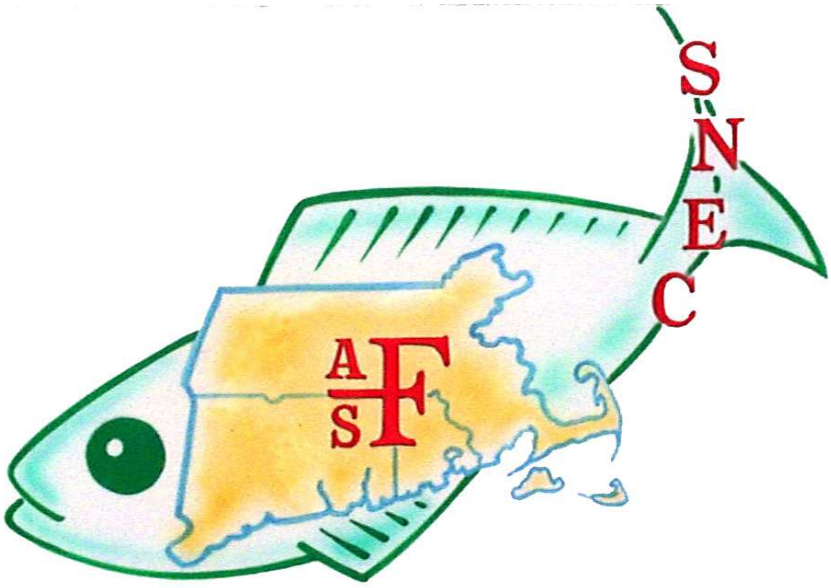
2020 Science Meeting



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Abstracts:
Platform Presentations

Fish Muscle Tissue Alone does not Indicate the Environmental Quality of a Historically Mercury Polluted River.* Anatone, Kayla, Barry Chernoff, *Biology Dept, Wesleyan University, Middletown, CT*

Mercury is a toxicant that is recognized as having deleterious effects on aquatic organisms. Mercury can remain in aquatic environments for decades after initial release. Hat-making factories active in the late 19th to early 20th centuries directly released mercury nitrate into the Still River and its various tributaries. *Rhinichthys atratulus*, Blacknose Dace, is a common non-migratory minnow that is abundantly found in the Still River, CT. The aim of the study is to use *R. atratulus* to evaluate the environmental quality of historically mercury contaminated sites in comparison to sites with no previous history of point source mercury pollution. Historical sites have more mercury present in their sediment (~10% greater) which should lead to a higher accumulation of mercury in fish. Fish muscle tissues were used as indicators of mercury bioavailable to organisms at study sites. Other biological parameters (i.e. condition factors, age, and population size) were used to assess environmental quality but were found to be similar among populations. Mercury concentrations were unexpectedly highest in sites with no previous history of mercury pollution. These results shed light on the complexity of the mercury cycle and evolutionary processes that may be at play. If mercury is not bioavailable to fish, then muscle measurements will not accurately represent environmental quality. Fish from historical sites may have evolved mechanisms to cope with constant mercury exposure such as rapid detoxification. Our results highlight that when studying mercury contamination fish muscle tissue, evolutionary and physiological processes should be considered.

Passage of Alewife (*Alosa pseudoharengus*) Before and After a Dam Removal on Town Brook in Plymouth, Massachusetts. Archer, Abigail[1], Alex Haro[2], David Gould[3], Michael Cahill[3], Nate Cristofori[3], Mark Brulport[3], Kim Tower[3], Eric Hutchins[4], Eric Derleth[5], *[1]Woods Hole Sea Grant & Cape Cod Cooperative Extension, Barnstable, MA, [2]U.S. Geological Survey Conte Anadromous Fish Research Center, Turners Falls, MA, [3]Town of Plymouth Department of Marine & Environmental Affairs, Plymouth, MA, [4]NOAA Restoration Center, Gloucester, MA, [5]U.S. Fish and Wildlife Service, Concord, NH*

Alewife (*Alosa pseudoharengus*) passage through a 750 meter section of Town Brook in Plymouth, Massachusetts was evaluated both before and after the removal of the Holmes Dam. In the spring of 2018 fish were required to enter and pass through two sections of steeppass fish ladder, a 202 foot long Denil fish ladder, and a pool & weir ladder in order to overcome the 25 vertical feet associated with the Holmes Dam and swim towards the 269 acre spawning pond at Billington Sea. The Holmes dam and the associated mill pond and fish ladders were removed between Fall 2018 and Spring 2019. In the spring of 2019 Alewife swimming through

the same section had to pass through a box culvert and a series of rock weirs to reach spawning grounds. In 2018 a total of 9 passive integrated transponder (PIT) antennas were installed downstream, upstream, and within the 3 fish ladder structures and dam spillways in the vicinity of Newfield St, and in 2019 in approximately the same locations after dam removal. In 2018 percent passage was 24.9% (95% CI 19.9%-30.5%). In 2019 percent passage was 91.7% (95% CI 88.5%-94.3%). Transit time in 2019 through the newly restored section of river ranged from 18.11 minutes to 10.49 hours with an average of 60 minutes and a median of 40 minutes. This is one of only a few data sets available on passage and transit time of Alewife before and after a dam removal.

Market Development to Diversify Shellfish Aquaculture Products in Massachusetts. Archer, Abigail[1], Josh Reitsma[1], Melissa Sanderson[2], Michele Insley[3], *[1]Woods Hole Sea Grant & Cape Cod Cooperative Extension, Barnstable, MA, 2Cape Cod Commercial Fishermen's Alliance, Chatham, MA, [3]Wellfleet Shellfish Promotion and Tasting, Wellfleet, MA*

Shellfish aquaculture is growing in the Northeastern US but has become dominated by the culture of American oysters (*Crassostrea virginica*) for the half-shell market. In Massachusetts the shellfish aquaculture industry has grown from $6.5 million in 2011 to $23 million in 2015 (DMF Annual Report, 2015). Of that $23 million over 93% was from oyster culture. A monoculture is inherently risky and so Woods Hole Sea Grant partnered with the Cape Cod Commercial Fishermen's Alliance and the Wellfleet SPAT (Shellfish Promotion and Tasting) to explore the viability of blood arcs (*Anadara ovalis*) and petite surf clams (*Spisula solidissima*) as alternative aquaculture products. Growing trials were carried out for these two species, a market analysis was commissioned to explore possible prices for them and for a shucked oyster product, and a promotion plan was commissioned for butter clams. It was determined that more study is needed to refine the nursery grow-out phase of blood arcs, that butter clams hold the most immediate promise in terms of feasibility of culture and potential price, and that labor and pricing questions still exist for a shucked oyster product.

Herring Restoration on the Merrimack River - Looking for Long Term Stability. Bailey, Michael, *U. S. Fish and Wildlife Service, Central New England Fish and Wildlife Conservation Office, Nashua, NH*

In the last decade the Merrimack River diadromous fisheries restoration efforts have shifted focus from Atlantic Salmon to river herring. This management shift has led to marked increases in river herring abundances from typical annual runs of thousands of individuals to hundreds of thousands of individuals within a small time frame. There are obvious ecological, cultural, and fisheries resource benefits to large runs of diadromous fish, however most of the population increases we see on the Merrimack are due increasing active management, specifically trap and transport fish stocking. These active efforts are triggering longer term commitments made under FERC license agreements which should allow for a new stable state of accessible habitat. I will also review other current opportunities for habitat improvement and how those changes may lead to a change in prospective in where to invest resources in restoration.

Designing a Long-Term Ventless Fish Pot Monitoring and Assessment Program for Recreationally Important Rhode Island Finfish. Balouskus, Richard, *RI Division of Marine Fisheries, Jamestown, RI*

Traditional fisheries-independent survey designs are often imperfect in assessing the relative abundance of structure-oriented marine species due to their inability to sample such habitats. To address this concern, Rhode Island's Division of Marine Fisheries is currently designing a standardized monitoring and assessment survey of recreationally important finfish utilizing fish pot gear. The goal of this survey program will be to assess and standardize a time series of relative abundance for structure-oriented finfish in Rhode Island state waters, particularly Black Sea Bass, Tautog, and Scup. Relative abundance indices derived from this survey will ideally be integrated into both local and coastwide assessments for the target species and will supplement state and regional trawl survey abundance indices. While a pot survey aids in being able to monitor species entire habitat range, several survey design decisions can influence catch rates including bottom type, pot design, soak time, and bait. These confounding factors on catch rates for recreationally significant finfish species for Rhode Island were evaluated in the summer and fall of 2019 through a directed study. The influence of these factors is presented to highlight their influence on catch of Black Sea Bass, Tautog, and Scup. Data from this study will be used to inform a long-term fish pot survey within Rhode Island state waters, and perhaps serve as a template for future efforts within other regions of these species' stock bounds.

Improving Juvenile Fish Populations Through Habitat Enhancement: Evaluating the Use of Oyster Reefs as a Tool to Increase Fish Abundance. Barrett, P.D.[1], E.G. Schneider[1], M.C. McManus[1], J.H. Grabowski[2], A.R. Hughes[2], W.S.K. Helt[3], H.A. Kinney[3], *[1]Division of Marine Fisheries, RI Department of Environmental Management, Jamestown, RI, [2]Marine Science Center, Northeastern University, Nahant, MA, [3]The Nature Conservancy, Providence, RI*

Juvenile fish rely on complex structured habitats, such as oyster reefs, for forage and refuge from predators. More than 70% of Rhode Island's recreationally and commercially important fish spend part of their juvenile lives in shallow-water coastal habitats with complex structure. However, many of these habitats have declined over recent decades in Rhode Island. The prevalence of the eastern oyster (*Crassostrea virginica*) has declined 90 percent since the mid-1900's, thus reducing this habitat resource for juvenile fish. We aimed to determine if oyster reef construction is a viable tool for improving abundance of recreationally important juvenile fish, including Black Sea Bass (*Centropristis striata*), Tautog (*Tautoga onitis*), and Winter Flounder (*Pseudopleuronectes americanus*). Oyster reefs were constructed in shellfish sanctuaries of Ninigret and Quonochontaug Ponds, Rhode Island, and seeded with different oyster lineages to evaluate how reef metrics may vary by location and lineage. Utilizing a before-after-control-impact design, juvenile fish assemblages at seeded oyster reefs were compared to unenhanced and structurally enhanced (i.e., cultch only) control sites using an array of fish survey techniques. Using generalized additive models we assessed the relative enhancement of juvenile fish as a function of different environmental and benthic habitat parameters (i.e., oyster density and biomass). This presentation provides an overview of results

focusing on fish-habitat linkages between oyster reefs and juvenile fish, and discusses the efficacy of this technique to improve abundance of recreationally-important juvenile fish. Results from this work will help inform future fish habitat enhancement and restoration efforts for Rhode Island and other states.

Investigating Patterns in Proximate Composition and Energy Density of Northwest Atlantic Forage Species.* Bean, Kelcie[1], Ken Oliveira[1], Mark Wuenschel[2], *[1]University of Massachusetts Dartmouth, Dartmouth, MA, [2]NOAA Northeast Fisheries Science Center, Woods Hole, MA*

Forage species facilitate energy flow between trophic levels in the marine ecosystem, and ecologists study their energy content to make predictions using bioenergetics models. It is important that models include values that are specific to species, life stage, location, and season. Six fish and two squid species were collected from four regions of the Northwestern Atlantic Ocean and were analyzed for proximate composition and energy content. Three objectives were examined: 1) the relationship between percent dry weight and energy density, 2) whether energy density of Northwestern Atlantic forage species depends on body mass, season, latitude, and year of collection, and 3) whether there have been changes in forage species energy density in the study area over the last three decades. Percent dry weight and energy density were highly correlated for all species, indicating that percent dry weight provides a tool for estimation of energy density. Body mass influenced the energy density of all species except *Illex* and *Loligo* squid species. Latitude and season influenced the energy content of all study species except *Loligo* squid. Year influenced the energy content of two species, and an interaction between the effects of latitude and season was observed for three species. Mean energy densities were compared to previous studies to examine interdecadal changes in energy density. There were apparent declines in the average energy densities of five study species and increases for three. These results indicate that there may have been shifts in forage species energy content over the last few decades.

Update on PFAS in New York State Fish. Becker, Jesse, Wayne Richter, Larry Skinner, *NYSDEC Division of Fish and Wildlife - Bureau of Ecosystem Health, Albany, NY*

Following discovery of PFOA in waters near Hoosick Falls, NY, and PFOS in waters near Newburgh, NY, we completed an intensive survey for PFAS in fish near these sites. DEC staff collected 2 – 6 species of fish from multiple potentially affected waters near each site. We analyzed edible-size sportfish in three portions: (1) a standard fillet, (2) the viscera, and (3) the remaining carcass. We also analyzed smaller forage fish. PFAS were detected in all 485 fish and in all but two of 1175 samples, including those from reference sites. PFOS was the dominant PFAS in both frequency (>99%) and concentration. Concentrations were highest in viscera with a maximum of 3570 ppb, intermediate in carcasses, and lowest in fillets. At the six non-reference sites in Newburgh and at a pond near the Hoosick Falls landfill, PFOS concentrations were high enough for NYSDOH to issue advisories against eating fish caught from these waters. In contrast to PFOS, PFOA was detected in fewer than half the samples and at low concentrations. The longer 10-, 11-, and 12-carbon acids were detected in 75% to 88% of the

samples, typically at concentrations higher than PFOA but less than PFOS. We have since expanded our sampling into a statewide survey, analyzing another 96 samples from 6 sites in 2017, and are in the process of analyzing another 447 samples from 12 sites collected in 2018. Findings support the idea that PFAS are pervasive in fish and can be found at high concentrations near release sites.

