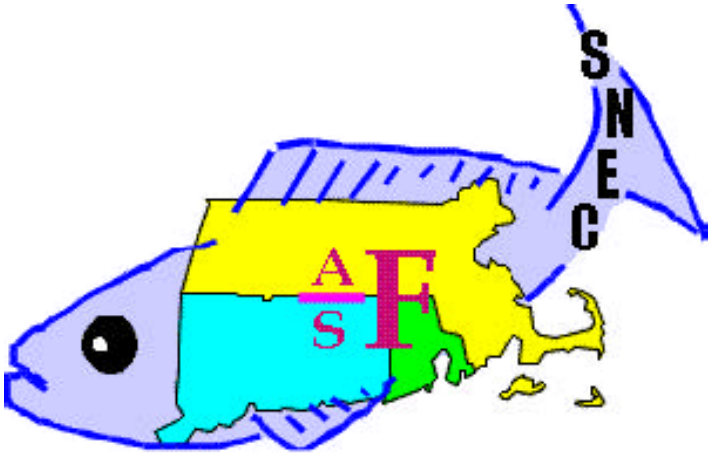
Southern New England Chapter
American Fisheries Society
2016 Winter Meeting



www.snec-fisheries.org

January 14, 2016
University of Connecticut
Avery Point Campus
Groton, CT

Program

AGENDA FOR SNEC AFS 2016 WINTER MEETING
THURSDAY JANUARY 14, 2016

8:20-8:50 ***Registration and Coffee***

8:50-9:00 **Opening Comments.** Glenn Chamberlain, SNEC AFS President

9:00-9:20 **Suitable indicators of fish condition: an evaluation of new and old metrics for three flatfishes with different reproductive strategies.** Mark Wuenschel, Dave McElroy, Ken Oliveira

9:20-9:40 **Observations of vertical movements and depth distribution of migrating female lumpfish (*Cyclopterus lumpus*) in Iceland from data storage tags and trawl surveys**. James Kennedy, Sigurður Þ. Jónsson, Halldór G. Ólafsson, and Jacob M. Kasper

9:40-10:00 **Evaluating reproductive strategies in alewife (*Alosa pseudoharengus*) using pedigree reconstruction**. Meghna Marjadi*, Adrian Jordaan, Allison H. Roy**,** Benjamin I. Gahagan, Andrew R. Whiteley

10:00-10:20 **Acoustic telemetry in American Shad (*Alosa sapidissima*): Surgical implantation and subsequent movements in the Charles River and coastal waters**. Ben Gahagan, Michael Bailey, and Kevin Cheung

10:20-10:40 ***Coffee break***

10:40-11:00 **A re-evaluation of yolked oocyte development and estimates of American shad annual fecundity in the Connecticut River, USA**. Richard S. McBride, Rosalia Ferreri, Emilee K. Towle, and Gualtiero Basilone

11:00-11:20 **Demographics and dynamics of the 2015 spawning migration of American shad (*Alosa sapidissima*) in the Connecticut River.** Boucher, Jason M., and Richard S. McBride

11:20-11:40 **The effects of anadromous forage fish biomass restoration on Northeast US Marine Ecosystem.** Beatriz S. Dias*, Steven Mattocks, and Adrian Jordaan

11:40-12:00 **Endocrine disrupting alkylphenolic pollutants in Long Island Sound adversely affect lobster survival, molting and metamorphosis**. Hans Laufer, Ming Chen

*denotes student

12:00-12:10 ***Awards and Business***

12:10-13:00 ***Lunch***

13:00-14:00 ***Poster session***

14:00-14:20 **Latitudinal patterns of condition factors and mercury in coastal fish species *Menidia menidia***. Zofia Baumann, Hannes Baumann, Prentiss Balcom[1], Nicholas S. Fisher, Robert P. Mason

14:20-14:40 **The impact of nutrient induced geomorphic change on production and foraging success of *Fundulus heteroclitus***. David P. Behringer, Linda A. Deegan, James A. Nelson, David S. Johnson, Nathalie R. Moore

14:40:15:00 **Estimating the impacts of fishing and recovery in the closed and opened areas of the Gulf of Maine, focusing on sea scallop mortality**. Samuel C. Asci*, Richard Langton, Kevin D.E. Stokesbury

15:00-15:20 ***Coffee break***

15:20-15:40 **Hybrid 'superswarm' leads to rapid divergence and establishment of populations during a biological invasion.** Denis Roy, Kay Lucek, Ryan P. Walter, O. Seehausen

15:40-16:00 **Characterizing bite marks for the identification of depredation sources in New England sink-gillnet fisheries**. Laura N. Sirak and Kathryn Ono

16:00-16:20 **Using Fishermen's Ecological Knowledge and Scientific Data to Map Cod Spawning Grounds on Georges Bank and Nantucket Shoals.** Greg DeCelles, Doug Zemeckis, David Martins, and Steve Cadrin

ABSTRACTS:

Oral presentations

Estimating the impacts of fishing and recovery in the closed and opened areas of the Gulf of Maine, focusing on sea scallop mortality. Samuel C. Asci*[1], Richard Langton[2], Kevin D.E. Stokesbury[1], *[1]University of Massachusetts Dartmouth, School for Marine Science and Technology, Fairhaven, MA 02719, [2]Northeast Fisheries Science Center, Orono, ME 04473; sasci@umassd.edu*

The Atlantic Sea Scallop (*Placopecten magellanicus*) has historically supported a fishery on the major banks and ledges in the central Gulf of Maine. Benthic photographs of Fippennies Ledge obtained in manned submersible studies in 1986 and 1987 identified dominant invertebrates including scallops, and observed how their densities were affected after 1 year of fishing. Several of these areas were permanently closed to fishing in 2002 (Fippennies, Cashes, and Jefferys Ledges) while Platts Bank remained open. We examined the benthic community, focusing on sea scallop densities and distributions, of the four areas using a drop camera video survey in 2009, 2010, 2011, 2013, 2014, and 2015. A strong year class of juvenile scallops was observed in 2009 in these areas and tracking this cohort through time will provide an estimate of natural mortality rate in fished and unfished areas. Further, the community structure can also be tracked as it changes in these closed and open areas and the video sampling technique allows comparisons with the 30 year old observations. This will enhance the understanding of changes on a decadal times series as well as effects of recent fishing activity to the benthic community structure, with an emphases on the sea scallop.

Latitudinal patterns of condition factors and mercury in coastal fish species *Menidia menidia*. Zofia Baumann[1], Hannes Baumann[1], Prentiss Balcom[1], Nicholas S. Fisher[1,2], Robert P. Mason[1],*[1]Department of Marine Sciences, University of Connecticut, 1080 Shennecossett Road, Groton, CT 06340, [2]School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794-5000; zofia.baumann@uconn.edu,*

We evaluated differences in mercury bioaccumulation in the Atlantic silverside (*Menidia menidia*), an annual fish species with a broad latitudinal distribution along the North American Atlantic coast. Temperature and thus growing season of silversides decrease strongly with latitude, but northern silverside populations evolved genetically faster growth compared to southern populations at a given temperature, thereby enabling them to reach the critical body size to survive the winter. Using samples from past field campaigns, we found that seasonal body mass dynamics from birth in spring/summer to spawning in the following year result in a latitudinal gradient of condition factors. One-year-old silversides collected in New Brunswick (Canada) or Maine (US) displayed 30% lower condition factors (CF) in comparison to fish from southern locations. This coincided with higher mercury concentrations (both total and methylHg) in silverside muscle in populations with lower CFs (average ± sd THg and CF over 5 locations from South Carolina to Maryland: 0.24 ± 0.13 ppm dry wt., 0.009 ±0.001, respectively) in comparison to fish from northern locations (average ± sd THg and CF over 5 locations from Massachusetts to New Brunswick: 0.41 ± 0.14 ppm dry wt., 0.007 ±0.001, respectively). This finding is consistent with the growth dilution hypothesis if fish food intake did not significantly vary and that Hg sources (i.e. water and particulate/food concentrations) remain similar over the geographic range of interest. This study contributes to the growing body of evidence for the growth dilution hypothesis in fish and comprises its first test for a marine fish, thus setting up the stage for planned laboratory experiments to further explore this hypothesis.