Watching the River Flow: Re-connecting Maine's Rivers. Bell, Jeremy, *The Nature Conservancy, Brunswick, ME*

Maine has the lowest density of dams in New England, and as the largest state in the region, potentially the most to gain through river and stream connectivity work. Following on the tremendous success of the Penobscot River Restoration, Maine has fallen behind other states in dam removal since that landmark project was completed. Some of the challenges faced are unique, yet some may be universal issues across the region and even the country. At the same time, significant success has been achieved in outreach and implementation of road stream crossing upgrades on communities and private lands. The speaker will present lessons learned following the Penobscot project and what the future may hold for free-flowing rivers in Maine.

Cold Water Stream Habitat in Connecticut. Bellucci, Christopher J., Mary E. Becker, *CT Department of Energy and Environmental Protection, Hartford, CT*

CTDEEP has a robust data set of stream fish community and temperature logger data dating back to the late 1980's. In previous work published in 2014, these data were used to develop cold water temperature metrics and fish species that were cold water indicators. In this discussion, we will expand on that work to present a map application that highlights cold water stream habitat in Connecticut and discuss the potential uses of this information.

Testing a Pelagic Species Distribution Model to Forecast River Herring Bycatch Hotspots. Bethoney, N.David[1], Sara M. Turner[2], Bradley P. Schondelmeier[3], *[1]University of Massachusetts Dartmouth School for Marine Science and Technology, New Bedford, MA, [2]MA Division of Marine Fisheries, New Bedford, MA, [3]MA Division of Marine Fisheries, Gloucester, MA*

River herring (Alewife, *Alosa pseudoharengus*, and Blueback Herring, *Alosa aestivalis*) are anadromous fishes that serve an important ecological and cultural role in southern New England. Currently, river herring populations are depleted and inconsistent signs of recovery, despite significant freshwater-focused restoration, have led to an increased focus on limiting their incidental catch in the mid-water trawl fishery targeting Atlantic Herring and Atlantic Mackerel. Since 2010, mid-water trawl vessels have participated in a voluntary bycatch avoidance program that has substantively contributed to decreased bycatch. However, the program is reactive requiring high bycatch events to occur, so their location can be communicated and avoided. Here, we explore the utility of habitat features that have been linked with marine-phase river herring in fisheries-independent catches to add a proactive

element to the program. To do this we used hindcasts of these habitat features to create river herring presence probabilities for cells of the avoidance program's communication grid. Using bycatch data from nearly a decade, we then attempted to identify a probability range that balanced inclusion of the most high bycatch events while leaving at least half the core fishing area classified as low risk. We found that probabilities that met this criterion, on average, identified 95% of high bycatch locations in December and 55% of these bycatch events in January in the portion of the fishery adjacent to southern New England. This suggests that these habitat models could be integrated into the bycatch avoidance program as forecasted bycatch hotspots.

Cod Movement Patterns from a Century of Tagging off New England. Cadrin, Steven[1], Doug Zemeckis[2], Greg DeCelles[3], Don Clark[4], Micah Dean[5], Jamie Cournane[6], David Goethel[7]
[1]University of Massachusetts Dartmouth School for Marine Sciences, New Bedford, MA, [2]Rutgers University, Toms River, NJ, [3]MA Division of Marine Fisheries, New Bedford, MA, [4]Fisheries & Oceans Canada, New Brunswick, CA, [5]MA Division of Marine Fisheries, Gloucester, MA, [6]New England Fishery Management Council, Newburyport, MA, [7]F/V Ellen Dianne, Hampton, NH

Atlantic Cod fisheries played a central role in the history of New England, and cod have been studied in this region for centuries. A comprehensive review of conventional and electronic tagging of Atlantic Cod in the Gulf of Maine region and adjacent areas was completed as a contribution to an interdisciplinary evaluation of population structure. Published tagging studies and updated analyses of available tagging data (including ~200,000 tag releases and ~12,000 recaptures dating back to the 1920s) were used to identify persistent patterns of movement and residence among geographic regions and fishing grounds. Results suggest relatively sedentary groups of cod within the Bay of Fundy, the western Gulf of Maine, southern New England, and the Mid Atlantic Bight, and little movement of Cod between the eastern and western Scotian Shelf. Results also indicate substantial movement corridors from the Great South Channel to the western Gulf of Maine, from eastern Georges Bank to Browns Bank, and from Browns Bank to the Bay of Fundy and the western Scotian Shelf. Analysis of distinct spawning groups suggest high residence and fidelity to spawning areas in the western Gulf of Maine and the Bay of Fundy, moderate spawning site fidelity on eastern Georges Bank with some post-spawning dispersal to other fishing grounds, and greater dispersal from the 'Cape Cod' spawning grounds. Major movement patterns are generally consistent across recent decades of tagging studies, but the frequency of residence and movement vary among studies.

Effects of Plunge Pool Configuration on Downstream Passage Survival of Juvenile Blueback Herring. Castro-Santos, T., K. Mulligan, M. Kieffer, A. Haro, *U.S. Geological Survey Conte Anadromous Fish Lab, Turners Falls, MA*

Juvenile Blueback Herring are fragile animals that are at high risk of injury and death associated with passage at hydroelectric facilities. Although turbine mortality is a common concern, conditions encountered when bypassed around these routes may also be hazardous. Downstream bypass structures typically discharge into plunge pools, which are highly turbulent

and may cause mechanical injury. We subjected live, actively migrating juvenile Blueback Herring to a suite of realistic plunge pool conditions (3 m drop, pool depth of 60-180 cm, and discharge of 0.28 – 1.70 m^3s^{-1}) and monitored them for >96 h. Survival was generally higher than expected (>80% in all cases). However, both plunge pool volume and total discharge affected survival with elevated discharge and shallow conditions associated with increased mortality. Mortality was often delayed: rates remained elevated throughout the monitoring period, indicating that survival studies based on shorter periods underestimate total mortality.

The Case Study of Marine Fisheries Partnership: From Scientific Exchange to Global Collaborations. Chang, Bowen, *University of Maine, Orono, ME*

The international scientific exchange has a long, illustrious history. In the era of global climate change, however, it has to assume new forms and take on new responsibilities. The present-day environmental conservation challenge is more global than ever before. Scientists and policymakers proposed 17 UN Sustainable Development Goals, pledged to by nations around the world. Internationally coordinated conservation efforts become integral in combating the looming global environmental calamity. Collaborations happen at different levels through different channels, both in science and policy. The global collaboration increasingly calls for innovative approaches and actors, as the traditional international forums were mired by inaction and conflicts of interests. The Marine Fisheries Partnership (MFP), formed in 2017 by a group of scientists and environmental NGOs based in the US and China, is representative of such an innovative approach. It seeks to garner the expertise and objectivity of the scientific community to actively engage with policymakers on an international stage. There are three important take-aways from MFP's work: 1) Focus on a well-defined challenge and location-specific solutions; 2) Involve a diverse range of stakeholders in all-inclusive forums; and 3) Facilitate comprehensive learning of integrated management systems. Still in its infancy, the future of MFP hinges on transitioning into a sustainable and continuous learning community. Nevertheless, MFP's case study harbors lessons for not only scientific exchange but also the future of global collaborations.

The URI-GSO Fish Trawl Survey: Documenting 60 Years of Ecosystem Change in Narragansett Bay. Collie, Jeremy[1], Joseph Langan[1], Austin Humphries[2], *[1]GSO, University of Rhode Island, Narragansett, RI, [2]FAVS, University of Rhode Island, Kingston, RI*

As a result of rapid warming due to climate change, the marine species assemblage of southern New England has shifted toward a warm-water community faster than any other along the US Atlantic coast. Already posing significant challenges to stakeholders and managers, these ecosystem changes must be monitored and understood in order to adapt and prepare for a warmer future. Conducted at two locations in Narragansett Bay, Rhode Island, the URI-GSO weekly fish trawl survey (1959-Present) provides a unique opportunity for in-depth study of changes in the coastal ecosystem. During the past 60 years, survey data indicate that the Narragansett Bay food web has shifted both in its assemblage and organization. Following the decline of cold-water, resident fish species during the 1970s and early-1980s, lower trophic

level taxa increased in abundance from an apparent predator release (Hake, Ocean Pout, Cod). During the 2000s, however, warm-water, migratory fish species began to dominate the community. Mirroring these shifts in abundance, the residence periods of migratory species in Narragansett Bay have in many cases changed by several months in response to shifting temperature fields across the continental shelf. Taken together, the observations of the URI-GSO fish trawl survey suggest that Narragansett Bay now resembles the Carolinian marine province. The insights gained from this unique data set help to anticipate further change in Narragansett Bay and provide an example of the effects of climate change on marine ecosystems.

Long Term CO_2 and Temperature Effects on Fecundity and Oocyte Recruitment in the Atlantic Silverside.* Concannon, Callie, Hannes Baumann, *University of Connecticut, Avery Point, Groton, CT*

Experimental ocean acidification research has identified many traits in marine organisms that are affected by elevated CO_2 levels, but most studies have encompassed only a small fraction of an organisms' life. In contrast, consequences of whole life exposure to high CO_2 environments such as potential effects on fecundity remain largely unknown. This study quantified potential annual fecundity and oocyte development in experimental Atlantic Silverside (*Menidia menidia*) populations reared from fertilization to maturity under contrasting CO_2 x temperature conditions. Silversides are important, annual forage fish in nearshore habitats along the North American Atlantic coast. In the spring of 2018, wild *M. menidia* adults were captured via beach seining, strip-spawned, and their offspring reared to maturity under ambient (~400 µatm) and high CO_2 conditions (~2,000 µatm) and two temperatures; 17°C, the natural temperature experienced in the spring, and 24°C, optimal silverside rearing temperature. Fish were sampled immediately prior to spawning, gonads extracted, and ovaries preserved (n = 88 females out of 377 individuals). In addition to calculating gonadosomatic indices for both males and females, we counted and measured oocytes in each ovary and used histology to identify and link developmental stages to corresponding size classes. Our results improve understanding of CO_2 effects on fitness-determining reproductive output in this important model species.

Vertical Movements of Young-of-the-Year White Sharks in a Summer Nursery Area - Implications for Bycatch Susceptibility. Curtis, Tobey[1], Rachel Shaw[2], Gregory Metzger[3], Christopher Fischer[4], Michael McCallister[5], Matthew Ajemian[5], *[1]Atlantic Highly Migratory Species Management Division, National Marine Fisheries Service, Gloucester, MA, [2]Florida Atlantic University, Ft. Pierce, FL, [3]South Fork Natural History Museum, Southampton, NY, [4]OCEARCH, Park City, UT, [5]Harbor Branch Oceanographic Institute, Ft. Pierce, FL*

Coastal waters off the south shore of Long Island, New York were recently confirmed as a summer nursery area for young-of-the-year (YOY) White Sharks (*Carcharodon carcharias*) in the northwest Atlantic. To gain insights into vertical movements and habitat selection in this region, we deployed high-rate pop-up satellite archival tags (PSATs) on 12 sharks (119-160 cm fork length) during July and August 2017-2019. These tags recorded depth and temperature

observations for 28 days following release. Tag data revealed vertical oscillations between the surface and bottom, as deep as 200 m and temperatures of 6-26 °C, but the sharks spent the majority of their time swimming at depths of 9 m (± 6 m), and in water temperatures of 19 °C (± 1 °C). Vertical rates of movement in the water column averaged less than 0.1 m/s. Individual and site-specific variation in vertical activity, including diel vertical migration, was apparent and likely influenced by local-scale foraging strategies. Bycatch of YOY White Sharks is infrequent, but mostly associated with bottom-associated gears including otter trawl, sink gillnet, and rod and reel targeting demersal species. Thus, proportion of time associated with the sea floor was calculated for the tagged sharks allowing estimation of the vertical component of bycatch risk. These results improve our understanding of essential fish habitat and bycatch susceptibility for White Sharks in this vulnerable life stage.

Assessing Consumer Access and Perceptions Towards Underutilized Fish Species: Key Ingredients for Cooking Up Future Sustainable Seafood A-fish-ionados.* Davis, Amanda[1,2,3], Michelle Staudinger[3], Alissa Nolden[1], Ezra Markowitz[1], Kathy Wicks[1], *[1]University of Massachusetts Amherst, Amherst, MA [2]Our Wicked Fish, Inc, Amherst, MA, [3]USGS DOI Northeast Climate Adaptation Science Center, Amherst, MA*

Climate change is challenging the socio-economic and environmental sustainability of New England's seafood industry by increasing costs for fishers, redistributing fish species and enhancing the imbalance between consumer demand and nature's supply. This multifaceted challenge highlights a need for innovative solutions that bring together ecological, economic, and social science knowledge to build resilient fisheries. One initiative that could accomplish this goal is increasing the demand for "underutilized species". This approach appears promising since culinary networks are advocating for lesser-known species and consumers are willing to pay a premium for local food. However, since the term "underutilized species" lacks a quantitative definition, regions are limited in their ability to identify - let alone market - their own unique underutilized species during this "eat local" movement. To ensure underutilized species are consistently characterized, we propose a quantitative definition that includes science-based sustainable fishing metrics that can be uniformly calculated within each region. Under our definition, the Northwestern Atlantic region currently has six underutilized species. Over 160 restaurant menus in Boston were assessed to gauge local capacity and demand for underutilized species and we have recently surveyed and tested a few of the species with Millenial and post-Millenial seafood consumers to assess perceptions towards unfamiliar offerings and name bias. Our project aims to support pier-to-plate collaborations as well as climate-smart decision-making and purchasing by exploring if consumers and industry are receptive to new seafood products involving underutilized species or species that are emerging into the region due to warming ocean temperatures.

Haddock Without Cod: A Habitat Model to Help Recreational Anglers Catch One Species and Avoid Another. Dean, Micah[1], William Hoffman[1], Gregory DeCelles[2], Matt Ayer[1], Emily Keiley[3], John Mandelman[4], Douglas Zemeckis[5], *[1]MA Division of Marine Fisheries, Gloucester, MA, [2]MA*

Division of Marine Fisheries, New Bedford, MA, [3]NOAA Greater Atlantic Regional Fisheries Office, Gloucester, MA, [4]New England Aquarium, Boston, MA, [5]Rutgers University, Toms River, NJ

Due to overlapping habitat preferences, Atlantic Cod (*Gadus morhua)* and Haddock (*Melanogrammus aeglefinus*) are frequently caught together in the Gulf of Maine recreational fishery. While the Haddock stock is currently at record abundance, cod remain near an all-time low. Despite a prohibition on keeping cod, concerns over discard mortality have led managers to impose limits on harvesting Haddock. To counteract this issue, we are offering guidance to the recreational fishery by identifying areas where the catch rate for Haddock is high, yet low for cod. We developed seasonally-resolved geo-statistical models for both species, fit to bottom trawl survey data, accounting for the non-linear relationship between abundance and habitat variables (depth, temperature, seafloor complexity). A second model was used to translate predicted groundfish density into an expected catch rate for baited hooks, accounting for the effects of gear saturation, species-specific attack rates, size selectivity, and angler experience. Standardized recreational fishing observations (n = 2400) were collected over 2 years to estimate the key parameters of the translation model. Predicted recreational catch rates were then used to classify the western Gulf of Maine into areas to target (high Haddock; low cod) and to avoid (high cod; low Haddock). Guidance maps will be distributed freely as waterproof booklets, and via a location-aware smartphone app. Our goal is reduce cod bycatch, thereby preventing further measures to restrict recreational anglers' access to the abundant Haddock resource.

Long-Term Changes in the Maturation and Growth of Cape Cod/Gulf of Maine Yellowtail Flounder. DeCelles, Greg[1], Tiffany Vidal[2], *[1]Massachusetts Division of Marine Fisheries, New Bedford, MA, [2]The Pacific Community, Nouméa, New Caledonia*

The objective of this study was to understand changes in the maturation and growth of Cape Cod/Gulf of Maine Yellowtail Flounder (*Limanda ferruginea*) by examining fisheries independent data from cohorts produced over a 38 year period (1976-2014). Yellowtail Flounder in the Gulf of Maine have been harvested by commercial fisheries since the 1930's, and the most recent stock assessment estimated that from 1985 to 2016 fishing mortality rates exceeded the biological reference point in all but one year. Maturity ogives demonstrated that the length and age at 50% maturity declined for cohorts throughout the time period. Probabilistic Maturation Reaction Norms (PMRN), which describe the probability than an immature individual will become mature at a certain age and size class, demonstrated a shift towards maturation at younger ages and smaller sizes. For age-three female and male Yellowtail Flounder, the size at which the probability of becoming mature was 0.5 declined from 30.7 cm and 26.0 cm to 23.9 cm and 20.1 cm, respectively. Using von Bertalanffy growth curves, a decrease in asymptotic length ($L\infty$) and an increase in the growth rate (K) was estimated for both sexes. These life history changes are suggestive of fisheries-induced evolution, and have important implications for the productivity and management of the resource. However, although the PMRN approach is designed to account for phenotypic plasticity associated with growth and survival, further work is needed to determine whether

other factors (e.g., temperature and body condition) could be responsible for the changes in maturation observed in this study.

Use of Decision Tree Models in Improving Quality of Fisheries Dependent Data. Duarte, Debra, *Northeast Fisheries Science Center, Woods Hole, MA*

Decision trees are a powerful machine learning tool that can be used for predictive analytics in many domains. Here, I present two examples of its use on data from fisheries observers. First is the challenge of retaining experienced, high quality observers. High turnover can lead to increasing training and support costs, more time spent on quality control, etc. Surveys can provide broad qualitative trends, but cannot identify which individual observers are most likely to quit observing. By combining different factors, the decision tree prediction algorithm gives a probability of how likely an observer is to remain working over a specified time period. The program manager can use these scores to decide how to prioritize staff time and resources. The second example is validation of species identification. Human experts may be able to pick out possible errors by visual inspection of the data, but that can be a daunting task. Instead, a decision tree can be trained on validated species records, using factors such as season, location, depth, and fishery. The trained model can then be applied to unconfirmed records, highlighting potential inaccuracies for further review. These are just two examples of how decision trees can be used to identify trends that might not otherwise be apparent and make allocation of human resources more efficient. Because of their broad applicability and relative ease of use (using open source software such as R), machine learning tools can become strong assets to any data collection program.

Embracing Ecosystem Change and Creating Resilience: Lessons Learned from CFRF's Lobster and Jonah Crab Research Fleet. Ellertson, Aubrey, Christopher Glass, *Commercial Fisheries Research Foundation, Kingston, RI*

Over the past several decades, southern New England waters have experienced dramatic and widespread warming. This has had profound impacts on key fisheries resources, such as American lobster. Southern species are increasingly appearing off the coast of Southern New England. New species and markets are emerging, and the fishing community must adapt. Increases in water temperature have likely resulted in changes to American lobster size at maturity and growth patterns, given temperature has a strong influence on these vital processes. In addition, Jonah crab is an emerging fishery of volume and value that has provided lobstermen recently with an opportunity to diversify in response to a decline in the Southern New England Lobster fishery. Here we focus on changes to southern New England marine ecosystems, how lobstermen have adapted their businesses to the emergence of Jonah crab, and explore future implications for the Gulf of Maine.

Since 2004, the Commercial Fisheries Research Foundation (CFRF) has focused on working collaboratively to build relationships among scientists, managers, and members of the fishing industry to solve problems facing fisheries resources and fishing communities across southern

New England. Among the CFRF's greatest accomplishments are the fishermen-led Research Fleets developed in particular for lobster, Jonah crab, and Black Sea Bass, which involve over 40 fishermen collecting biological and environmental data while conducting their normal fishing operations for these valuable resource species. We will review data from CFRF's Lobster and Jonah Crab Research Fleet, and share lessons learned from the Southern New England Lobster industry.

The Massachusetts Aquaculture Permitting Plan: An Update. Ford, Kathryn[1], Chris Schillaci[1], Sean McNally[2], *[1]MA Division of Marine Fisheries, New Bedford, MA, [2]University of Massachusetts Boston, Boston, MA*

As the shellfish aquaculture industry expands in Massachusetts, the need for clearer permitting guidelines and assessments of cumulative impact have grown. State law gives municipalities jurisdiction over the licensing (or granting) of space to run an aquaculture facility, but the state has several additional layers of permitting. These layers include approving the municipal action, issuing permits related to operating an aquaculture facility, and issuing environmental permits for projects that trigger certain impact thresholds. Also, a public review of the Massachusetts Ocean Plan recommended that aquaculture be included in the update to the plan being done in 2020. In addition to state permitting, aquaculture facilities have federal permitting requirements through the Army Corps of Engineers. In order to address regulatory and industry-based concerns regarding cumulative impact, impact calculations, gear types, and the complicated permitting pathways, we are in the second year of developing the Massachusetts Aquaculture Permitting Plan (MAPP). This talk, which is an update from last year's introduction to MAPP, will present progress on the geographic distribution of aquaculture and progress on defining the permitting pathway and thresholds will be shown, including a website to guide a grower through permitting. Linkages to the Massachusetts Ocean Plan and the Massachusetts Shellfish Initiative will be highlighted. This work is being funded by ASMFC.

Linking Life Stages: Exploring Alewife Population Fluctuations. Gahagan, Ben[1], Adrian Jordaan[2], Eric Palkovacs[3], Kerry Reid[3], Carlos Garza[4], Alison Bowden[5], Brad Schondelmeier[1], Michael Armstrong[1], Gary Nelson[1], *[1]MA Division of Marine Fisheries, Gloucester, MA, [2]University of Massachusetts Amherst, Amherst, MA, [3]University of California Santa Cruz, Santa Cruz, CA, [4]NOAA Southwest Fisheries Science Center, Santa Cruz, CA, [5]The Nature Conservancy, Boston, MA*

Alewife populations have declined throughout much of their range and, despite harvest moratoria, recovery has been absent or intermittent in some regions. One possible explanation for both the population crash and lack of recovery has been large-scale removals in the Atlantic Herring and Mackerel fisheries. Concurrently, stressors related to watershed changes associated with an increasing human population and climate change have been documented. Thus, proactive conservation of Alewife likely hinges on bycatch controls in at-sea fisheries and accurate knowledge of population abundances and environmental drivers of productivity. We created a multiple life stage simulation model to investigate how marine mortality and nursery

productivity interact to affect anadromous Alewife populations. The simulation results showed that Alewife productivity will dictate the ability of a population to remain resilient when bycatch impacts are present. In general, as the ability of a system to support larger numbers of Alewife increases, the population is able to respond by growing larger young, lowering mortality as growth increases, and producing more eggs when individuals of a cohort return to spawn at larger sizes. Under moderate to high levels (≤50% population harvested annually) of bycatch mortality, the population does remain stable albeit at a lower levels. At very high mortality rates (≥80%), the population is likely to decline to levels closer to zero, increasing the risk of a population going extinct, especially at low productivity levels. This model represents a significant step forward in our ability to understand Alewife population dynamics and should improve restoration efforts.

Survival and Condition Evaluation of the Scotland Fish Lift. Gardner, Lynette, *Kleinschmidt Associates, Essex, CT*

Construction of the new fish passage facility at the Scotland Hydroelectric Project (FERC No. 2662-CT) was completed by Spring 2018. The new facility includes a fish lift and a smooth fiberglass chute that convey fishes upstream of the Scotland Dam in the Shetucket River. A study was conducted in 2018 and 2019 to evaluate the condition of American Shad which were subjected to a full lift cycle and held for a 24-hour period. Survival and malady-free rates were estimated using a mark recapture model. The results from these tests suggest that the new fish passage facilities at the Scotland Hydroelectric Project are a safe and effective mode of transporting American Shad upstream of the Project dam.

Movements and Feeding of Arctic Char Relative to Summer Ice-Off in an Arctic Embayment.* Hammer, Lars[1], Nigel Hussey[2], Robert Hodgson[3], Nathan Furey[1], *[1]University of New Hampshire, Durham, NH, [2]University of Windsor, Windsor, Ontario, Canada, [3]Department of Fisheries and Oceans, Winnipeg, Manitoba, Canada*

The Arctic is the fastest warming region on the planet and is thus an ideal region to study climate effects on organisms and their habitats. Arctic species must adapt to strong seasonal variations in productivity induced by changes in ice cover, which are likely to shift in the future. The Arctic Char (*Salvelinus alpinus*) is a fish of particular concern, providing sustenance and income to Arctic inhabitants through subsistence fisheries. Although char are an important resource, little is known about their responses to the spring ice-off, which results in a pulse of food. To investigate the movement ecology of Arctic Char, 58 individuals were tagged with acoustic transmitters in July of 2017 within Tremblay Sound, Nunavut, Canada. An array of 70 acoustic telemetry receivers were deployed to monitor char movements and recorded a total of 210,757 detections over ~1 year. All char exited Tremblay Sound between July 26 and September 1, 2017 with 55% returning to the sound between June 21 and July 7, 2018. Most char (~86%) exited the system to freshwater tributaries and the remaining ~14% exited to the marine environment. We hypothesize that movements in and out of Tremblay Sound are linked to food availability, particularly of the amphipod *Onisimus litoralis*, which was found in 69.6% of

sampled stomachs during the post-ice-off period. Quantifying how char move in relation to ice cover and food availability can provide clues to how their behavior and energetics will be affected by continued climate change and earlier ice-off.

Conservation Physiology: A Mechanistic Approach to Informing Sustainable Fisheries in China. Helmuth, Brian [1], Yunwei Dong[2], Francis Choi[1], Aubrey Foulk[1], *[1]Northeastern University Marine Science Center, Nahant, MA 01908 USA, [2]Fisheries College, Ocean University of China, Qingdao, Shandong, China*

The rapid evolution of sustainable fisheries policy in China offers an opportunity to implement flexible adaptive management tools that incorporate the ongoing and future impacts of global climate change. Unlike correlative approaches, which assume model stationarity and space for time substitution, process-based (mechanistic) models can be applied under novel suites of environmental conditions by quantifying vulnerability based on both environmental exposure and sensitivity to those environmental factors. Using a series of case studies in the U.S. and China, we describe how controlled physiological experimentation coupled with modeling can illuminate both potential opportunities and vulnerabilities in commercially important species, as well as in keystone species that ultimately control assemblage-level responses. Using intertidal invertebrates, we show how the interaction of high levels of environmental heterogeneity with intraspecific (inter-individual) variation in sensitivity can lead to complex patterns of population-level responses. These argue for management strategies that allow consideration of local, often idiosyncratic environmental conditions, and which are sufficiently flexible to facilitate rapid, pro-active responses to interannual variability such as heat waves.

Assessing Barrier Effects of Road-Stream Crossings on Fish and Other Aquatic Organisms in the Northeastern United States. Jackson, Scott, *University of Massachusetts Amherst, Amherst, MA*

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a network of individuals from universities, conservation organizations, environmental businesses, and state and federal natural resource and transportation agencies focused on improving aquatic connectivity across a thirteen-state region, from Maine to Virginia. The NAACC has developed common protocols for assessing road-stream crossings (culverts and bridges) and a regional database that allows for the storage, scoring and retrieval of field data. In 2015, the NAACC released a protocol for assessment aquatic connectivity for non-tidal streams. A Tidal Stream Crossing Assessment protocol was developed in 2019 as a complement to the non-tidal protocol. It is particularly challenging to assess aquatic passability for tidal streams because daily fluctuations in water levels and flow characteristics mean that, for some streams, barrier effects may vary greatly throughout a single day. Conditions that would be impassable at low tide might be fine at high tide. These two crossing assessment protocols are rapid assessment methodologies designed to provide a rough assessment of the barrier effects of culverts and bridges on aquatic organism passage. Data from these assessments are incorporated into an aquatic barriers prioritization tool developed by The Nature Conservancy and Critical Linkages analyses conducted by UMass

Amherst. These prioritization systems quantify or rank restoration potential for each crossing and can be used to identify high priority bridges and culverts for upgrade or replacement. In additional to aquatic passability modules, the NAACC also has new protocols for assessing culvert condition and passability of road-stream crossings for terrestrial wildlife.