The impact of nutrient induced geomorphic change on production and foraging success of *Fundulus heteroclitus*. David P. Behringer[1], Linda A. Deegan[1], James A. Nelson[2], David S. Johnson[3], Nathalie R. Moore[4], *[1]Marine Biological Laboratory, Woods Hole, MA 02543, [2]University of Louisiana, Lafayette, LA 70503, [3]Virginia Institute of Marine Science, Gloucester Point, VA 23062, [4]College of William and Mary, Williamsburg, VA 23185*; Dbehringer@mbl.edu

The TIDE Project, a twelve-year ecosystem-scale experiment, has examined the effects of chronic nutrient enrichment on salt marshes in the Plum Island Estuary (PIE), MA. This experiment has shown that chronic nutrient enrichment causes decreased belowground root biomass of creek-bank *Spartina alterniflora* and accelerates microbial decomposition of organic matter, which destabilizes creek-edges and causes creek-bank collapse. Peak biomass of *Fundulus heteroclitus* in nutrient enrichment creeks relative to control creeks steadily increased each of the first six years of enrichment, as expected from bottom-up stimulation of the food web. However, after six years, *Fundulus heteroclitus* biomass in the fertilized creeks exhibited a steady decline relative to the reference creek biomass. The high marsh, which floods roughly ten times a month, provides an important protein source essential to *Fundulus heteroclitus* growth and survival. We hypothesize that a decrease in habitat connectivity between creek channels and the high marsh via creek-edge cracking and slumping creates physical barriers that limit access to the high marsh and as a result, affect the foraging success and production of *Fundulus heteroclitus*. To test this hypothesis, we examined the relationship between creek bank morphology and fish across a gradient of creek bank geomorphologies. Twelve creeks were scored for habitat fragmentation based on creek-bank geomorphology surveys. To determine access to the high marsh and foraging success we used Breeder Trap collections, gut content analysis, and total lipid extraction. Preliminary analysis suggests a negative relationship between habitat fragmentation and fish production. A more complete understanding of this relationship is necessary to fully assess how nutrient enrichment alters habitat connectivity and will provide insight to the impact eutrophication has on energy transport from salt marshes to marine habitats, along with its impact on fisheries.

Demographics and dynamics of the 2015 spawning migration of American shad (*Alosa sapidissima*) in the Connecticut River. Boucher, Jason M.[1], Richard S. McBride[2], *[1]Integrated Statistics, 16 Sumner Street, Woods Hole, MA 02543, [2]National Marine Fisheries Service, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543,* jason.boucher@noaa.gov

Although great effort has been invested in restoring the Connecticut River Atlantic salmon population, with no sign of improvement, other anadromous species have rebounded greatly during this same period. American shad is one of the success stories, as passage at the first dam (Holyoke) has increased from 4899 to 370,506 between 1955 and 2014, with a high of 721,336 in 1992. Presumably, adult shad migrating past the dams are using this expanded range of habitat for spawning, but this has been poorly documented, which is the focus of this work. In 2015, adult shad were collected at four locations along the river: at the river mouth (Old Lyme, CT), at Holyoke Dam (Hadley, MA), at the Cabot Power Station (Turners Falls, MA), and the Vernon Power Station (Vernon, VT). Males and females entered the lower river in late April, while temperatures were still below 14°C. Females were consistently larger (both length and weight) and older than males. However, there was a higher ratio of males than females at all sites, except Holyoke. Sex-based ages were not different between locations or time periods, indicating a well-mixed population throughout the spawning season. Spawning-condition females, including running-ripe individuals, were collected at the most upstream sampling site (southern Vermont), indicating that increased fish passage at these dams has opened up nearly all of the potential historic spawning habitat for American shad. The age structure of downstream-migrating shad

remained similar to upstream migration for both sexes, with no apparent age bias in survival to downstream passage. Both males and females collected during downstream migration displayed decreased somatic weight at length, supporting earlier hypotheses that somatic energy is used during the spawning migration.

Using Fishermen's Ecological Knowledge and Scientific Data to Map Cod Spawning Grounds on Georges Bank and Nantucket Shoals. Greg DeCelles[1], Doug Zemeckis[1], David Martins[2], and Steve Cadrin[1], [1]*School for Marine Science and Technology, University of Massachusetts – Dartmouth, Fairhaven MA 02719,* [2]*Massachusetts Division of Marine Fisheries, New Bedford, MA 02740; gdecelles@umassd.edu*

Atlantic cod (*Gadus morhua*) have supported important commercial fisheries on Georges Bank for centuries, but considerable uncertainty remains regarding their spawning dynamics, stock structure, and seasonal movement patterns. The objective of this study is to improve our understanding of the spatial and temporal distribution of cod spawning on Georges Bank by combining Fishermen's Ecological Knowledge and scientific data to map cod spawning grounds. We are exploring multiple existing scientific datasets including trawl surveys, ichthyoplankton surveys, tagging databases, and observer data to document both the past and current state of scientific knowledge regarding cod spawning on Georges Bank. These data are being plotted and overlaid with fine-scale bathymetry and habitat maps to identify cod spawning grounds. We are also conducting structured interviews with active and retired fishermen from Point Judith, RI to Nova Scotia to gather Fishermen's Ecological Knowledge on the spawning habitats, seasonal distribution, and stock structure of cod on Georges Bank and Nantucket Shoals. The interviews are ongoing, and thus far we have interviewed fifteen fishermen. These fishermen have an average of 40 years of experience fishing for cod on Georges Bank, and have acquired detailed ecological knowledge about the location, timing, duration, and magnitude of cod spawning. We mapped the identified spawning grounds, and compared it to the available scientific data to examine regions where there is agreement between the two information sources. By combining multiple data streams, we will identify cod spawning grounds on Georges Bank that remain active, and also look for potential shifts in the location and timing of spawning events. This information is needed to better understand cod population structure and Essential Fish Habitat on Georges Bank, and can help inform the design of future resource surveys.

The effects of anadromous forage fish biomass restoration on Northeast US Marine Ecosystem. Beatriz S. Dias*[1,2], Steven Mattocks[1], and Adrian Jordaan[1], [1]*University of Massachusetts Amherst, MA 01003,* [2]*CAPES Foundation, Ministry of Education of Brazil, DF; bdossantosdi@eco.umass.edu*

In the light of complex and dynamic marine species interactions, we are migrating from single species to ecosystem-based approaches to management. In the past decade studies have explored the role of forage species as a key player in energy transfer throughout food webs by better understanding population dynamics and ecosystem-level impact. However, few studies have focus on evaluating the ecosystem impacts of stock restoration. To explore the effects of forage fish restoration, we focused on the alosine group (alewife, blueback herring and American shad) along the Northeastern US coast. To assess the effect of forage biomass increase on prey and predator species we used Ecopath with Ecosim (EwE 6.0) mass balance framework to produce three models employing different biomass scenarios for alosine. The first model employed the Northeast Fisheries Science Center trawl survey biomass of 0.2 for the year 2000; the second biomass of 0.95, considered the lost biomass of five New England watersheds from 1600 to 1900; the third used biomass of 1.72, combined lost biomass of the New England model and nine Maine

watersheds. The result of increasing alosine biomass on shorebirds, pinnipeds, coastal and pelagic shark populations as well as other forage species suggested positive impacts of alosine restoration across the ecosystem. A negative impact on micronekton was also detected, probably due to increased egg predation. The implications of alosine restoration outputs within an ecosystem-based framework suggest that freshwater restoration could play an important role in improving fisheries and ecosystem functioning.