Stock Management by Population Fecundity.* Kasper, Jacob, Eric Schultz, *University of Connecticut, Storrs, CT*

Fish stock sizes are traditionally estimated with spawning stock biomass (SSB). This approach assumes reproductive equivalence per gram of tissue. Yet, fecundity scales hyperallometrically with length for many species of fish. Additionally, fishing mortality reduces the abundance of the largest individuals. Thus, SSB estimates may over represent the spawning capacity of truncated populations. Here we expand on our earlier work to broaden the size structure of truncated populations with harvest slot limits. We estimate the total population fecundity of the Long Island Sound Tautog, *Tautoga onitis*, and examine the impacts of harvest slot limits on total population fecundity.

Habitat Persistence Across Space and Time: A Novel Approach for Instream Habitat Assessments. Kennedy, Katie[1], Melissa Grader[2], Jesse Leddick[3], *[1]The Nature Conservancy, Northampton, MA, [2]U.S. Fish and Wildlife Service, Sunderland, MA, [3]MA Natural Heritage and Endangered Species Program, Westborough, MA*

Most large rivers across the United States are managed by dams, which substantially alter riverine habitat and ecology, including the hydrological regime. Changes in a river's hydrology can influence sediment and nutrient regimes, reproductive and dispersal cues, and the composition, availability, and persistence of habitat. When assessing the impacts of flow alteration or determining needed modifications for habitat restoration, managers often use methods focused on weighted usable area, which use habitat suitability curves to identify a level of discharge that provides a sufficient area of suitable habitat. These methods allow a rough estimate of habitat composition and availability under various discharge levels. To evaluate persistence, managers often use dual flow methods, which examine the minimum habitat area among a high and low discharge. These methods are especially ubiquitous in the relicensing of hydropower projects that operate with a peaking regime, where water is stored and released based on energy prices. In these cases, managers look at combinations of high and low flow that provide enough habitat area on a consistent basis to meet species needs. However, the hydrological regime is in large part characterized by temporal factors (e.g., rate of change, timing, frequency, duration), to which river-dependent species have adapted. As such, habitat persistence is not solely a function of spatial area, but of time as well. We use modeled hydrological data and habitat suitability curves to evaluate spatio-temporal habitat persistence, and propose some potential metrics for managers to utilize in hydropower relicensing processes and other dam management efforts.

Confronting Scientific, Economic, and Management Challenges in the Fujian Swimming Crab Fishery. Boenish, Robert[1], Shen Changchun[2], Liu Min[3], Lin Baian[3], Wang Songlin[4], Daniel Willard[1], Jake Kritzer[1], *[1]Environmental Defense Fund, Boston, MA, [2]Fujian Fisheries Research Institute, China, [3]Xiamen University, China, [4]Qingdao Marine Conservation Society, China*

China is undergoing sweeping reforms toward environmental sustainability across many policy sectors, including fisheries management. A core component of this transformation is pilot projects in management by total allowable catch (TAC) in coastal fishing provinces to build experience in an approach that is largely absent from the management toolbox at present. Fujian province selected the multispecies swimming crab pot fishery as the focus of its pilot, a fishery that has suffered declines in biomass and mean size of crabs. The pilot has illuminated key challenges in monitoring, stock assessment, gear conflicts, and industry cooperation. We use a bio-economic model to evaluate the biological and economic performance of alternative management strategies. Results suggest that fishing at a consistent level of fishing mortality throughout the year is the optimal strategy, as opposed to the pulses of effort that occur at present on either side of China's summer fishing moratorium and before the trawl fishery resumes. However, the summer moratorium is seen by many as foundational to China's fishery management system, and exemptions are only granted if high standards can be met. Specifically, the fishery would need to verify that pots are in fact being fished, the catch is predominantly crabs and not finfish, and that size limits and TACs are respected. This would require a level of at-sea monitoring not yet in place in most Chinese fisheries. To examine how this might be achieved, a group of fisheries practitioners from China visited the Quinault Nation in Washington State to examine their expanding use of electronic monitoring (EM) in the Dungeness Crab fishery. That exchange illustrated how EM can improve stock assessments and compliance with regulations, while also expanding management options for economic and operational benefit of the fishery and resolving key scientific uncertainties about spatial and temporal stock dynamics.

A Bayesian State-Space Approach to Improve Projections of Stock Biomass for Managing New England Groundfish.* Langan, Joseph A.[1], Christopher M. Legault[2], Gavino Puggioni[3], Jason E. McNamee[4], Jeremy S. Collie[1], *[1]University of Rhode Island Graduate School of Oceanography, Narragansett, RI, [2]Northeast Fisheries Science Center, Woods Hole, MA, [3]University of Rhode Island, Kingston, RI, [4]RI Division of Marine Fisheries, Jamestown, RI*

Specification of Allowable Biological Catch requires projecting biomass one to three or more years beyond the terminal year of fish stock assessments. However, these projections are often highly uncertain and can perform poorly under retrospective review. For many New England groundfish stocks, consistent biases in assessments, known as retrospective errors, have led to overestimation of biomass resulting in unintentional overfishing, sharp reductions in catch quotas, and decreased stakeholder confidence in the management process. In an effort to address such issues, this work will develop a Bayesian state-space model aimed at improving projections of fish stock abundance. The approach will allow for the inclusion of climate data, expert input (e.g. use of estimates of biological parameters from the literature as prior information), and inference from similar species, where appropriate, to make full use of all data

available to inform stock projections. The performance of the developed modeling framework, compared with existing approaches, will be evaluated both in simulation and through retrospective forecasting of assessment data for three data-rich and three data-limited New England groundfish stocks by calculating the prediction-error variance (based on the difference between the realized and projected biomass). The results will then be openly shared with assessment scientists through the development of an R package to implement the proposed modeling strategy such that it can be applied broadly in the management of marine fisheries.

Are Cost-Minimizing Spatial Management Strategies Effective in Dynamic Social-Ecological Systems? A Case Study in China.* Li, Yunzhou[1,2], Ming Sun[1,2], Keith Evans[2], Yiping Ren[1,3], Yong Chen[2], *[1]Ocean University of China, Qingdao, China, [2]University of Maine, Orono, ME, [3]Pilot National Laboratory for Marine Science and Technology (Qingdao), China*

The rapid evolution of sustainable fisheries policy in China offers an opportunity to implement flexible adaptive management tools that incorporate the ongoing and future impacts of global climate change. Unlike correlative approaches, which assume model stationarity and space for time substitution, process-based (mechanistic) models can be applied under novel suites of environmental conditions by quantifying vulnerability based on both environmental exposure and sensitivity to those environmental factors. Using a series of case studies in the U.S. and China, we describe how controlled physiological experimentation coupled with modeling can illuminate both potential opportunities and vulnerabilities in commercially important species, as well as in keystone species that ultimately control assemblage-level responses. Using intertidal invertebrates, we show how the interaction of high levels of environmental heterogeneity with intraspecific (inter-individual) variation in sensitivity can lead to complex patterns of population-level responses. These argue for management strategies that allow consideration of local, often idiosyncratic environmental conditions, and which are sufficiently flexible to facilitate rapid, pro-active responses to interannual variability such as heat waves.

Realizing the Potential of Underutilized Local Seafood: Producing, Certifying, and Marketing Refreshed Scup Fillets. Long, Michael[1], Christopher Glass[1], Fred Mattera[1], Scott Bode[2], *[1]Commercial Fisheries Research Foundation, Kingston, RI, [2]Pier Fish Company, New Bedford, MA*

Following a stock rebuild in the 1990s and early 2000s, abundance of Scup (*Stenotomus chrysops*) has rebounded beyond abundance levels of past decades. However, even with the current high abundance of Scup, only around half of the annual quota has been landed in recent years following the rebuilt stock status in 2009. The main reason for this underutilized status of Scup is a lack of market demand. Fishermen receive prices for as low as $0.01 per pound at the dock, giving little incentive for them to actively target Scup while fishing. A major limitation to expanding the market is the seasonality of the fishery with the majority of landings occurring in summer being sold as whole fish. The Commercial Fisheries Research Foundation, in partnership with Johnson and Wales University, Pier Fish Company, Seafreeze Ltd., Sustainability Incubator, and Dodge Associates, have led multiple efforts to expand markets for new Scup products as fresh and refreshed fillets through at-sea handling trials, processing trials,

sustainability certifications, blind taste tests, public tasting events, and marketing outreach. Expanded markets for Scup would result in higher ex-vessel prices and an incentive for fishermen to utilize the full potential of the fishery, while potentially relieving stress on more pressured fisheries and supplying local sustainable seafood to consumers. With encouraging results and feedback from culinary professionals and consumers, continued promotion of expanding markets for Scup, and other underutilized species, remains vital to supporting and expanding local sustainable seafood.

Exploring Uncertainty in Qualitative Models. Lucey, Sean M.[1], Jamie C. Tam[2], Alida Bundy[2], Sarah K. Gaichas[1], Robert J. Gamble[1], *[1]Northeast Fisheries Science Center, Woods Hole, MA, [2]Bedford Institute of Oceanography, Darmouth, NS, Canada*

The use of Qualitative Network Models (QNMs) for exploring ecosystem-based management and integrated ecosystem assessments has increased dramatically over the last decade with several models built to represent socio-ecological systems across the US, Norway, and Canada. Compared to quantitative end-to-end ecosystem models, that require lots of data, QNMs can incorporate input from stakeholders or disciplines with limited data availability (including anecdotal data or qualitative data). However, several questions remain about the performance of QNMs in offering strategic management advice compared to quantitative ecosystem models. To test their performance, we developed a series of QNMs based off existing quantitative mass balance models of the Gulf of Maine and Western Scotian Shelf. To simulate the degree of input data, models were constructed using specific cut-offs in link strengths where weaker thresholds represent a more complete model of the system while stronger thresholds represent only major pathways of the system. Perturbations to the system were carried out using the R packages Qpress for the QNMs and Rpath for the mass balance models. Performance of the QNMs under specific scenarios are compared to the mass balance models for both systems. The results conclude that there are limits to the interpretation of results from QNMs, but that these limits do not necessarily outweigh the benefits of using QNMs in data depauperate circumstances.

A Cooperative Approach to Build a Wolffish Maturity Schedule for the Next Stock Assessment. McBride, R.S.[1], E.A. Fairchild[2], Y.K. Press[3], S.P. Elzey[4], *[1]Northeast Fisheries Science Center, Woods Hole, MA, [2]University of New Hampshire, Durham, NH, [3]Integrated Statistics, Woods Hole, MA, [4]Massachusetts Division of Marine Fisheries, Gloucester, MA*

Atlantic Wolffish (*Anarhichas lupus*) has been designated a Species of Concern under the US Endangered Species Act, with a similar status in Canada. Impediments to determining its status are low catches in fishery-independent surveys, a prohibition on direct landings by commercial and recreational fishing, and a lack of a maturity schedule to separate immature from mature fish in assessment models. A review of the data available prior to 2009, based on macroscopic observations, yielded imprecise estimates of size at maturity. From 2009 to 2018, wolffish were collected offshore of Cape Ann, in particular, and broadly in the Gulf of Maine. Working with a cooperating industry partner with a fishing permit in 2017, funded by a NOAA Saltonstall-

Kennedy grant, sample size doubled, resulting in a total of 255 females collected from the months April to December. Using gonad histology, a cohort of yolked oocytes was observed to increase in size from 1 to 4 mm between spring and autumn, and the ovary returned to a new spawning cycle by November. We present revised maturity schedules, by length and age, which will be used in the upcoming 2020 operational assessment to provide a more accurate estimate of spawning stock biomass. We also document: 1) abortive maturation [an advanced cohort of oocytes develops in first-time mature females, but this cohort undergoes cell death before the spawning season] and 2) skipped spawning [a fish that has spawned in the past does not advance or completely advance a cohort of oocytes in a subsequent year].

A Novel Method for Synchronizing Clocks and Removing Multipath Error Associated with Acoustic Tagging Technologies. Nebiolo, Kevin[1], Thomas Meyer[2], *[1]Kleinschmidt Associates, Essex, CT, [2]University of Connecticut, Storrs, CT*

The US Department of Energy and the US Army Corps of Engineers developed the Juvenile Salmon Acoustic Telemetry System (JSATS) to monitor the movement and survivability of juvenile salmonids as they transit through fish-passage structures at hydroelectric facilities. With JSATS, fish are surgically implanted with acoustic transmitters (a.k.a. “tags”) that are detected by hydrophones (a.k.a. “receivers”) mounted in a waterbody. Using multiple, stationary submerged hydrophones and proper synchronization of the transmissions allows the determination of a smolt’s position in three spatial dimensions over time, resulting in a high-resolution track of a fish’s loitering in the forebay and subsequent passage through the dam. From June 11 to August 27, 2018, 172 tagged smolts were tracked in the Cowlitz River (Washington, USA), of which 146 fish had successful position determinations, producing a total of nearly 200,000 positions. The most problematic aspects of the research were correctly synchronizing the hydrophones’ internal clocks and eliminating multipath receptions. This presentation will discuss how we addressed these problems so that we may aid other researchers in conducting their acoustic telemetry studies. The number of successful positions per fish ranged from 4 to 12,044. The positioning success ranged from 2% (27/1303) to 79% (2961/3730).