Acoustic telemetry in American Shad (*Alosa sapidissima*): Surgical implantation and subsequent movements in the Charles River and coastal waters. Ben Gahagan[1], Michael Bailey[2], and Kevin Cheung[3], [1]*Massachusetts Division of Marine Fisheries, Annisquam River Marine Fisheries Station Gloucester, MA, USA,* [2]*United States Fish and Wildlife Service, Central New England Fishery Resources Office, Nashua NH, USA,* [3]*United States Fish and Wildlife Service, North Attleboro National Fish Hatchery, North Attleboro MA, USA; ben.gahagan@state.ma.us*

Advances in acoustic telemetry technology have improved efficacy in coastal marine waters and increased tag life now enables multi-season studies using relatively small tags. American shad are often the focus of upstream and downstream fish passage studies on the East coast of North America but are easily stressed from handling. Accordingly, gastric insertion of a transmitter is considered the standard method for tagging for both radio and acoustic telemetry studies. However, gastric tagging is not considered a viable long-term methodology as fish will regurgitate or pass transmitters. In 2015, we implemented a study of tag retention and survival comparing gastric tagging to three methods of surgical tagging (single suture closure of incision, no closure of incision, and chemical adhesive closure of incision). We also designed and conducted a field study of adult shad in the Charles River, MA to inform future restoration of shad to that watershed. Preliminary results suggest that tagged shad experienced delays associated with passage at both dams and the locks at the interface of the Charles River and Boston Harbor. Tagged shad were also detected on arrays in coastal waters, providing unique observations of near-shore coastal movement of American shad.

Observations of vertical movements and depth distribution of migrating female lumpfish (*Cyclopterus lumpus*) in Iceland from data storage tags and trawl surveys. James Kennedy[1,2], Sigurður Þ. Jónsson[1], Halldór G. Ólafsson[2] and Jacob M. Kasper[1,2,3], [1]*Marine Research Institute, Skúlagata 4, PO Box 1390, 121 Reykjavík, Iceland,* [2]*Biopol, Einbúastíg 2, Skagaströnd, Iceland,* [3]*Kasper Fisheries Consulting, West Hartford, CT 06117, jacobkasper@gmail.com*

Lumpfish (*Cyclopterus lumpus*) is a high latitude species most abundant in Arctic and sub-Arctic waters of the North Atlantic. Vertical behaviour of this fish is unclear as it is often caught by both pelagic and demersal trawls. To gain greater insight into its behaviour, 41 female lumpfish caught during the Icelandic Groundfish Survey (IGFS) in March were tagged with data storage tags (DSTs); the IGFS finishes 1 week before the beginning of the lumpfish fishing season (20 March). Data retrieved from returned tags were compared with information on depth and distribution of catches of lumpfish from the IGFS. Thirteen tags were returned with days at liberty ranging from 20 to 61 d. Maximum depth recorded was 308 m (maximum depth of the tag) but based upon interpolation of temperature recordings, one fish may have descended to 418 m. Lumpfish displayed a range of vertical behaviours termed demersal, surface, and pelagic. During March, most exhibited either demersal or pelagic behaviour but the time spent in surface behaviour increased from March to April. During demersal behaviour, depth was rarely constant indicating the fish was not stationary. Both DST and catch data from the IGFS indicate that lumpfish exhibit diel patterns in vertical behaviour. As lumpfish frequently exhibit demersal

behaviour, the use of the IGFS to monitor changes is justified. As lumpfish spend a significant amount of time in both the pelagic and demersal zone, they should be considered as a semi-pelagic (or semidemersal) fish during this life stage/time of year.

Endocrine disrupting alkylphenolic pollutants in Long Island Sound adversely affect lobster survival, molting and metamorphosis. Hans Laufer[1,2], Ming Chen[1,2], *[1]Department of Molecular and Cell Biology, University of Connecticut, Storrs, CT 06269-3125, [2]The Marine Biological Laboratory, Woods Hole, MA 02543; laufer@uconn.edu*

Lobsters in Long Island Sound (LIS) have decrease by 97% since 1998. They had a major die off in 1999. There are multiple factors in this population decline including increased water temperatures, water acidification, and toxic endocrine disrupting alkylphenolic pollutants, among others. We are studying effects of alkylphenols on lobster survival, development, molting and metamorphosis. Millions of tons of alkylphenols such as bisphenol A (BPA) and other alkylphenols are produced annually as detergents, antioxidants and plastics, which degenerate. Sixty percent of alkylphenols end up polluting marine environments. We tested the blood of 752 lobsters from nine areas of New England and found on average 39% were contaminated with alkylphenols. In some areas as many as 50% were polluted. The average amount of alkylphenols found by GCMS were compounds 1: 2-t-butyl-4-(dimethylbenzyl)phenol, 8.45 ng/ml ; 2: 2,6-bis-(t-butyl)-4-(dimethylbenzyl)phenol, 3.72 ng/ml; 3: 2,4-bis-(dimethylbenzyl) phenol, 28.55 ng/ml; 4: 2,4-bis (dimethylbenzyl)-6-t-butylphenol, 17.08 ng/ml; bisphenol A: 4,4'-(propane-2,2-diyl)diphenol ranged from 14.4 to 27.9 ng/g in 3 egg samples and 21.7 ng/g in larvae; 4-cumylphenol: 4-(2-phenylisopropyl)phenol ranged from 1.31 ng to 5.16 ng/g in 3 egg samples and 1.49 ng/g in larvae. Extreme concentrations in lobster blood were 18844 ng of compound 4/ml from eastern LIS, and 1055 ng of compound 3 in southern LIS. We examined the survival and development of larval lobsters fed 5 or 10 ng of compound 3 or BPA per day. These compounds were toxic to 70% of larvae, but more than 76% of controls metamorphosed normally to juveniles. Molting in experiments was delayed by 2 days at stage 3 and again at metamorphosis. Sixty three percent of treated survivors were intermediates rather than normal juveniles. Experiments to determine molecular mechanism of action for alkylphenols, we found that the retinoid nuclear receptor (RXR/RXR) and ecdysone receptor (EcR/RXR) both bind BPA and compound 3 in competitive binding assays. These results are consistent with delays in molting and disruption of larval metamorphosis that were found in larval experiments. In order to reestablish viable lobster populations in LIS there is a need to select and propagate temperature resistant survivors, and reduce chemical pollutants, including endocrine disrupting alkylphenols.

A re-evaluation of yolked oocyte development and estimates of American shad annual fecundity in the Connecticut River, USA. Richard S. McBride[1], Rosalia Ferreri[2], Emilee K. Towle[3], and Gualtiero Basilone[2], *[1]National Marine Fisheries Service, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543, [2]The Institute for Coastal Marine Environment of the National Research Council (IAMC-CNR), Capo Granitola Via del Mare, 3, 91021 Torretta Granitola, Campobello di Mazara, Sicily, Italy, [3]Integrated Statistics, 16 Sumner Street, Woods Hole, MA 02543; richard.mcbride@noaa.gov*

Annual fecundity has been estimated by a determinate method for many populations of American shad. In response to recent scrutiny of American shad annual fecundity, initially focused on a southern (Virginian) population, we re-evaluate the assumptions of the determinate method for a northern (Connecticut River) population. Criteria for using a determinate method were satisfied for this northern population: 1) a size hiatus was evident in the oocyte size frequency distribution, and while it was unexpectedly small and only briefly observed during the spawning run, it

indicated group synchronous development of yolked oocytes; 2) the number of yolked oocytes declined early in the run, which would be predicted if production of yolked oocytes stopped during the run; and 3) levels of atresia at the end of the run were low. We applied the determinate method to new (2015) collections from the Connecticut River, and these estimates of annual fecundity were remarkably similar to historic measures for this and a neighboring river. In contrast, a recent study using an indeterminate fecundity method found very different estimates of annual fecundity for the Virginian population compared to that measured by a determinate method in the past. American shad, which is distributed within its native range from the Canadian maritimes to Florida, USA (30 – 50 ^{o}N), may be a particularly well suited to evaluate intra-specific variation in oocyte development, a relatively unexplored life history trait.