Impacts to the Feeding Behavior of Larval Sheepshead Minnow (*Cyprinodon variegatus*) Exposed to the Harmful Dinoflagellate *Cochlodinium polykrikoides*. Pascucci, Daniel, Konstantine J. Rountos, *Department of Biology, St. Joseph's College NY, Patchogue, NY*

Harmful algal blooms (HABs) caused by the toxic dinoflagellate, *Cochlodinium* (a.k.a. *Margalefidinium*) *polykrikoides*, have increased in geographic extent, frequency, and duration in many coastal ecosystems worldwide. In Long Island NY, blooms of this “rust tide” algae have become annual events, plaguing bays for more than a decade. While field observations and laboratory experiments have revealed the potent fish killing ability of this HAB species, considerably less is known of the potential behavioral impacts to fish. This research provides the first assessment of the effects of *C. polykrikoides* exposure on the overall feeding success of larval fish. Feeding assays evaluated the direct effects of both short and long-term HAB

exposure to larvae, as well as the potential delayed effects on feeding behavior resulting from embryonic exposure. Sheepshead Minnow (*Cyprinodon variegatus*) larvae exposed to *C. polykrikoides* had significantly decreased feeding ability compared to control treatments, while larvae that were exposed to this HAB during their embryonic life stage did not exhibit any noticeable feeding impairment. The experimental approach and laboratory framework developed here can aid in our understanding of the ecosystem effects of these blooms or other coastal hazards on fish populations.

Summer Water Temperature Regimes in Heavily Forested Yet Significantly Impounded Sub-watersheds and Associated Impacts on Eastern Brook Trout (*Salvelinus fontinalis*). Pelletier, Corey, *RI Department of Environmental Management, West Kingstown, RI*

Water temperatures in the native range of the Eastern Brook Trout (*Salvelinus fontinalis*) continue to rise, threatening the long-term survival of the species. Rhode Island has one of the highest human population densities in the country, yet still has large areas of contiguous forest that serve as a buffer from anthropogenic impacts to rivers and streams. In two studied watersheds, forested lands make up approximately 80% of the total area in each, and their rivers and streams host the largest contiguous patches of wild Brook Trout in the state. Despite the presence among the highly undeveloped watershed, temperatures still fluctuate within the main stems and tributaries to the brink of thermal thresholds, limiting suitable summer habitat and densities. Recent work by Rhode Island Fish and Wildlife has begun to focus on collecting summertime temperature data. In 2018, a suite of data loggers was deployed within the tributaries of the upper Wood River watershed to record temperatures from May through September and create a snapshot of thermal gradients. Similarly, in 2019, numerous loggers were spread throughout two neighboring sub-watersheds. The sub-watersheds have impoundments scattered throughout that negatively influence water temperatures. Electrofishing surveys were conducted to correlate densities with water temperature data. Understanding temperature regimes within a watershed and the effects on wild Brook Trout will help guide future projects to improve water quality and habitat.

Comparing Localized Feeding Ecology of Black Sea Bass (*Centropristis striata*) at Natural and Artificial Reefs Using Stomach Content and Stable Isotope Analyses. Price, André[1], Cara Schweitzer[2], Maurice Crawford[3], Rich McBride[1], Bradley Stevens[3], *[1]NOAA Northeast Fisheries Science Center, Woods Hole, MA, [2]Hampton University, Hampton, VA, [3]University of Maryland Eastern Shore, Princess Anne, MD*

Diets of Black Sea Bass (BSB, *Centropristis striata*) have been studied in the Mid-Atlantic Bight, but no studies have compared differences in dietary composition of BSB between natural and artificial reefs. Black Sea Bass (n=407) at selected natural and artificial reefs near Ocean City, MD were sampled in 2016 and 2018, using hook-and-line angling to determine how reef type influenced length and age relationships, sex ratios, diets, and stable isotope ratios of ∂12C/∂13C and ∂14N/∂15N from three tissue types: liver, muscle, and mucus. Diets of BSB caught in 2016 and 2018 were compared to a NOAA dataset (n=1304) of trawl-caught BSB

spanning 2000-2016 in proximity to the selected reef sites for angling. There were no significant differences in age composition between fish at natural and artificial habitats, indicating that the sorting of age by location type did not occur. Stomach content analyses indicate that crustaceans dominate diets of BSB at artificial and natural sites by proportion and by frequency of occurrence. ANOVA tests determined that location type (artificial vs. natural) had a significant effect on stable isotopes values in all tissues except for ð15N in mucus. This study shows that natural and artificial reefs are ecologically equivalent for BSB caught near Ocean City, MD, however, there are subtle differences in trophic dynamics that warrant further investigation, and isotopes from mucus samples may be a reliable, non-lethal method for such future investigation.

Tracking the Condition of Massachusetts' Large Rivers. Quiñones, Rebecca M., Steven Mattocks, *MA Division of Fisheries and Wildlife, Westborough, MA*

The condition of 19 mainstem rivers in Massachusetts was evaluated for two time periods (1998-2005, 2016-2019) using Target Fish Community (TFC) models and percent similarity. Fish communities were established through standardized electrofishing surveys (n ≥ 6) in each waterbody. Species abundances from reference streams were then ranked and converted to fish community proportions in order to establish corresponding TFCs. Percent similarity between TFCs and current fish communities were used to categorize rivers in good (> 75%), fair (50-75%), and poor (<50%) condition. A comparison of the two time periods suggests that river conditions are improving (2), unchanged (5) or worsening (4) across the state. Conditions in the Quinebaug and Shawheen rivers appear to have improved in the last 10-20 years while conditions in the Hoosic, Ipswich, West Branch Farmington, Blackstone, and Charles rivers remain fairly unchanged. The four rivers (e.g., Corcord, Housatonic, Nashua rivers) in potentially degrading trends, include the Westfield River, the only river previously in good condition. Similarity indices were calculated for the first time for the remaining eight rivers; all of which are categorized as being in poor condition with the exception of the Deerfield River (fair condition). In the next few months, fish community data and watershed characteristics will be analyzed to explore factors (e.g., urban development, reforestation) that could mitigate or exacerbate land-use impacts on instream habitat quality. This analysis will be used to develop management actions that best address habitat restoration needs.

Modular and Scalable Downstream Bypass System for Silver American Eels. Rackovan, Jenna[1], Steve Amaral[1], Brian McMahon[1], Joe Zottoli[1], Eric Truebe[2], Jon Truebe[2], Mark Timko[3], Corey Wright[3], *[1]Alden Research Laboratory, Holden, MA, [2]Lakeside Engineering, Mirror Lake, NH, [3]Blueleaf Environmental, Ellensburg, WA*

Downstream passage of silver-phase American Eel (*Anguilla rostrata*) is a major issue at hydro projects due to population declines. Hydropower facilities can impact eel populations by causing migratory delays or mortality during passage through turbines. However, providing safe downstream passage can be logistically difficult and costly for dam owners. The objective of this research was to successfully address the need for biologically effective and less expensive

downstream passage technologies for eels by evaluating and optimizing the design and operation of two modular and scalable bypass systems. Bypass efficiency of migrating silver American Eels was evaluated in the laboratory with two new innovative bypass systems: the KLAWA horizontal zig-zag and the Lakeside Engineering vertical bypass with both 1 and 2-in bar rack spacing. Bypass efficiency ranged from 14% for the vertical bypass with 2-in spacing to 91% for both bypass systems evaluated together with 1-in bar spacing. The results of the laboratory evaluation indicate both bypass systems have potential to reduce turbine entrainment in the field by providing safe alternative routes. Additionally, these lower flow systems will have less impact on power generation and may alleviate the need for more restrictive agency requirements for narrower bar spacings (e.g., 0.75 inch clear).

Application and Ecosystem Improvements of Large Woody Material in Headwater Streams. Rodgers, Erin, Colin Lawson, Joel DeStasio, *Trout Unlimited, Brattleboro, VT*

Trout Unlimited, in partnership with state and federal agencies and private landowners, has installed over 46 miles of in-stream large woody material throughout New England using three methodologies: hand-placed, chop-and-grip, and engineered log jams. Historic land use practices and stream management have resulted in little to no large in-stream woody material throughout New England's streams. Large woody material plays multiple vital roles in the stream and riparian ecosystems. Restoring large woody habitat back into streams has shown substantial improvements in sediment transport and sorting, floodplain connectivity, mesohabitat diversity, and fish size and abundance. This presentation will highlight the results of several case studies in New Hampshire, Vermont, and Massachusetts.

Unpacking Fish Responses to Impervious Cover in Massachusetts. Roy, Allison[1], David Armstrong[2], Matthew Baker[3], Catherine Bentsen[4], Robert Smith[5], Jason Stolarski[6], *[1]U.S. Geological Survey, MA Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, MA, [2]U.S. Geological Survey, New England Water Science Center, Northborough, MA, [3]Geography & Environmental Systems, University of Maryland Baltimore County, Baltimore, MD, [4]MA Division of Ecological Restoration, Boston, MA, [5]Biology Department, Lycoming College, Williamsport, PA, [6]MA Division of Fisheries and Wildlife, Westborough, MA*

While urbanization typically results in a suite of hydrologic, geomorphic, and chemical alterations that degrade biotic assemblages (i.e., the urban stream syndrome), local responses likely vary based on the physiographic context, specific features and arrangement of impervious cover, disturbances proximal to the stream, and resilience of native biota. The goal of the study was to better understand what aspects of the landscape and in-stream habitat alter or attenuate impacts of impervious cover on stream biota. We used data from 1012 fish sampling sites in Massachusetts to investigate the impacts of natural and anthropogenic variables on fish responses to urbanization. Fish response to impervious cover was strongly influenced by environmental context, with sites in western MA losing sensitive species at lower levels of impervious cover (~2%) than sites in eastern MA (~8%). Cartesian distance-weighted impervious

cover metrics were better supported than distance-along-flowpath metrics, suggesting that the impervious effect is due to simple proximity (e.g., removal of local shading) or is hydrologically-dispersed in space or time (e.g., an effect on groundwater recharge), rather than related to surface hydrologic transport (e.g., contaminants in stormwater runoff). At the reach scale, colder water temperatures, higher dissolved oxygen, and more wood were related to higher proportions of intolerant fishes, suggesting that local conditions can provide critical habitat to sustain biota in areas with relatively low impervious cover. Identifying characteristics of watersheds and streams that exacerbate urban effects or, conversely, provide more resilience to urban disturbance can inform watershed-specific stream protection and restoration guidelines.

Assessing the Productivity of Juvenile Atlantic Salmon in Maine Streams Through a Long-term Electrofishing Dataset.* Ryan, Athena[1], John Kocik[2], Ernie Atkinson[3], Nathan Furey[1], *[1]University of New Hampshire, Durham, NH, [2]NOAA National Marine Fisheries Service, Orono, ME, [3]ME Department of Marine Resources, Jonesboro, ME*

Atlantic Salmon (*Salmo salar*) populations were in decline throughout New England even before the fall of the fishery in 1948. Protection efforts have included stocking of juveniles, but natural production remains very low. Identifying correlates of juvenile productivity could help inform further conservation measures. We are using a long-term sixty-eight year (1960-2017) electrofishing dataset to understand the productivity of juvenile Atlantic Salmon in Maine streams within four large watersheds (East Machias, Narraguagus, Penobscot, and Sheepscot). We are using age composition and size (length) as proxies for condition and assessing trends in these metrics through time and among the four watersheds. Further analyses relating fish size to environmental conditions revealed that larger Salmon are consistently found in lower-elevation habitats and warmer waters among the four watersheds. Age composition analysis showed that the Narraguagus and East Machias drainages were found to have longer living fish than the other two drainages. Analyses demonstrated shifts in age structure, with potential simplification towards specific year classes in the East Machias and Narraguagus drainages. Results will be used to identify habitats currently underutilized and prioritize future stock enhancement efforts. Ultimately, my research will provide managers with information to aid in the recovery of the Atlantic Salmon in New England.

(Sea)food for Thought: Envisioning a Role for Marketplace Activism in Ecosystem-Based Fisheries Governance. Schumann, Sarah[1,2], Kate Masury[1], Margot Wilsterman[1,3], *[1]Eating with the Ecosystem, Narragansett, RI, [2]Commercial Fisherman, Narragansett, RI, [3]University of Massachusetts Dartmouth School for Marine Science and Technology, New Bedford, MA*

Marketplace activism leverages the relationships of consumerism to change some aspect of the way in which goods or services are produced, typically by encouraging consumers to choose one type of product over others through informed individual action. Going beyond the usual emphasis on individual consumers and products, this presentation will adopt a systems-based ethos by asking: how can New England scientists, policy makers, marketers, and seafood supply

chain practitioners join forces to promote whole-system resilience, accelerate a transition to ecosystem-based fisheries management, and make "ecosystem-based fisheries governance" a new organizing principle for marketplace initiatives and investments? Together, this presentation and the panel discussion that follows will serve as a broad call for collaborators for an effort to publish a roadmap for ecosystem-based fisheries marketing in New England.

Panel Discussion: Ecosystem-Based Fisheries Marketing: A New Paradigm for Sustainable Seafood? Schumann, Sarah[1,2], Kate Masury[1], Margot Wilsterman[1,3], *[1]Eating with the Ecosystem, Narragansett, RI, [2]Commercial Fisherman, Narragansett, RI, [3]University of Massachusetts Dartmouth School for Marine Science and Technology, New Bedford, MA*

There is increasing momentum among New England fisheries scientists and managers to transition from the prevailing single-species approach to fisheries management to a more holistic approach, ecosystem-based fisheries management (EBFM). At the same time, New England is experiencing a surge in interest in sea-to-table eating, local and regional food systems, and seafood traceability. This panel will juxtapose these two contemporary place-based trends and ignite a thought exercise framed by the questions: (a) what would it mean to design a marketplace strategy for New England seafood based on the principles of ecosystem-based fisheries management? and (b) how can the local foods movement be leveraged to help support a transition to EBFM in New England?

Adult Blueback Herring (*Alosa aestivalis*) Spawner Age Structure, Over Time and Space in the Lower Connecticut River Basin (2013-2018). Sprankle, Kenneth, Darren Desmarais, *U. S. Fish and Wildlife Service, Connecticut River Fish and Wildlife Conservation Office, Sunderland, MA*

We have conducted annual spring adult river herring (Alewife and Blueback Herring) sampling using boat electrofishing to obtain population assessment data in the lower Connecticut River basin since 2013. Sampling occurs in fixed tributary reaches of the lower Mattabesset and Farmington rivers in Connecticut and in the Westfield and Chicopee rivers in Massachusetts, as well as Wethersfield Cove in Connecticut. Sampling typically begins at the start of April and extends through early June, capturing the arrival of Blueback Herring at sites, with Alewife often already present. From 2013 to 2019, a total of 13,788 Blueback Herring were field sampled, with 6,163 of those non-selectively retained for laboratory processing for otolith, scales, and other special project data. Typically, 5-7 timed sampling runs are completed with a target of 80 fish (among runs) for the laboratory. Sex composition has been consistently skewed towards males (69%, range of 61-78%). Whole otoliths are examined with a digital imaging system following procedures developed by MA Division of Marine Fisheries Fish Aging Laboratory for these species. Age composition of both males and females has varied considerably among years, partially attributed to year-class strength based on Connecticut Fisheries Division's long-term juvenile alosine seine survey at seven main stem sites. From 2013 to 2018, a total of 3,305 males and 1,385 females have been assigned ages. Our talk will explore both age structure and abundance of cohorts of Blueback Herring over both time and space, and in relation to Connecticut's annual juvenile index values.

The Role of Sand Lances (*Ammodytes* sp.) in the Northwest Atlantic Ecosystem. Staudinger, Michelle, *DOI, Northeast Climate Adaptation Science Center, Amherst, MA*

The American Sand Lance (*Ammodytes americanus*) and the Northern Sand Lance (*A. dubius*) are small forage fishes that play an important functional role in the Northwest Atlantic Ocean (NWA). However, specific aspects of their regional ecology, population dynamics, and vulnerability to current and future stressors are poorly understood. The NWA is a highly dynamic ecosystem currently facing increased risks from climate change, fishing, and energy development. Consequently, a better understanding of the biology, population dynamics, and ecosystem role of *Ammodytes* is needed to inform relevant management, climate adaptation, and conservation efforts. To meet this need, this comprehensive review summarized available data on the 1) life history, behavior, and distribution, 2) trophic ecology, 3) threats and vulnerabilities, and 4) ecosystem services role related to *Ammodytes* in the NWA. Overall, 72 regional predators including 45 species of fishes, 2 squids, 16 seabirds, and 9 marine mammals were found to consume *Ammodytes*, highlighting the key role they play as forage. Priority research needs identified during this effort include: basic information on the patterns and drivers in abundance and distribution of *Ammodytes*, improved assessments of reproductive biology schedules, and investigations of regional sensitivity and resilience to climate change, fishing, and habitat disturbance. Holistic studies are also needed to evaluate trophic linkages, such as the consequences of inconsistent zooplankton prey and predator fields on energy transmission processes within the NWA ecosystem. Results represent the first comprehensive assessment of *Ammodytes* in the NWA and are intended to inform new research and support regional ecosystem-based management approaches.

Evolution of Marine Fisheries Management in China from 1949-2019: How Did China Get Here and Where Does China Go Next?* Su, Shu[1], Yi Tang[2], Bowen Chang[1], Wenbin Zhu[3], Yong Chen[1], *[1]University of Maine, Orono, ME, USA, [2]Shanghai Ocean University, Shanghai, China, [3]Marine and Fisheries Research Insititute of Zhejiang, Zhejiang, China*

China is the world's biggest fishing nation and a major player in the global seafood trade. Its fisheries development can decisively influence the global seafood trade, food security, and marine conservation. In recent years, significant changes have taken place in China's fisheries management priorities, policies, and regulations. In this paper, we review the evolving fisheries management practices in China to delineate changes in the management policies, measures and their performances from 1949 to 2019. We found that the extremely large scale of fishing fleet, the large number and poorly organized fishers, the "hidden" fishing capacity, the contradiction between the different local fisheries and the relatively consistent management approaches, the unclearly defined and assigned fishing rights, the limited data quality and availability, insufficient fisheries monitoring programs, the lack of robust scientific research methods, and the insufficient integration of science and stakeholders' thoughts into policies are the key issues that impede the development, implementation, and enforcement of fisheries policies and regulations. Combining those problems with China's current management initiatives, we provided nine recommendations for China's future fisheries reform. We hope

this paper can inform China's marine fisheries policy and provide valuable references for further researches related to China's sustainable fisheries management.

A Comparative Analysis of Science-Based Decision Making Processes in Fisheries Management. Suatoni, Lisa[1], Bowen Chang[2], Shu Su[2], *[1]NRDC, New York City, NY, [2]University of Maine, Orono, ME*

Sustainable fisheries management requires decisions based on sound science. To help ensure this, fisheries policies should establish institutions to conduct the best available science and processes to ensure that it forms the basis of decision making. The Chinese government has recently initiated an ambitious fisheries reform effort, elevating the goal of sustainability in its 13th Five Year Plan. If China is to successfully implement this plan, it will need to undergo institutional reforms to support strong science and its integration into decision making. To inform these reforms, NRDC, in collaboration with the Yong lab at the University of Maine, has conducted a comparative study on institutional structures and processes to ensure science-based decision making in fisheries management in the United States, the European Union, Chile, New Zealand, and Thailand.

An Age Validation Study Using Illicia and Vertebrae of Monkfish, *Lophius americanus*. Sutherland, S. J., R. Anne Richards, *NOAA Fisheries, Woods Hole, MA*

An extremely strong year-class of Monkfish (*Lophius americanus*) was first observed in the spring of 2015, and the length mode remained evident for several years. We took advantage of this opportunity, regularly collecting samples (N=203) from within the length mode and regarding them as known-age fish (0-3 years old) in an age validation study. The standard ageing method for Monkfish, using vertebrae, had recently been demonstrated to be invalid, and a European method using illicia (modified first dorsal fin rays) seemed promising. In this study, ages estimated by counting rings on illicia matched the known age only 50% of the time and were not replicable (9% agreement). Vertebral ages did not match the known age at all, but were somewhat replicable (68% agreement). Marginal increment analysis showed that one annulus formed on the illicia each year, in spring/summer. However, due to the low accuracy, we concluded that neither structure is useful for age estimation of Monkfish.

Integrating eDNA Fish Community Analysis into Stream Assessments.* Thomas, Devin[1], Alison Watts[1], Aaron Kernan[1], Davide Neils[2], *[1]University of New Hampshire, Durham, NH, [2]NH Department of Environmental Services, Concord, NH*

eDNA monitoring in aquatic systems is a potentially powerful tool for assessing fish community, biodiversity and invasive species presence. In 2019 we sampled 40 stream locations as part of the New Hampshire Department of Environmental Services long term trend monitoring program. One liter water samples were filtered onsite, then the DNA was extracted and analyzed for fish community. We identified over 80 fish species, with up to 37 species in one

sample. Fish community, as identified by DNA, is a function of both the species present, sampling location, and stream transport properties. Smaller streams may retain DNA longer, although sunlight and warmth degrade the signal. Water quality, including natural tannins may inhibit DNA amplification. Replicate samples were highly variable, indicating the need for multiple samples to fully identify a community. Once extracted the DNA can be re-run for additional species, and can be frozen for many years in case additional analyses are requested at a later date. We will evaluate the DNA-identified fish community with respect to stream and watershed parameters, including temperature, nutrients, land use etc. and will provide recommendations on the use of eDNA-based fish surveys in stream assessments.

Assessing the Impact of an Open-cycle Power Plant on Local Fish Communities: Revisiting Mt. Hope Bay After the Decommission of Brayton Point Power Station. Truesdale, Corinne L., M. Conor McManus, Jason E. McNamee, *RI DEM Division of Marine Fisheries, Jamestown, RI*

From 1963 until 2012, Brayton Point Power Station in Somerset, Massachusetts (decommissioned in 2017), employed an open-cycle cooling system, drawing in seawater from adjacent Mount Hope Bay and releasing heated effluent water back into the Bay. Concerns for the potential biological impact of elevated temperature in the Bay, as well as direct mortality of ichthyoplankton and juvenile fish via impingement and entrainment, resulted in several long-term monitoring programs designed to detect prospective shifts in marine biota community structure and fish abundance that may be associated with plant activities. Previous analyses of monitoring data indicated a significant decline in fish abundance and species diversity in Mount Hope Bay corresponding to an increase in seawater uptake at the plant. As a result of these findings, Brayton Point transitioned to a closed-loop cooling system in 2012, substantially reducing seawater intake and discontinuing thermal discharge into the Bay. Seven years after this transition, we revisit the analyses conducted over 20 years ago to examine changes in fish community structure and abundance trends in Mount Hope Bay. We re-run pertinent analyses performed in previous studies and discuss alternative analytical methods. Focus is placed on detecting any changes in abundance trends since 2012, when the old open-cycle cooling system was taken offline and replaced with the new closed-cycle cooling system. The presented results will be used to understand the influence of Brayton Point Power Station on the Mt. Hope Bay fish community and how any changes correspond to the trends of the larger Narragansett Bay region.

Does Fyke Net Sampling Accurately Characterize Anadromous Rainbow Smelt, *Osmerus mordax*, Spawning Population Demographics in a Coastal Massachusetts River? Turner, Sara[1], Bradford Chase[1], Michael Bednarski[2], Scott Elzey[3], Matthew Ayer[3], *[1]MA Division of Marine Fisheries, New Bedford, MA, [2]VA Department of Game & Inland Fisheries, Henrico, VA, [3]MA Division of Marine Fisheries, Gloucester, MA*

Rainbow Smelt are a small (< 35 cm), short-lived (< 6 years), anadromous species native to the northwest Atlantic Ocean. Populations range-wide have declined because of overfishing, habitat degradation, and climatic warming. A small, mid-channel survey fyke net is annually

deployed to collect demographic information to assess the population structure of Rainbow Smelt in several rivers in Massachusetts. Understanding the efficiency of this fyke net to provide representative data on abundance, size, and sex of the spawning population is essential for accurate population assessment. To evaluate this efficiency, we deployed an experimental fyke net that spanned the width of the river channel, concurrently with the survey fyke net in the Weymouth-Fore River, Massachusetts from March - May 2009-2011. Survey net catches were generally correlated with efficiency net catches, although at lower abundances catches were low and variable relative to the experimental net catches (mean = 2.7%; range = 0 – 13.7%). Sex ratios and size distributions were similar between nets. Significant differences were found in length comparisons between the survey and experimental nets, but fewer differences were observed when fish were binned in 10 mm length bins. Age-at-length was a function of sex and year, with no significant effects of net; therefore the survey net does not bias interpretations of age/length distributions. Thus, while fyke nets may have limited application for monitoring rivers with very small populations and/or in wide river reaches, catches in larger populations should generally reflect the overall population demographics.

Understanding Climate Impacts on Marine Biodiversity and Community Structure in the Gulf of Maine. Weston, Ashley, Lisa Kerr, Kathy Mills, Andrew Allyn, Andrew Pershing, *Gulf of Maine Research Institute, Portland, ME*

The Gulf of Maine is warming at an unprecedented rate and understanding the effects of environmental change in conjunction with fishing pressure on marine biodiversity is critical for the sustainability of marine resources. Fishery-independent surveys such as the Maine-New Hampshire inshore trawl, the Massachusetts inshore trawl, and the Northeast Fisheries Science Center bottom trawl provide long-term information that can be used to determine how populations change over time and space in relation to such factors. The objective of this study was to use trawl survey data to quantify changes in biodiversity and community structure in the Gulf of Maine and greater Northeast US waters. We calculated biodiversity indices using generalized additive models to determine if changes in biodiversity were linked to environmental variables (i.e. temperature and salinity). We defined and evaluated changes in community structure using multivariate ordination analysis. The Gulf of Maine supports some of the most valuable and culturally important fisheries in the nation. Information on resource-environment relationships is needed to improve our ability to manage living marine resources and anticipate how ecosystems and fisheries may change in the future.

Lessons from Disputes over Science: What Can Negotiation Teach us about Groundfish? Williams, Lindsey, *MIT Sea Grant College Program, Cambridge, MA*

Significant literature points to the importance of credibility, legitimacy, and salience in the use of science (Cash et al. 2003). Disputes over science provide an opportunity to better understand the drivers of these factors, and what can be learned to improve the use of science in conflict settings, including many fisheries. More specifically, we can explore cases of distrust in science and the concomitant disputes over management, to better understand potential paths ahead.

Drawing lessons from dispute resolution and negotiation theory taken together with the literature on public engagement and collaborative processes, we present findings from two case studies, including New England groundfish management and science. This research provides a way to explore the drivers of conflicts, explore lessons for potential paths ahead for existing conflicts, and also possible approaches to avoid future disputes where possible. Based on participant observation and analysis of semi-structured interviews with researchers, managers, and the regulated community within each case, we explore the role of credibility, legitimacy, and salience in the use of science and discuss other patterns emerging from the data. We also explore lessons for how researchers and managers are trained, particularly in preparation for entry into work on controversial topics. These findings provide potential approaches to think differently about how public engagement processes and opportunities to collaborate are designed but also how scientists and managers are trained. Understanding current challenges provides a window to learn and improve for the future.