Evaluating reproductive strategies in alewife (*Alosa pseudoharengus*) using pedigree reconstruction. Meghna Marjadi*[1], Adrian Jordaan[2], Allison H. Roy[3], Benjamin I. Gahagan[4], Andrew R. Whiteley[2], [1] *Massachusetts Cooperative Fish and Wildlife Research Unit, Organismic and Evolutionary Biology Program, University of Massachusetts Amherst,* [2]*Department of Environmental Conservation, University of Massachusetts Amherst,* [3]*U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, Department of Environmental Conservation, University of Massachusetts Amherst,* [4]*Massachusetts Division of Marine Fisheries; mmarjadi@umass.edu*

Alewife (*Alosa pseudoharengus*), a native New England anadromous fish, migrate from oceans to freshwater lakes and ponds in spring to spawn. Alewife populations have declined drastically over the last century, and population reductions have been accompanied by declines in mean body size and altered migration timing, leading to possible impacts on reproductive success. In 2013 and 2014, we introduced adult alewives to Pentucket Pond in Massachusetts, a natal Alewife pond that is currently uninhabited, to investigate reproductive strategies. Juvenile fish were sampled during both summers. Fish lengths and fin clips were collected from all transplanted adult fish and sampled juveniles. DNA was extracted from fin clips and pedigrees were reconstructed using microsatellite data. Data indicate high prevalence of small families dominated by half- rather than full-siblings, suggesting that adults are spawning with multiple individuals. Fish introduced earlier exhibited greater success, perhaps because they had more opportunity to spawn. Results also suggest larger body size was an indicator of reproductive success for females, independent of timing of arrival in ponds, perhaps as a result of greater fecundity. Pedigree results will be combined with ages of sampled juveniles to examine the duration adults spend in ponds and the timing of spawning. Understanding the implications of migration timing and duration and body size on reproductive success will allow managers to better assess how trends towards smaller body size and earlier migration timing may influence alewife populations, informing better population management and stocking policies.

Hybrid 'superswarm' leads to rapid divergence and establishment of populations during a biological invasion. Denis Roy[1§], Kay Lucek[1,2], Ryan P. Walter[3], O. Seehausen[1,2], [1]*Centre for Ecology, Evolution & Biogeochemistry, EAWAG Federal Institute of Aquatic Science and Technology, Kastanienbaum 6074, Switzerland*, [2]*Institute for Ecology and Evolution, University of Bern, Bern 3012, Switzerland*, [3]*Department of Biological Science, California State University at Fullerton, Fullerton CA 92831, USA*, [§]*Current address: Department of Natural Resources and the Environment and Center for Environmental Sciences and Engineering University of Connecticut, Storrs, CT 06269-4210. USA; denisroy1@gmail.com*

Understanding the genetic background of invading species can be crucial information clarifying why they become invasive. Intraspecific genetic admixture among lineages separated in the

native ranges may promote the rate and extent of an invasion by substantially increasing standing genetic variation. Here we examine the genetic relationships among threespine stickleback that recently colonized Switzerland. This invasion results from several distinct genetic lineages that colonized multiple locations and have since undergone range expansions, where they coexist and admix in parts of their range. Using 17 microsatellites genotyped for 634 individuals collected from 17 Swiss and two non-Swiss European sites, we reconstruct the invasion of stickleback and investigate the potential and extent of admixture and hybridization among the colonizing lineages from a population genetic perspective. Specifically we test for an increase in standing genetic variation in populations where multiple lineages coexist. We find strong evidence of massive hybridization early on, followed by what appears to be recent increased genetic isolation and the formation of several new genetically distinguishable populations, consistent with a hybrid 'superswarm'. This massive hybridization and population formation event(s) occurred over approximately 140 years and likely fuelled the successful invasion of a diverse range of habitats. The implications are that multiple colonizations coupled with hybridization can lead to the formation of new stable genetic populations potentially kick-starting speciation and adaptive radiation over a very short time.

Characterizing bite marks for the identification of depredation sources in New England sink-gillnet fisheries. Laura N. Sirak[1] and Kathryn Ono[2], [1]*Museum of Science, Boston, MA 02114,* [2]*University of New England, Biddeford, ME;* lsirak@une.edu

Gray seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) are often taken as bycatch in sink-gillnet fisheries in New England and are believed to consume and damage fish in gillnets. As seal populations increase, interactions with fisheries are also likely to increase, affecting both seal stocks and the New England fishing industry. There is some uncertainty among fishermen and scientists concerning the identification of sources of depredation (e.g. seal vs. spiny dogfish *Squalus acanthias*). Characteristics of seal and spiny dogfish bites were identified using foam imprints of jaws and bites by captive animals in the soft tissue of fish. Measurements from bite imprints and damaged fish were used to develop a protocol for identifying the source of damage in the field. In general, dogfish bites were clean (flesh completely removed), circular in shape, with a bite ratio (bite length/bite width) less than 0.6, whereas seal bites were ragged (flesh not completely removed, but partially torn from the bite), rectangular or trapezoidal in shape, with a bite ratio greater than 1. This protocol was tested by three independent observers, who identified the correct source of damage 95.2% of the time (n=49), with overall 87.8% agreement in identification. The application of this protocol was then used to identify damaged catch observed on a commercial gillnet fishing vessel targeting skate in New England waters June – August 2014. In this small-scale study, dogfish bites were identified as the damage source significantly more frequently than seal bites. This inexpensive, quick, and practical protocol can be used on a larger scale to further understand depredation by seals and dogfish throughout New England. Once sources of depredation are identified, mitigation methods can be developed to more effectively exclude certain predators.

Suitable indicators of fish condition: an evaluation of new and old metrics for three flatfishes with different reproductive strategies. Mark Wuenschel[1], Dave McElroy[1], Ken Oliveira[2],[1]*NOAA, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA 02543, USA*. [2]*Department of Biology, UMass Dartmouth*; Mark.Wuenschel@noaa.gov

We measured variation in body and reproductive condition, in comparison to proximate composition and energy content of liver and muscle in winter, yellowtail, and summer flounder. Near-monthly samples were analyzed for Gulf of Maine, Georges Bank and Southern New

England stocks of winter and yellowtail flounder, and the single stock of summer flounder. Traditional measurements of fish condition [hepato-somatic index (HSI), Fulton's *K*, relative condition factor (K_n), and the percent dry weight (%DW) and proximate composition of muscle and liver tissue] and reproductive condition [gonado-somatic index (GSI)] were determined to evaluate seasonal changes in energy accumulation and depletion. In addition, bioelectrical impedance analysis (BIA) and a recently proposed morphometric index - the scaled mass index (SMI) - were also evaluated as metrics of fish condition. All three species had similar strong relationships between %DW and the total energy density of both muscle and liver ($r^2 > 0.96$); however, both winter and yellowtail flounder depleted energy in muscle to a greater extent than summer flounder. In all species, the BIA metrics were strongly correlated to fish size. K_n and SMI were independent of fish size, and were related to muscle and liver %DW for winter and yellowtail flounder (r = 0.4 -0.6), but not summer flounder. In contrast the BIA metrics were correlated to muscle and liver %DW for summer flounder (r=0.5-0.7) but likely serving as a proxy for fish size. Although Fulton's *K* was related to muscle and liver %DW for each species, it lacked size-independence which complicates interpretation. The different reproductive and energetic strategies of these three flatfishes impact the utility of various morphometric condition indices, and highlight the need to validate such indices to physiological condition. Not surprisingly, the morphometric indices K_n and SMI were useful indicators of condition for the two capital breeders that undergo dramatic changes in body condition (winter and yellowtail flounder) but not for the income breeding summer flounder. Simple condition metrics, though broadly applied, have limitations and capture different (species-specific) aspects of physiological state.

ABSTRACTS:

Poster presentations

Evidence of endocrine disrupting chemicals in fishes of the Quinnipiac River watershed. Meghan N. Amarante and John T. Kelly, *University of New Haven, Department of Biology and Environmental Science, West Haven, CT 06516; mamar1@unh.newhaven.edu*

Endocrine disrupting chemicals (EDC's) are a broad class of pollutants that interfere with the normal functioning of the endocrine system in animals. Even at low concentrations, exposure to estrogen and estrogenic chemicals can have negative impacts on fishes, including feminization of males, intersexuality, and changes in population dynamics. Male fishes exposed to estrogenic chemicals typically show elevated levels of gene products associated with female reproduction, such as vitellogenin or choriogenin. In this study, two common fish species residing in the Quinnipiac River watershed, CT, mummichog (*Fundulus heteroclitus*) and long nose dace (*Rhinichthys cataractae*), were captured at locations ranging from near the headwaters of the mainstem to the harbor mouth. Gonadosomatic Index was calculated and liver tissue was analyzed by qPCR for evidence of vitellogenin and choriogenin gene expression. There was minimal evidence that EDC's were present at biologically meaningful levels in the brackish areas of the river, but Vtg I mRNA expression was 1-3 fold higher in male mummichogs collected in the harbor, with the highest levels noted at the harbor mouth. Samples from the freshwater reaches of the river are currently under analysis.

Partnerships make it possible to empower the growth of the marine ornamental aquaculture industry. Paul A. Anderson[1], Eric L. Litvinoff[2], Sergey V. Medvedev[2], and Nicholas J. Spera[2], *[1]Mystic Aquarium, Mystic, CT 06355, [2]Marine Science Magnet High School of Southeastern Connecticut, Groton, MA 06340; panderson@mysticaquarium.org*

Mystic Aquarium has partnered with the Marine Science Magnet High School of Southeastern Connecticut (MSMHS) to conduct research and development in marine ornamental aquaculture to support the sustainable sourcing of livestock for the estimated 530 marine aquarium businesses in the Northeast U.S. and beyond. The partnership features a Joint Aquaculture Research Internship, where a recent college graduate trains in aquaculture methods under the tutelage of Mystic Aquarium's Fishes and Invertebrates Husbandry department. After the traineeship, the Intern conducts day-to-day operations at the Joint Aquaculture Research Laboratory, based at MSMHS, which provides a state-of-the-art aquaculture facility enabling the simultaneous production of phytoplankton, zooplankton, and live fish culture. After several successful trials rearing clownfish as a proven model species group, the team is embarking on a new venture: the royal gramma *(Gramma loreto*). The species is vulnerable to anthropogenic impact to the coral reef environments in which it resides, having been deemed an "indicator" species of pollution. Its tenuous (and unknown) wild population status is also heavily fished for the aquarium trade: It is the 19th most imported marine aquarium fish species into the U.S. (out of 1,802 spp.). These reasons make the species a good candidate for marine ornamental aquaculture R&D, in addition to its ease of culture & economic value. This project proposes to 1) optimize sex ratios of broodstock groups of the royal gramma in aquaculture production, and 2) demonstrate economically efficient larval rearing protocols. Results from this study promise to encourage the commercial production of this species, with the subsequent reduction in fishing pressure on wild populations supporting their sustainability in native habitats.

A synthesis of climate change-induced shifts in phenology of marine mammals in the northwest Atlantic Ocean. Gabrielle Calandrino[1], Michelle Staudinger[1,2], Adrian Jordaan[1], *[1]University of Massachusetts Amherst, Amherst, MA 01003, [2]DOI Northeast Climate Science Center, Amherst, MA 01003, gcalandrino@umass.edu*

The overall goal of this study is to synthesize existing information and data on climate induced shifts in phenology, or the distribution and timing of important life events, of marine mammals throughout the Northeast United States. An initial literature search was conducted in Web of Science, yielding 59 relevant studies that primarily focused on four species of cetaceans and pinnipeds: harbor seals (*Phoca vitulina)*, grey seals *(Halichoerus grypus)*, harbor porpoises *(Phocoena phocoena)*, and northern Atlantic right whales *(Eubalaena glacialis)*. The majority of regional research conducted to date (N = 17 (29% of all papers)) was on right whales. Articles detailed the effect of climate change on right whale prey abundance, *Calanus finmarchicus,* in the greater northwestern Atlantic Ocean, and subsequent effects of low prey densities on calving, population growth, and migration timing. Harbor seals were the best studied species of pinniped in the region (N = 15 (25% of all papers)) with descriptions of changes in foraging locations and patterns, occurrence at specific haul-out sites, and seasonal behaviors associated with reproduction. Seven papers (12% of all papers) were found on grey seals and contained potential impacts of decreasing sea ice coverage and increasing sea surface temperatures on their populations. With the exception of the Gulf of St. Lawrence stock, grey seals may benefit from climate change due to increasing availability of habitat and prey. Relevant information (N = 8 (5% of all papers)) was found on several other species including killer whales *(Orcinus orca)*, fin whales *(Balaenoptera physalus)*, short and long-finned pilot whales *(Globicephala macrohynchus and G.melas*); however there appears to be a paucity of climate-focused research on these species in the northwest Atlantic. Initial results will inform species-specific case studies to explore shifts in phenology across the region, and ultimately improve understanding of where and when current and future marine mammal populations may be at risk to climate change impacts.

***Jellyfishing*: Using crowd-sourced data to gather ecologically relevant observations in coastal waters.** James J. Corbett*, Lynn Carlson, and Caroline A. Karp, *Brown University, Providence, RI 02906; james_corbett@brown.edu*

The ctenophore or comb jelly, *Mnemiopsis leidyii*, is sometimes considered a nuisance at bathing beaches, as are other "true" jellyfish such as the Lion's Mane (*Cyanaea*) or the increasingly common stinging sea nettle (*Chrysaora*). Some hypothesize that the increasing frequency and magnitude of jellyfish blooms reflect ecological disturbance related to eutrophication, overfishing, oyster cultivation, coastal development and/or climate change (Breitburg 2006, Schrope 2012, Costello et al. 2012, Purcell 2012, Beaulieu et al. 2013, Duarte et al. 2013). As a result, we suggest that charismatic *jellies* may represent useful "sentinels" or indicators of ecological change in near coastal waters. We field-tested a crowd-sourced, geographically based application (*Collector for ArcGIS* by ESRI, Inc.) for smart phones and tablet devices to gather observations about the distribution and abundance of nine species of gelatinous plankton (jellyfish) in Rhode Island waters. The free app allows citizen monitoring groups, fishermen, anglers, surfers, beachgoers and others to report their observations of commonly occurring gelatinous zooplankton, as well as associated weather, water use, water quality and habitat conditions. The observations are recorded immediately in a GIS database maintained by Brown University. Brown University faculty and students, in association with staff and volunteers from the Narragansett Bay Water Quality Control Commission, University of Rhode Island's *Watershed Watch*, *Save the Bay*, the *Salt Ponds Coalition*, *Surfrider* and the RI *Saltwater Anglers Association,* recorded over 500 observations in Narragansett Bay waters using the ESRI *collector app* since 2014. 44% of these jellyfish-related observations have associated water quality data.

*denotes student

Four species of gelatinous plankton were added to the *collector app* since 2014 because they occur commonly in embayments and salt ponds in association with *Mnemiopsis*, although not reported in earlier zooplankton studies of Narragansett Bay. Sightings of two species of gelatinous plankton have only been recorded when *Mnemiopsis* were also present in the immediate area. In addition, robust populations of several species occur much later in the fall in the salt ponds than in the inner bay as reported by Beaulieu et al. (2013).

Optimal sampling effort for estimating juvenile alewife densities in freshwater lakes using a pelagic purse seine. Matthew T. Devine *[1], Adrian P. Jordaan[1], Allison H. Roy[2], and Andrew R. Whiteley[1], [1]*Department of Environmental Conservation, University of Massachusetts-Amherst, Amherst, MA 01003,* [2]*U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts-Amherst, Amherst, MA 01003;* mtdevine@umass.edu

Anadromous alewives (*Alosa pseudoharengus*) transport large amounts of nutrients across marine and freshwater ecosystem boundaries during migration and provide forage for a variety of species. Alewife populations, and thus their role in aquatic ecosystems, have declined throughout their range over the past five decades due in part to habitat degradation and overfishing. Currently, anadromous alewife populations are monitored using adult run counts at river fishways and fisheries surveys at sea and in large rivers and estuaries. However, both types of monitoring have limitations. Run counts have logistical challenges (e.g., equipment failure, irregular volunteer counters, costs of electronic monitoring) and provide only a snapshot into one facet of alewife population status, while fisheries surveys catch individuals from many population sources, making discernable links to individual runs difficult. Quantifying recruitment of juveniles in freshwater nursery habitat is essential to determining alewife stock status and management targets for mortality. We are exploring the sampling effort required for using a small-sized pelagic purse seine in freshwater lakes to capture juvenile alewife and estimate densities. Thirty-two lakes from Connecticut to Maine were sampled in 2014 and 2015. We will describe variation in catch data across systems and investigate the effect of incremental purse seine sampling on density estimates. The goal is to determine the optimal sampling effort required in lakes of varying size to obtain sufficient estimates given limitations in cost, time and personnel. Ultimately, we will provide guidance for using pelagic purse seines for assessing juvenile alewife populations to better understand stock status and help develop monitoring strategies.