Triggering a Diverse Seafood Diet: Exploring Perceptions of Sustainable Seafood Systems in New England. Witkin, Taylor, *University of Maine, Orono, ME*

New England's seafood production systems involve social relationships with food that are at odds with ecosystem health and longevity. Customers continue to demand, fishers continue to catch, and suppliers continue to sell species from increasingly threatened populations instead of abundant species that can be harvested sustainably. Harvesters and markets have been trapped, forced to depend on a narrow range of species despite opportunities to diversify marine food system markets and tastes. The aim of this study is to build a better understanding of how New England's local seafood movement and market can foster a sustainable socio-ecological seafood system. The argument of this thesis is that, while conscientious customers and harvesters are essential to an ecologically sustainable and socially equitable food system, seafood dealers have more power to swing local and regional seafood markets in a new direction. Caring for the ecosystem and caring for fishermen can still involve wild harvested seafood, it just means passing up the mighty cod for a more diverse array of seasonal, locally abundant species. That shift does not happen without innovative middlemen: seafood dealers that are willing to gamble.

The Reproductive Biology of Female Atlantic Herring in US Waters: Validating Classification Schemes to Assess the Importance of Spring and Skipped Spawning. Wuenschel, Mark, Jonathan Deroba, *NOAA NEFSC Population Biology Branch, Woods Hole, MA*

Atlantic Herring (*Clupea harengus*) are repeat spawners with group-synchronous oocyte development, determinate fecundity, and exhibit plasticity in other aspects of reproductive biology. Studies in other regions have reported skipped spawning and errors in macroscopic classification of maturity, both of which could bias estimates of reproductive potential, but a critical assessment of these in US waters is lacking. In the Gulf of Maine and Georges Bank, herring are assessed as a single stock complex, where females typically mature as 3-4 year olds and may live to 11 years. To evaluate 'skipped spawning', herring ovaries from fishery-

dependent and fishery-independent sources over multiple seasons were analyzed histologically to assess imminent (having vitellogenic or maturing oocytes) or recent spawning (having postovulatory follicles). Gonad histology allowed us to determine spawning seasonality and skipped spawning. Macroscopic maturity classification was more accurate in fall than in spring (1-4% vs. 7% incorrect maturity). The spatial distributions of immature and mature fish differed, which impacted estimation of maturity at length and age. We estimated 9-14% spring spawners, but found no evidence of skipped spawning. Macroscopic data (1987-2018) shows increases in spring spawning with latitude, which have not changed much over recent decades. The effects of up to 30% spring or skipped spawning on a stock assessment were evaluated. Spring spawning had little effect relative to assuming 100% fall spawning (the current assumption) and skipped spawning decreased the scale of SSB and related reference points, with the degree of change increasing with skipped spawning rates, but otherwise had few consequences.

Abstracts:
Poster Presentations

April Showers in November: Examining How Altered Hydrology from Winter Drawdowns Can Impact Habitat and Biota.** Baker, Alec[1], Allison Roy[1], Todd Richards[2], Michelle Craddock[3], Catherine Bentsen[3], *[1]MA Cooperative Fish and Wildlife Research Unit, University of UMass Amherst, MA, [2]MA Division of Fisheries and Wildlife, Westborough, MA, [3]MA Division of Ecological Restoration, Boston, MA*

Management of dams and their impoundments typically alter hydrology. Winter water-level drawdowns in lakes are a common management tool in New England where surface water elevation is lowered to protect in-lake structures and control nuisance aquatic vegetation. Not only do winter drawdowns alter lake hydrology, they also alter the natural hydrological regime of downstream rivers by increasing flows during fall drawdown and reducing flows during spring refill. We aim to understand the effects of this altered hydrologic regime on downstream hydrology, temperature, geomorphology, habitat, and biota. We predict reduced spring flows will decrease mobilization of fine sediments and decrease scour of periphyton, resulting in less gravel spawning habitat and increased proportion of fish and macroinvertebrate herbivores downstream of drawdown vs. non-drawdown reservoirs. In contrast, higher than normal fall flows may wash out young-of-year fish and mobilize gravel spawning habitat. Lakes with higher magnitude or longer duration drawdown and refill periods are likely to have more severe impacts. We hope to better understand the effects of drawdowns on ecosystem drivers and inform state-issued drawdown guidelines to better conserve biotic integrity.

Defining NH Warmwater Fish Communities and Selecting Candidate Biotic Integrity Metrics. Chapman, Andy, *NH Department of Environmental Services, Concord, NH*

New Hampshire's surface water quality regulations require that surface waters shall support and maintain a balanced, integrative and adaptive community of organisms that is comparable to similar natural habitats in the region. As a result, New Hampshire has developed numeric fish indices of biotic integrity (IBIs) to assist with interpreting the narrative water quality criteria for wadeable streams. A coldwater fish IBI (CWIBI) was developed in 2007 and coolwater or transitional water fish IBI (TWIBI) in 2011. To date, a warmwater IBI (WWIBI) covering remaining wadeable, warmwater rivers and streams has not been developed. Data gathered since 1997 for more than 180 warmwater sites were split into reference and non-reference categories and analyzed for differences in physical variables. Reference sites were evaluated using non-metric dimensional scaling and found two distinct "natural" groups responding to latitude and basin slope. Candidate metrics were analyzed for the two groups. This presentation will provide the methodologies for predicting which of the two natural groups a

site is best associated and preliminary findings for metrics with the greatest potential for assessing New Hampshire's warmwater fish communities.

Interannual Variability in Size-at-Age and Growth of Spawning Sand Lance (*Ammodytes dubius*) on Stellwagen Bank.** Clancey, Emily[1], Justin Suca[2], David Wiley[3], Joel Llopiz[2], *[1]University of North Carolina Wilmington, Wilmington, NC; [2]Woods Hole Oceanographic Institute, Woods Hole, MA, [3]NOAA, Stellwagen Bank National Marine Sanctuary, Scituate, MA*

Sand Lance (*Ammodytes dubius*), are highly nutritious prey in Stellwagen Bank National Marine Sanctuary for many marine species; however, there is still little known about their basic biology and population dynamics in the sanctuary ecosystem. This study looked at size-at-age and percent and absolute growth of Sand Lance. Spawning Sand Lance were collected on the southern flank of Stellwagen Bank in November 2016, 2017, and 2018. Forty Sand Lance from 2016, 50 from 2017, and 40 from 2018 were measured, dissected, and aged using otoliths. The majority of the Sand Lance aged were age 1, 2, or 3. We found that there was a significant difference in size-at-age for age-2 Sand Lance among years, with 2016 age-2 fish being significantly smaller than 2017 and 2018. There was no significant interannual difference in size of age-1 fish. Mean percent growth between age-1 and age-2 fish also varied, with greater percent growth and absolute growth in 2017 than 2018. Both temperature and change in food quality may interact to result in the smaller size-at-age for Sand Lance. Mean monthly temperature anomalies in the Gulf of Maine were higher in 2016 than 2017 or 2018 while the copepod community was dominated by smaller species in 2016 than 2017 indicating lower food quality for this zooplanktivorous species. Understanding growth and age structure of Sand Lance in Stellwagen Bank and its potential drivers can be useful for understanding the population dynamics of this species and its quality as a prey item for higher trophic levels.

Are They Born Ready? Evaluating Migratory Physiology of Juvenile Alewife (*Alosa pseudoharengus*).** Colby, Rebecca S.[1], Stephen D. McCormick[2], Eric T. Schultz[1], *[1]University of Connecticut, Storrs, CT, [2]U.S. Geological Survey S.O. Conte Anadromous Fish Lab, Turners Falls, MA*

Juveniles of migratory fishes must endure rigors with which even adults struggle. For diadromous species, those that migrate between freshwater and seawater, the physiological costs of migrating are especially high, as shifting osmotic stressors (e.g. salinity) and performance demands (e.g. predator avoidance) require energetically costly responses. While it is expected that juveniles of diadromous species undergo some physiological preparation before initiating migration, little is known about juvenile migratory physiology aside from a few focal taxa. In Alewife (*Alosa pseudoharengus*), a diadromous species of concern, juveniles hatched in the freshwater environment migrate to the ocean for growth and maturation. If physiological preparation for seaward migration is present, actively-migrating individuals may perform better in ecologically relevant challenges than those not yet migrating. In particular, we hypothesize that actively-migrating juvenile Alewife will have increased osmoregulatory

ability compared to pre-migratory individuals. We tested this hypothesis with salinity challenge experiments that yielded assessments of survival and gill NKA activity for pre-migratory and actively-migrating juvenile Alewives from Bride Lake (East Lyme, Connecticut). Increasing our understanding of how juveniles interact with their environment during freshwater-seawater transition is crucial for management and restoration since juvenile growth and survival may have a profound influence on adult spawning stock size.

Diet of Striped Searobin in Narragansett Bay.** Heinichen, Maggie[1], Jeremy Collie[1], Joseph A. Langan[1], Annie Innes-Gold[2], Austin Humphries[2], Tyler Richman[3], *[1]University of Rhode Island Graduate School of Oceanography, Narragansett, RI, [2]University of Rhode Island College of the Environment and Life Sciences, Kingstown, RI, [3]Roger Williams University, Bristol, RI*

Narragansett Bay is warming at a faster rate than the global average, shifting the fish community from one dominated by cold-water resident species to one of predominantly warm-water, summer transient species. As they have expanded their presence in the estuary, it is suspected that these summer transients have disrupted historical trophic dynamics. One such climate invader, Striped Searobin (*Prionotus evolans*), continues to increase in abundance and residence time in the Bay. Until now, limited diet data existed for Striped Searobin, with no samples originating in this system. To address this research need, fish were collected from the URI GSO and RIDEM trawls beginning in May 2019. Striped Searobin consumed species from a variety of trophic levels, but their gut contents were dominated by shrimps and amphipods. Striped Searobin exhibit ontogenetic diet shifts, whereby large individuals eat a wider variety of species including larval and post-larval stages of commercially important fish species such as Cod and Winter Flounder. Data gathered throughout the residence period yielded evidence of a seasonal diet trend, hypothesized to be related to spawning time. As these summer omnivores become increasingly abundant in Narragansett Bay, the spatial, size, and temporal resolution of the collected diet data will allow for a close examination of the role of Striped Searobin in this changing food web.

How Modified Trophic Interactions can Create Socio-Ecological Tradeoffs: A Case Study of Narragansett Bay Fisheries.** Innes-Gold, Annie[1], Maggie Heinichen[2], Kelvin Gorspe[1], Jason McNamee[3], M. Conor McManus[3], Jeremy Collie[2], Austin Humphries[1], *[1]Department of Fisheries, Animal and Veterinary Science, University of Rhode Island, Kingston, RI, [2]Graduate School of Oceanography, University of Rhode Island, Narragansett, RI, [3]RI Division of Marine Fisheries, Jamestown, RI*

Integrating social and ecological data could improve resource management by addressing how humans interact with the environment and vice versa. For example, high fishing pressure and harvest reduce the biomass of fish species. The availability of fish, in turn, influences the behavior of fishers. Narragansett Bay, Rhode Island, provides a case study for this type of social-ecological feedback loop. Here, recreational and commercial fisheries, along with aquaculture and tourism, provide livelihood for thousands of people. The success of these interrelated industries depends heavily on the ability of ecosystem-based management to be

operationalized. In this study, we explore a subset of social-ecological trade-offs in Narragansett Bay using the Ecopath with Ecosim model (EwE). Specifically, we create an integrated ecosystem model to explore the role of planktivorous fish as harvested species versus their value in providing food for other fisheries (i.e. the recreational fisheries of Striped Bass and Bluefish). The next steps in this research will be to use the biomass of fished species as the input to an agent-based fisher behavior model, predicting how changes in the availability of fish will influence fishers in Narragansett Bay. Our EwE model outcomes provide ecosystem-based management guidance to managers (e.g., RI Dept of Environmental Management) whose policy decisions must consider both social and ecological dynamics.

Non-Lethal Detection of the Invasive Eel Parasite *Anguillicola crassus*.** Lavoie, Danielle, Kenneth Oliveira, *University of Massachusetts Dartmouth, North Dartmouth, MA*
Anguillicola crassus is an invasive nematode species that parasitizes the swimbladders of anguillid eels. While the species is endemic to southeast Asia, it has spread throughout Europe and now North America. *A. crassus* feeds on blood within the swimbladder and can cause the structure to become thickened and scarred. This can further lead to reduced growth, changes in gas composition, and possibly a reduction in buoyancy control, which can detrimentally affect an eel's ability to make its spawning migration. Currently, the only way to confirm parasite infection is to dissect an eel and visually inspect the swimbladder. Studies conducted on European Eels have shown that X-ray can be helpful in detecting parasite infection, but this requires eels be brought into the laboratory. This study is using a digital hand-held X-ray to determine the presence or absence of *A. crassus* in American Eels. Yellow eels were collected from two areas in southern Massachusetts via electrofishing between June and August 2019. Eels were transported back to the lab, where they were anesthetized, and X-rays were taken from multiple angles. Eels were then dissected, and photographs of the swimbladder were taken in order to determine the intensity of infection. The photographs were then compared to X-ray images to validate the method. It is expected that the results of this ongoing study will be able to provide a non-lethal, field-based method for determining the presence of *A. crassus* in American Eels.

Juvenile American Shad Monitoring in the Connecticut River. Mattocks, Steven[1], Brian Keleher[1], Kenneth Sprankle[2], *[1]MA Division of Fisheries and Wildlife, Westborough, MA, [2]U.S. Fish & Wildlife Service, Sunderland, MA*

American Shad (*Alosa sapidissima*) populations in the Connecticut River have declined as a result of centuries of habitat loss and degradation. Three mainstem 19th century dams continue to prevent upstream passage and access to historical spawning habitat. Although fish passage has improved in recent decades, upstream passage of adults remains below restoration targets, and low passage rates at the Turner's Falls Dam is of particular concern. Adult passage rates likely directly influence subsequent juvenile (offspring) populations, which live and feed in freshwater through summer and fall and are an important forage base for many freshwater fish. Currently, juvenile shad are monitored below the Holyoke Dam but little is known about

their population characteristics upstream of the Holyoke Dam and how adult passage rates and dam configurations impact juvenile productivity. We conducted (ongoing) random stratified electrofishing surveys within each impounded section above Holyoke, Turners, and Vernon dams to identify and track differences in juvenile shad population characteristics including size, biomass, condition, and relative abundance. We observed density-dependent effects with variability in relative abundance, size, and condition across all three dam sections. Three years of data are presented and future work and management implications are outlined. American Shad support a large recreational and commercial fishing industry along the eastern US and are an important prey source for a variety of fish, birds, and mammals.