The effects of a human contraceptive, levonorgestrel, on the anal fin morphology and reproductive behavior of the eastern mosquitofish (*Gambusia holbrooki*). Tyler E. Frankel*[1], Amanda B. Gillis[1], Michael T. Meyer[2], and Edward F. Orlando[1], [1]*University of Maryland, College Park, MD 20742,* [2]*Kansas Water Science Center, Lawrence, KS 66049;* frankelt@umd.edu

Historically, endocrine disrupting chemical research has focused on environmental androgens, estrogens, and thyroid hormones. Recent efforts have begun to examine the effects of gestagens, which include endogenous progestogens and synthetic progestins, on aquatic wildlife. Gestagens have been measured in human wastewater effluent and agricultural runoff, and a limited number of lab exposure studies have demonstrated profound effects of these chemicals on reproduction, morphology, and physiology. However, little work has been done to examine the impacts of short-term progestin exposure on reproductive biology, and no studies have examined effects on reproductive behavior. Thus, we exposed adult eastern mosquitofish (*Gambusia holbrooki*) to two concentrations of levonorgestrel (LNG), 10 ng/L and 100 ng/L, and an EtOH control using a static replacement system, and examined the effects on anal fin development, morphology, and

reproductive behaviors. Exposure to LNG at both concentrations caused morphological masculinization of the female anal fin into a male-like gonopodial structure, and at 100 ng/L caused the hypermasculinization of males. LNG exposure at 100 ng/L also caused decreases in attending and gonopodial thrust behaviors in paired interaction trials, indicating an overall decreased interest in courtship and mating. Results from this study provide further evidence that the human progestin, LNG, functions as an environmental androgen, causing rapid effects on morphology and behavior in a viviparous species. As this is the first time the effects of LNG on behavior has been examined in mosquitofish, our results also highlight the importance of examining reproductive behavior as an endpoint for endocrine disruption testing.

Description and prevalence of *Mycobacterium* lesions in Georges Bank Sea Scallops. Carl J. Huntsberger[1], Catherine Grimm[2], Roxanna M. Smolowitz[2], *[1]Coonamessett Farm Foundation. East Falmouth, MA 02536, [2]Roger Williams University, Bristol, RI 02809; chuntsberger@cfarm.org*

Atlantic sea scallops, *Placopecten magellanicus* collected from Georges Bank have shown variably sized orange nodular lesions, predominantly in the adductor muscle tissue, but also present in other tissues. Samples were collected from Scallop Access Area I during the 2012-2013 seasonal bycatch survey to identify the causative agent of these lesions. Histological evaluation of the lesions showed rod-shaped bacteria that stain acid-fast positive and Gram positive. PCR methodology was employed to identify the causative organism of the lesions as *Mycobacterium* spp. These lesions are macroscopically different from those reported in the mid-Atlantic associated with nematode infection. Prevalence and distribution data has been collected during the 2015 seasonal bycatch survey conducted on Georges Bank. Infected animals have been concentrated near the Northern Edge Juvenile Cod habitat closure on Georges Bank with site specific prevalence as high as 11%. Sites which routinely have infected scallops identified also have high percentage of catch with empty shells, with intact hinges, suggesting natural mortality. The long term effect of this infection on scallop populations is unknown but data will continue to be collected.

Spatial variations in mercury and selenium concentrations in marine fishes of Rhode Island: Risks and benefits to human health. Joshua Jacques*, Mary Yurkevicius, and David L. Taylor; *Department of Marine Biology, Roger Williams University, Bristol, RI; jjacques396@g.rwu.edu*

Mercury (Hg) is a prevalent environmental contaminant that poses risk to human health, and exposure occurs mainly by consuming fish. Therefore, the U.S. Environmental Protection Agency (EPA) introduced a Hg action level of 0.3 ppm (wet weight) in fish tissue, above which consumption may become a health risk. Selenium (Se), a trace element that mitigates Hg toxicity, is also present in fish, thus increasing their health benefits. In this study, total Hg and Se concentrations were measured in the muscle tissue of four fish species collected from the Narragansett Bay (inshore) and Rhode Island/Block Island Sound (offshore), including summer flounder (*Paralichthys dentatus*), scup (*Stenotomus chrysops*), bluefish (*Pomatomus saltatrix*), and black sea bass (*Centropristis striata*) (offshore: n = 8-10 per species, inshore: n = 19-20 per species). Data were analyzed and compared based on spatial variations (inshore and offshore) relative to fish body size to assess bioaccumulation patterns. Health Benefit Values (HBV) were calculated to estimate the relative health risk vs. benefit of each species for human consumers. There is evidence supporting that offshore bluefish, black sea bass, and summer flounder have less total Hg than inshore conspecifics, whereas total Se concentrations did not vary spatially. Conversely, scup showed no spatial variation in total Hg or total Se concentrations. Total Hg

concentrations were positively related to total length for all fish, and values routinely exceeded the U.S. EPA action level at larger body sizes for inshore and offshore fishes (exception = summer flounder). In contrast to Hg bioaccumulation patterns, Se concentrations were relatively constant across fish size. HBVs were inversely related to fish length, suggesting that larger fish pose greater health risks. Among all species, summer flounder had the lowest Hg concentration, yet the highest Se content; therefore this species provides the most health benefits according to the matrices of this study. Future work includes increasing the sample size of the offshore species for analysis of total Hg and Se concentrations.

Growth and maturity of Narragansett Bay black sea bass, *Centropristis striata.* Connor P. Jones*[1,2], Jeremy Collie[1], Mary Kane[1], Anna Malek[1], and Conor McManus[1], [1]*Graduate School of Oceanography, University of Rhode Island, Narragansett RI 02882,* [2]*State University of New York at Binghamton, Binghamton NY 13902; jonesco29@gmail.com*

Black sea bass (*Centropristis striata*) inhabit the continental shelf along the east coast of the United States, and are targeted by commercial and recreational fisheries. Black sea bass grow up to 60 cm in length and are protogynous hermaphrodites, transitioning from female to male as they grow and mature. Most studies of black sea bass have been conducted in southern areas; hence little is known about when this sexual transition occurs or the growth rate of the Narragansett Bay population. Thus, the black sea bass minimum catch size limit (28cm) could have dire impacts on spawning stock biomass and spawning production for the populations. To address this uncertainty, 96 black sea bass (66 females and 30 males), ranging in size from 21 cm to 45.5 cm, were collected from Narragansett Bay from June to July, 2015 and analyzed for growth and maturation. Total length (cm), weight (kg), sex, sexual maturity (immature, developing, ripe, spent), gonad length (mm), gonad weight (g), and age of the fish (determined using both scales and otoliths) were measured to determine the size-at-age and size/age at sexual maturity relationships. Mature males and females were found in almost every size and age class collected. Due to their seasonal nature, no transitional fish were caught. Based on our length-weight and length-age relationships, the transition was estimated to occur between ages 2 and 4 when the fish weighed between 0.43 and 0.57 grams. The growth curves were similar to literature values and those derived from the NOAA Spring and fall bottom trawl surveys, yet the fish in Narragansett Bay were estimated to transition at a larger size than literature values. This is something to take into account when it comes to managing different populations of black sea bass along the east coast.

Improving the EBFM toolbox with an alternative open source mass balance model. Sean M. Lucey[1], Sarah K. Gaichas[1] and Kerim Y. Aydin[2]. [1]*Northeast Fisheries Science Center, Woods Hole, MA 02543,* [2]*Alaska Fisheries Science Center, Seattle, WA 98115; Sean.Lucey@NOAA.gov*

As ecosystem-based fisheries management (EBFM) moves from the theoretical stage towards implementation the need for flexible tools will increase. The main tools utilized for EBFM are ecosystem models. Ecosystem models can address many questions not typically covered by more traditional fishery models such as how alternative management policies may impact the ecosystem both directly and indirectly. Among a wide range of ecosystem models, a common approach for fisheries related questions are aggregate or box models, including a popular representation of the ecosystem as a mass balance model. Mass balance models use a series of equations to balance the energy flow through a system ensuring that energy is conserved. Here we present Rpath, an alternative open source implementation of the popular Ecopath (mass balance) with Ecosim (dynamic simulation) (EwE) box model algorithms. The original implementation of EwE has many strengths including its ease of use both in terms of set-up and run time due to a

convenient user interface. In addition, EwE is open source which means that there is universal access to the code and the code can be redistributed and subsequently improved by any interested users. This form of open collaboration makes EwE a powerful tool. However, a major draw-back to modifying the EwE code is the Microsoft Visual Basic platform upon which it is built. Many ecologists do not have the skills necessary to modify the code to tailor the model to their needs. Rpath is a complementary product to EwE built on a more familiar software platform, R. R is a rapidly growing open source statistical language that is familiar to many ecologists. Once fully developed, Rpath will allow users to fully customize their models to meet their needs. R has the advantage of allowing fully customizable outputs of publication quality without switching between software packages. Here we demonstrate the similarities and differences between EwE and Rpath using a generic ecosystem, R Ecosystem. Further development of this flexible tool that integrates statistical analysis and visualization tools in one package will be extremely useful in bridging the gap from theory to practice.

Evaluating bias and precision of fish fecundity estimates: Location effects within the ovary. Richard S. McBride[1], Emilee K. Towle[2], and Jason Boucher[2], [1]*National Marine Fisheries Service, Northeast Fisheries Science Center, 166 Water Street, Woods Hole, MA 02543,* [2]*Integrated Statistics, 16 Sumner Street, Woods Hole, MA 02543;* emilee.towle@noaa.gov.

Oocyte densities (number/gram) may vary within the ovary, which could bias or reduce precision of fecundity estimates. This issue was addressed previously for American shad, *Alosa sapidissima*, when a single sample was taken from six different but fixed locations (i.e., left vs. right; anterior, middle, posterior) within the ovary of ten females (i.e., individual fish constituted the replicates). No effect of location was detected by ANOVA, but if oocyte densities varied between fish, then this approach would be flawed. Here, we repeated this test with new data, in this case, by measuring the oocyte density for three subsamples from these same six locations for individual fish. Effect of location was examined with a two-way ANOVA (i.e., $y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ijk} + \epsilon_{ijk}$, where α is the effect of gonad lobe [left, right], and β is the effect of lateral position [anterior, middle, or posterior]). In each of three fish, the results were different: 1) no main nor interactive effect ($P > 0.05$), 2) a main effect of lateral position ($P_\beta = 0.003$), and 3) an interactive effect ($P_{(\alpha\beta)} = 0.04$). Together, these results indicate unbiased variations of oocyte density, by gonad location, among individual fish. Nonetheless, measuring oocyte density may be unrepresentative of the whole gonad if only based on one subsample. Mean densities and confidence limits estimated from 2 to 18 samples per fish demonstrated that 3 samples provide a cost-effective, precise estimate of batch fecundity, which we went on to estimate for Connecticut River females in 2015.

Study of feeding habits of Alewife (*Alosa pseudoharengus*) in northeastern United States. Habibollah Mohammadi*[1,2], Matthew Devine[1], Steven Bittner[1], Allison H. Roy[1,3,4] and Adrian Jordaan[1], [1]*Department of Environmental Conservation, University of Massachusetts Amherst,* [2]*Gorgan University of Agricultural Sciences & Natural resources, Gorgan, Iran,* [3]*U.S. Geological Survey,* [4]*Massachusetts Cooperative Fish and Wildlife Research Unit;* habibm64@gmail.com

Alewife (*Alosa pseudoharengus*) were sampled as part of an ongoing study on juvenile production to determine diet through analysis of stomach contents. Alewife were sampled by pelagic purse seine and stored on ice or in 95% ethanol. Stomach contents were identified to genus. Preliminary work has identified stomach contents of 40 small alewives (≤70 mm) in Upper Mystic Lake (Massachusetts) and Highland Lake (Maine) from September 2016. Two zooplankton orders including Copepoda and Cladocera were the major food items consumed by

alewife. Diets consisted primarily of Epischura, Cyclops, Mesocyclops and Tropocyclops (Copepoda) and Bosmina and Daphnia (Cladocera). In total 9 genera, 6 families and 2 phyla were identified in stomach contents. Bosmina was the most frequently identified prey taxon in Highland (89%) and in Upper Mystic (74%) and Thermocyclops was the least abundant in stomach contents of fish from Highland (0.13%) and Upper Mystic (0). There was no significant difference in abundance of Bosmina and Cyclops between Highland and Upper Mystic, but t-tests of the other genera between the two lakes were significantly different ($p<0.05$). The Shannon-Weiner index (species richness) was 0.65±37 and 0.86±27, and the Margalef index (species diversity) was 1.49±0.28 and 1.257±0.082 for Highland and Upper Mystic, respectively. Thus, initial findings suggest that diet items were relatively similar among these 2 lakes late in the year, although there were differences in the total numbers of each prey item. These findings will help interpret any growth and productivity differences among ponds in the northeastern United States.

Localized depletion of squid around Nantucket Island: are we asking the right questions at the right scales? Owen C. Nichols*[1] and Steven X. Cadrin[1], [1]*School for Marine Science and Technology, University of Massachusetts – Dartmouth, Fairhaven, MA 02719; onichols@umassd.edu*

Longfin inshore squid (*Doryteuthis pealeii*) occur seasonally in the waters around Nantucket Island (northeast USA), where they are targeted by fisheries and considered an important prey species for several species of recreationally and commercially harvested fishes. Fishermen have expressed concern regarding an apparent recent decline in squid abundance and a related shift in predator distribution (e.g. striped bass, *Morone saxatilis*) away from nearshore waters. Several hypotheses have been posed by fishermen for the causes of apparent changes in fish and squid abundance and distribution, including increased commercial fishing pressure on squid and environmental effects. Following targeted outreach to the fishing community, a review of fishery regulations was conducted and regional fisheries landings data were compiled. Where possible, the above information was used to formulate testable hypotheses regarding the relative effects of fishing effort, environmental variability, and trophic dynamics on the local abundance of *D. pealeii*. These hypotheses are placed in a fisheries management context to provide a mechanism for science-based evaluation of proposed regulatory actions. The spatiotemporal resolution of available data may not be high enough for testing hypotheses related to localized depletion of squid; future investigations may require fine-scale data collection and analysis.

Uses and capabilities of HabCam IV. O 'Hara, Tasha E., Nicole E. Charriere, *Integrated Statistics, Inc., Woods Hole, MA 02543; tasha.o'hara@noaa.gov*

In 1979, the Northeast Fisheries Science Center (NEFSC) began conducting an annual scallop survey to track scallop populations, as well as the overall health of the species and ecosystem. Historically, this survey utilized an 8', New Bedford-style dredge as the primary instrument of data collection. In 2012, however, the NEFSC began implementing an updated, underwater habitat camera system as another survey tool to use in conjunction with the dredge. This system, built by Woods Hole Oceanographic Institution and known as the HabCam IV, is an advanced, stereo-optic, towed-camera array that is towed behind a vessel and captures six, paired images per second. Since its inception, the HabCam IV has been used to survey ecosystems, track fisheries populations and behaviors, collect oceanographic data, as well as a myriad of other applications. The system was modeled on earlier versions designed by WHOI with input from scallop industry in an effort to develop a more ecologically neutral survey tool. The multifunctional and spacious design of the HabCam allows potential to incorporate new technologies in the upcoming years, the full breadth of which has yet to be realized.