Ocean Literacy as Part of Outreach Programs in Marine and Environmental Science Education. Mrakovcich, Karina, Deanna Bergondo, Lucy Vlietstra, Victoria Futch, *US Coast Guard Academy, New London, CT*

The US Coast Guard Academy is an undergraduate institution that also provides STEM education programs to the local community and other partners. These efforts include classroom, lab, and field-based activities conducted on campus, at local schools, and at host internship institutions across the county. In one undergraduate course, for example, we partner with a local STEM high school to collect fish and environmental data on board a research vessel and present results of a scientific project, tying learning objectives to ocean literacy principles. In other courses, faculty and cadets create activities that focus on ocean science and stewardship, such as oil spill prevention and response, ocean exploration, patterns in marine biodiversity, and conservation issues in aquatic habitats. Innovative science demonstrations used to enhance ocean literacy include real-time interactions with the Exploration Vessel (E/V) Nautilus, ocean circulation simulations using rotating tanks, and determining which materials work best to contain and clean-up oil. In addition, the Academy participates in outreach programs, including Women in Science and the Ocean Exploration Trust Honors Research Program. It also sends cadets to biennial Model Arctic Council events to engage the international community in conversation about the Arctic environment. Children's books, posters and videos are some other creative ways students summarize their understanding of ocean sciences and marine conservation. These programs impacts have been overwhelmingly positive. We have built stronger relationships with local community, enhanced ocean literacy, facilitated communication and mentorship between young students and scientists, and encouraged interest of underrepresented minorities in STEM education.

Fish Community Signals Long-Term Warming in a Southern New England Estuary. Mrakovcich, Karina, Lucy Vlietstra, *US Coast Guard Academy, New London, CT*

Researchers at the US Coast Guard Academy have been measuring long-term trends in biological and physical parameters of the Thames River Estuary, Connecticut, tracking changes over time in the abundance and biodiversity of the demersal fish community. Bottom trawl data have been collected consistently on a weekly basis from August to October for >20 years. Overall, we found a shift in the species composition from one dominated by cold-adapted

epibenthic species in the 1970s to one dominated by warm-adapted demersal species in the 2010s. Bottom trawl surveys conducted from 2003-2016 show an increase in the proportion of fish species typically found in subtropical waters. Other studies conducted in nearby estuaries have also observed a warming trend in surface waters and a shift in fish species. In a study conducted from 2013 to 2015, hydroacoustically determined finfish biomass in the water column of the Thames River estuary was compared to seasonal trends (April-December) in sea surface and bottom temperatures. In general, fish biomass was most abundant during the warmest periods of the year, when the water column was thermally stratified, approx. 2-4 weeks prior to autumn mixing. Demersal and epibenthic fish biomass was strongly correlated with bottom temperature in two of the three years of the study, supporting the idea that water temperature plays a role in the local distribution of fish over the annual cycle. Understanding the fluctuation of finfishes and possible links to climatic factors and other sources of environmental variability is important for the effective management of fisheries.

Characterizing the Relationship Between Native Biodiversity and the Seasonal Phenomenon of Tropical Fish Dispersal in New England Waters.** O'Neill, Michael[1,2], Owen Nichols[3], *[1]New England Aquarium, Boston, MA, [2]University of Massachusetts Boston, Boston, MA, [3]Center for Coastal Studies, Provincetown, MA*

Each summer and fall, New England coastal water temperatures are capable of sustaining tropical and sub-tropical finfish species. Arriving as eggs, larvae, and juvenile fishes via the Gulf Stream, non-migratory species (including several that are reef-associated) are capable of inhabiting New England waters for several months until temperatures drop below their thermal tolerances. The factors that dictate the dispersal of these fishes in coastal New England waters are largely undetermined. Seine and trawl data from surveys conducted in Pleasant Bay, Orleans, MA were analyzed for the distribution of both native and non-native species as well as environmental conditions to characterize the factors that influence distribution and habitat selection of these unusual seasonal species. Considerations including strategies for habitat selection by reef species in their native ranges we also assessed for viability in coastal New England ecosystems.

Competition Between Atlantic Cod and Black Sea Bass due to Warming Southern New England Waters.** Santos, Nina[1], Christopher Mayer[2], Joseph A. Langan[1], Kelton W. McMahon[1], *[1]University of Rhode Island Graduate School of Oceanography, Narragansett, RI, [2]University of Rhode Island, South Kingstown, RI*

The Atlantic Cod (*Gadus morhua*) fishery has played an important role in the ecosystem, economy, and history of the Northwest Atlantic. Broadly speaking, populations of this cold-water predator are at historic lows due to overfishing and environmental stressors. Warm-water competitors moving northward, such as Black Sea Bass (*Centropristis striata*), are also a threat as temperatures rise. Based on previous diet analyses, Black Sea Bass are expected to be one of the top competitors with cod in southern New England. In this study, we examined the feeding and trophic dynamics of southern New England Atlantic Cod and Black Sea Bass using

stomach content analysis, bulk isotope analysis, and compound specific isotope analysis of amino acids. Together, these approaches allowed us to examine specific dietary preferences, integrated trophic level, and source nitrogen as a proxy for foraging location along a nearshore-offshore isotopic gradient. We found significant overlap in carbon and nitrogen isotope values for Black Sea Bass and southern New England cod, indicating strong competition between species. Both species registered as top predators in the region (trophic level >4) foraging on offshore production. Gut contents suggest strong preferences for decapod crustaceans (e.g., *Cancer* Crabs), though cod appeared to rely more heavily on fish (e.g. flatfish and hake) than Black Sea Bass. With Atlantic Cod already exhibiting evidence of declining productivity due to rising temperatures, the added stress of warm-water competitors may further exacerbate conditions for cod in the region.

Temporal Shifts in Migratory River Herring Diets and Zooplankton Assemblages within a Connecticut River Cove.** Slocombe, Meghan-Grace[1], Meghna Marjadi[2], Matthew Devine[2], Lian Guo[2,4], Adrian Jordaan[2], Allison Roy[1], *[1]MA Cooperative Fish and Wildlife Research Unit, University of Massachusetts Amherst, Amherst, MA, [2]University of Massachusetts Amherst, Amherst, MA, [3]U.S. Geological Survey, S.O. Conte Anadromous Fish Research Laboratory, Turners Falls, MA*

Juvenile river herring (Alewife *Alosa pseudoharengus* and Blueback Herring *A. aestivalis*) feed on zooplankton during their residence in freshwater. In lakes with high densities of planktivores, juvenile river herring may deplete food resources. Shifting zooplankton densities during summer may influence juvenile growth, health, and emigration timing of juvenile river herring; however, these relationships are not fully understood, especially within large river systems. We will compare gut contents of juvenile river herring and zooplankton samples from Chapman Pond, a cove along the southern portion of the Connecticut River. Twenty juvenile river herring and three zooplankton samples were taken once per month in June, July, August, and September 2019. Preliminary analyses of zooplankton samples show differences in zooplankton richness and densities among months. A decline in large zooplankton species (i.e., *Cladocera* and *Cyclopoida*) coincided with a peak in juvenile river herring populations in July. We predict these zooplankton assemblage differences will be reflected in diets of the river herring and corresponding growth and health indices. Understanding the complex relationships between zooplankton communities and the timing of juvenile river herring emigration is important for guiding monitoring and management of river herring populations.

Downstream Fish Passage at Hanover Pond Dam through the Use of an Archimedes Screw Generator. Steeves, Michael, Alex Malvezzi, Kevin Nebiolo, *Kleinschmidt Associates, Essex, CT*

In 2016, an Archimedes Screw Generator (ASG) was installed at the Hanover Pond Dam located in Meriden, CT on the Quinnipiac River to support hydroelectric operations for New England Hydropower Company, LLC (NEHC). The ASG is the first of its kind implemented in the United States, and while they are largely described as 'fish friendly', adequate scientific literature evaluating fish passage is lacking at these facilities. The Connecticut Department of Energy and

Environmental Protection (CT DEEP) with consultation from U.S. Fish and Wildlife Service (USFWS) and Kleinschmidt Associates designed and implemented a study to evaluate American Shad downstream fish passage at Hanover Pond Dam. The objective of this study was to determine whether American Shad would enter the darkened penstock, pass beneath the downward closing sluice gate and utilize the ASG for safe downstream passage. A radio telemetry study was designed with three fixed monitoring stations; including one station upstream of the dam, another station within the intake structure, and a third station downstream of the dam. Twenty adult American Shad were collected from Holyoke Dam Fish lift, transported to Hanover Pond and radio tagged. Fish were released upstream of the dam and monitored from May 30 to July 15, 2019. In total, 16 fish were detected upstream of the dam, and 8 of those fish passed downstream. Seven of the eight fish that passed through the project (87.5%) utilized the intake and the ASG before being detected at the downstream receiver. One fish passed downstream via the spillway and/or use of a notch in the dam. All fish that passed downstream were detected with a 2-second tag burst at the downstream monitoring station, suggesting a 100% survival rate through the ASG.

Preliminary Fish Assemblage Assessment for Potential Drawdown Effects from a New Water Supply. Turcotte, Lucas, Tracy Tarr, *GZA GeoEnvironmental, Inc, Bedford, NH*

GZA GeoEnvironmental, Inc. (GZA), working with Wright-Pierce, completed a habitat assessment, including aquatic relative abundance sampling in Bethel, CT during May of 2018. As required by Connecticut Department of Energy & Environmental Protection (CT DEEP), both terrestrial monitoring for rare turtle species and a preliminary fisheries survey were completed to further evaluate potential drawdown effects from the proposed installation of new water supply well. GZA's work was focused on providing a baseline indicator of environmental water quality for East Swamp Brook. GZA used existing CT DEEP Fisheries Division data and worked closely with CT DEEP for consistency in methodology, to compare species diversity and biomass. GZA used electrofishing survey to make species observations along East Swamp Brook and collect site specific data. A total of six (6) fish species were captured in the 2018 electrofishing survey including one Eastern Brook Trout young of the year. Our survey yielded evidence of Eastern Brook Trout – a classic aquatic indicator of water quality in New England, however analyses of data for the period of record indicates a decline in biological diversity and biomass for coldwater fisheries in this specific reach of East Swamp Brook.

Monitoring of low-head dam removals in Connecticut. Vander Werff, Jon C., Gwen Macdonald, *Save the Sound, New Haven, CT*

In November 2015, Save the Sound removed a dam on Whitford Brook in Mystic, Connecticut, improving ecosystem function by restoring access to over 4.1 miles of habitat and reconnecting the river to its floodplain. In early 2016, Save the Sound removed a dam on the West River in New Haven, Connecticut, restoring diadromous fish passage to 2.6 miles and 76 acres of pond habitat. Both projects improve passage and habitat for Alewife (*Alosa pseudoharengus*), American Eel (*Anguilla rostrata*), American Shad (*Alosa sappidissima*), Gizzard Shad (*Dorosoma*

cepedianum), and Sea Lamprey (*Petromyzon marinus*). Removal of these dams prevents potential dam failure and reduces the probability of flooding in adjacent neighborhoods. As part of the permitting process Save the Sound is conducting a five-year monitoring study for both projects. Presence/absence of anadromous fish at both locations was conducted throughout the spring fish run and electrofishing was conducted annually. Vegetation was monitored in both sites to track native and invasive plants, recolonization of vegetation within the former impoundment, and the succession of the plant community. Preliminary conclusions indicate that while fish assemblage and vegetative succession may vary, both sites have rebounded rapidly following dam removal. Monitoring efforts will contribute knowledge that will be used to improve aquatic connectivity restoration practices and project cost-effectiveness. Each year the study continues and more data is collected, it becomes more robust and multifaceted. By refining the research and reporting on the findings, Save the Sound aims to disseminate the information and make it available for analysis to inform and enhance future barrier removal projects.

Harmful algal bloom impacts on fisheries. Van Gulick, Emily, *CT Department of Agriculture, Bureau of Agriculture, Milford, CT*

There is a general consensus among scientists that harmful algal blooms (HABs) are increasing in intensity and frequency around the world. HABs are “harmful” because they are detrimental to human health, the environment, and/or the economy. Fishing and recreation/tourism losses, increased healthcare usage, and HAB management costs the U.S. millions of dollars, by some estimates up to around $100 million, annually. Some HABs produce toxins, which can bioaccumulate through aquatic food webs and become concentrated in fish tissues. Toxins pose a tangible threat to the natural environment, such as through mass animal killings, as well as to humans through consumption of aquatic animals that are toxin vectors. In addition to the impacts of well-known toxins (e.g. brevetoxins associated with Florida red tide and the tropical Ciguatera fish poisoning) on fisheries, there are increasing concerns about the accumulation and impacts of other marine toxins, such as domoic acid produced by *Pseudo-nitzschia*, and freshwater toxins from cyanobacteria. There are also HABs that produce substances that are non-toxic to humans, but can alter the natural food web and cause mass animal kills. *Margalefidinium polykrikoides* (formerly *Cochlodinium polykrikoides*), *Alexandrium monilatum*, *Aureococcus anophagefferens*, and *Akashiwo sanguinea* are a few examples of “non-toxic” HABs that can cause ecological disruption. This presentation will provide an overview of both toxic and non-toxic HABs that negatively impact the fishing industry and aquaculture operations.