Hiding in drift weed: Evaluation of spectral background matching and crypsis in *Sargassum* associated crabs. Russell, Brandon J.*[1]; Heidi M. Dierssen[1, 2]; [1] *Department of Marine Science, University of Connecticut, Groton, CT 06340, USA,* [2]*Department of Geography, University of Connecticut, Storrs, CT 06268, USA; brandon.russell@uconn.edu*

Floating mats of the macroalgae *Sargassum* are an important ecological resource for many pelagic species, including commercially and recreationally important fish. Endemic organisms, which often serve as prey items, have convergently evolved similar colors and patterns. Here, spectral camouflage of two crab species (*Portunus sayi* and *Planes minutus*) was assessed using hyperspectral imagery (HSI). Crabs matched *Sargassum* reflectance across blue and green wavelengths (400-550 nm) and diverged at longer wavelengths. Maximum discrepancy was observed in the far-red (i.e., 675 nm) where Chlorophyll *a* absorption occurred in *Sargassum* and not the crabs. In a quantum catch color model, both crabs showed effective color matching against blue/green sensitive dichromat fish, but were still discernible to tetrachromat bird predators that have visual sensitivity to far red wavelengths. The two crab species showed opposing trends in background matching with relation to body size. Variation in model parameters revealed that discrimination of crab and background was impacted by distance from the predator, and the ratio of cone cell types for bird predators. This is one of the first studies to detail background color matching in this unique, challenging ecosystem at the air-sea interface.

Ecological and management implications of climate change induced shifts in phenology of alewife (*Alosa psuedoherengus*). Sam Stettiner*[1], Michelle Staudinger[1,2], Adrian Jordaan[1], and John Sheppard[3], [1]Un*iversity of Massachusetts Amherst, Amherst, MA 01003,* [2]*DOI Northeast Climate Science Center, Amherst, MA 01003,* [3]*Massachussets Department of Fish and Game – Division of Marine Fisheries, New Bedford, MA 02740; sstettin@umass.edu*

Climate change is causing species to shift their phenology, or the timing of recurring life events such as migration and reproduction, in variable and complex ways. This can potentially result in mismatches or asynchronies in food and habitat resources that negatively impact individual fitness, population dynamics, and ecosystem function. This project seeks to improve our understanding of shifts in the timing of seasonal migration and spawning of adult anadromous alewife, *Alosa psuedoherengus* in seven natal stream systems within the state of Massachusetts: Acushnet, Agawam, Herring, Jones, Nemasket, Stoney Brook, and Town Brook Rivers. Initial analyses examined if and how the direction and magnitude of annual spawning run initiation, peak and end dates have shifted over recent decades. Preliminary results suggest that changes in alewife migration timing are not consistent across runs within Massachusetts. Trends from an overall analysis of all sites show a shift of earlier timing in run initiation dates and a shift towards later end dates of the runs. Ongoing work seeks to evaluate the extent of estuarine habitat availability around each of the seven alewife run sites; this will be accomplished by measuring the area of continuous wetland habitat downstream from alewife spawning ponds. Additionally, shifts in the timing of alewife migration in relationship to environmental conditions such as river and sea surface temperature, river flow and winter conditions are being evaluated. Project results will help managers assess the vulnerability of alewife and other coastal species to the interactive effects of environmental and anthropogenic stressors influencing their populations across the region.

Preliminary review of cusk, *Brosme brosme*, reproductive biology in U.S. waters. Emilee K. Towle and W. David McElroy, *Integrated Statistics, Woods Hole, MA and Northeast Fisheries Science Center, Woods Hole, MA 02543; Emilee.Towle@noaa.gov*

Cusk, *Brosme brosme*, have declined in abundance and are proposed as a candidate for listing under the Endangered Species Act (ESA). Evaluating their status is hampered by a lack of recent (< 30 years) and regional (U.S.) information on cusk life history. As part of the response, the Northeast Cooperative Research Program bottom longline survey (NECRP–BLLS) sampled cusk during the spring and fall of 2014-2015 (n = 1234), targeting rocky bottom habitat in the Gulf of Maine. These efforts dramatically increased the samples collected from the Northeast Fisheries Science Center bottom trawl survey (n = 32), and collaborating commercial vessels, (n = 17). Oogenesis was examined from length frequencies of oocytes in the spring and fall. In the fall, the vitellogenic clutch is evident and continues to develop through winter. By spring, there is a distinct hiatus between the reservoir of primary and secondary growth oocytes. In May, hydrated oocytes were present, indicating spawning started, with peak spawning occurring by summer. This seasonal pattern of oocyte development confirms female cusk have determinate fecundity with group-synchronous oocyte development. Female gonadosomatic indices are high in the spring and low for most individuals in the fall, which also supports a seasonal spawning pattern. Macroscopic staging of females indicates nearly all are mature by 45 cm. Male maturity was difficult to stage macroscopically and analysis of gonad histology will be necessary. The sex ratio indicated a higher proportion of females for fish < 50 cm and a higher proportion of males for fish ≥60 cm. This information gained largely from the BLLS will contribute to informing the ESA candidate listing and improving management plans for this data poor species.

Fatty acid profiles of marine fishes from Rhode Island coastal waters. Mary Yurkevicius[1], Joshua Jacques[1], Nancy E. Breen[2], and David L. Taylor[1], *Roger Williams University, Department of Marine Biology[1] and Chemistry[2], One Old Ferry Rd, Bristol, RI, 02809, myurkevicius061@g.rwu.edu*

Marine fish are an excellent source of omega-3 fatty acids, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which provide numerous health benefits to human consumers. Further, the majority of consumed fish are of marine origin, thus underscoring the importance of research focused on this topic. In this study, fatty acids were analyzed in Rhode Island coastal fishes, including summer flounder, *Paralichthys dentatus* (n = 10); black sea bass, *Centropristis striata* (n = 10); striped bass, *Morone saxatilis* (n = 6); scup, *Stenotomus chrysops* (n = 11); winter flounder, *Pseudopleuronectes americanus* (n = 10); and bluefish, *Pomatomus saltatrix* (n = 11). Fatty acid profiles of fish muscle tissue were determined by esterification and gas chromatography. Data were categorized as mono-saturated, saturated, omega-3, and omega-6 fatty acids, and results were expressed as concentrations (mg/100 g wet weight; [*FA*]) and percent of total fatty acid content (%*FA*). Irrespective of fish species, mono-saturated fatty acids had the highest [*FA*] and %*FA* (mean [*FA*] = 183.5 mg/100 g; %*FA* = 46.2%), followed by saturated ([*FA*] = 146.6 mg/100 g; %*FA* = 32.7%), omega-3 ([*FA*] = 44.3 mg/100 g; %*FA* = 18.6%), and omega-6 fatty acids ([*FA*] = 7.5 mg/100 g; %*FA* = 2.5%). Fatty acid profiles also demonstrated significant inter-species differences. With respect to %*FA*, mono-saturated fatty acids were significantly higher in scup and bluefish relative to summer flounder and striped bass (SCP = 54.6%, BF = 48.8%, SF = 40.1%, SB = 39.3%). Conversely, omega-3 fatty acids were significantly higher in both flounder in comparison to black sea bass and scup (SF = 31.1%, WF = 26.3%, BSB = 12.1%, SCP = 8.3%). With respect to [*FA*], bluefish had significantly higher concentrations of mono-saturated and saturated fatty acids relative to summer flounder (BF = 245.4-307.4 mg/100 g, SF = 52.5-81.3 mg/100 g). Ratios of omega-6-to-omega-3 (n6:n3) fatty acids were reduced in flounder and striped bass (n6:n3 = 0.14-0.23) relative to scup, bluefish, and black sea bass (n6:n3 = 0.30-0.36); hence suggesting the former species provide greater health benefits for human consumers. Future research will examine total mercury and selenium concentrations of each fish species to evaluate their respective health risks and benefits.