Northeast Fisheries Science Center Reference Document 18-14

16th Flatfish Biology Conference 2018
Program and Abstracts

December 4-5 2018
Water's Edge Resort and Spa, Westbrook, CT

by Conference Steering Committee: Renee Mercaldo-Allen (Chair),
Christopher Chambers, David Davis, Mark Dixon, Stephen Dwyer,
Elizabeth Fairchild, Penny Howell, Thomas Munroe,
Christopher Powell, and Sandra Sutherland

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National Oceanic and Atmospheric Administration
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Northeast Fisheries Science Center
Woods Hole, Massachusetts

November 2018

Northeast Fisheries Science Center Reference Documents

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Jarita Davis
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Gyotaku Fish Print
Jack Brown
Kecheneny Fish Prints, Stonington CT
Gyotaku, or Japanese fish printing, is a process where a fish is coated with ink and pressed onto paper, creating a detailed reverse image. This traditional art form was historically used as a means for fishermen to record their catches.

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Flatfish Biology Conference 2018

December 4th & 5th
Water's Edge Resort and Spa, Westbrook, CT

Oral Presentations
Salons A/B

Tuesday December 4th

8:00 a.m. **Registration/Coffee/Continental Breakfast**

8:45 a.m. Welcome and Introduction
Renee Mercaldo-Allen, Chair
NOAA Fisheries, Northeast Fisheries Science Center
Milford Laboratory, Milford, CT

Dr. Jon Hare, Director
NOAA Fisheries, Northeast Fisheries Science Center
Woods Hole Laboratory, Woods Hole, MA

Session I
Elizabeth Fairchild, Chair
University of New Hampshire, Department of Biological Sciences
Durham, NH

9:00 a.m. Seasonal Differences in Flatfish Assemblages in a Georgia Estuary
Mary Carla Curran[1]* and Dara H. Wilber[2]
[1]Savannah State University, Marine Sciences Program, Savannah, GA, [2]College of Charleston, Graduate Program in Marine Biology, Charleston, SC

9:20 a.m. Video from Oyster Cages and Mixed Live Oyster, Shell and Sand Bottom: Preliminary Observations of Habitat Use by Flounders
Renee Mercaldo-Allen[1]*, Peter Auster[2], Paul Clark[1], Erick Estela[1], Yuan Liu[1, 3], Lisa Milke[1], Gillian Phillips[1, 3], Dylan Redman[1], and Julie Rose[1]
[1]NOAA Fisheries, Northeast Fisheries Science Center, Milford Laboratory, Milford, CT, [2]University of Connecticut, Department of Marine Sciences and Mystic Aquarium, Groton, CT, [3]Integrated Statistics, Woods Hole, MA

9:40 a.m. Using Fishermen's Ecological Knowledge to Identify Climate Driven Distribution Shifts in Flatfish and Investigate Their Potential Impact on Population Assessments

John P. Manderson[1]*, Gregory DeCelles[2], David Richardson[3], Mary Hudson[4], and Tyler Pavlowich[3, 5]

[1]NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ, [2]Massachusetts Division of Marine Fisheries, New Bedford, MA, [3]NOAA Fisheries, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI, [4]Maine Coast Fishermen's Association, Brunswick, ME, [5]Integrated Statistics, Woods Hole, MA

10:00 a.m. Genomic Signatures of Environmental Selection despite Near-Panmixia in Summer Flounder

Jennifer A. Hoey* and Malin L. Pinsky

Rutgers University, Department of Ecology, Evolution, and Natural Resources, New Brunswick, NJ

10:20 a.m. **Break/Coffee/Refreshments**

Session II

Thomas A. Munroe, Chair

NOAA Fisheries, National Systematics Laboratory
Smithsonian Institution, Washington, DC

10:50 a.m. Elemental Signatures in Winter Flounder Otoliths Can Help Determine Natal Grounds

Elizabeth A. Fairchild[1]*, Linda Kalnejais[2], and David Bailey[3]

[1]University of New Hampshire, Department of Biological Sciences, Durham, NH, [2]University of New Hampshire, Institute for the Study of Earth, Oceans and Space, Durham, NH, [3]Biology Department, Woods Hole Oceanographic Institute, Woods Hole, MA

11:10 a.m. Effects of Climate Change on Winter Flounder and its Impacts on Fisheries in Narragansett Bay

Joseph A. Langan* and Jeremy S. Collie

University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

11:30 a.m. The Maximum Swimming Speed and Startle Response of Windowpane Flounder (*Scophthalmus aquasus*), and Applications in Reducing Their Bycatch in Scallop Dredges

Margot Wilsterman*, Pingguo He, and Christopher Rillahan

University of Massachusetts Dartmouth, School for Marine Science and Technology, Fish Behavior and Conservation Engineering Lab, New Bedford MA

11:50 a.m. Size and Abundance of Juvenile Winter Flounder, *Pseudopleuronectes americanus*, in a Long Island Sound Embayment

Students from Wilton High School Marine Biology Club[1], Sarah Crosby[2]*, Suzanne Steadham[1], Peter Fraboni[2], Nicole Cantatore[2], and Joshua Cooper[2]

[1]Wilton High School, Wilton, CT, [2]Harbor Watch, Earthplace, Westport, CT

12:10 p.m. **Hosted Buffet Lunch**

Session III

Penny Howell, Chair

Connecticut Department of Energy and Environmental Protection
Marine Fisheries Division, Old Lyme, CT

1:30 p.m. The Flatfishes of New York/New Jersey Harbor: A Summary of 10 Years of Bottom Trawl and Ichthyoplankton Sampling

David S. Davis[1]*, Dara H. Wilber[2], Catherine Alcoba[3], and Jenine Gallo[3]

[1]HDR Engineering, Inc., Mahwah, NJ, [2]HX5, Charleston, SC, [3]US Army Corps of Engineers New York District, New York, NY

1:50 p.m. Evaluation of Alternative Management Strategies for the Recreational Summer Flounder Fishery

Jason McNamee[1]* and Gavin Fay[2]

[1]Rhode Island Department of Environmental Management, Division of Marine Fisheries, Jamestown RI, [2]University of Massachusetts, Dartmouth, New Bedford, MA

2:10 p.m. Two Species of Flounder in the Baltic Sea: Can They Be Distinguished Based on Otolith Microchemistry?

Melvin A. Samson* and Karin E. Limburg

Department of Environmental and Forest Biology, State University of New York, College of Environmental Science and Forestry, Syracuse, NY

2:30 p.m. Flatfish Habitat Use near North America's First Offshore Wind Farm

Dara. H. Wilber*, Drew A. Carey, and Matthew Griffin

INSPIRE Environmental, Middletown, RI

2:50 p.m. **Refreshment Break and Poster Set-up**

Session IV
Christopher Chambers, Chair
NOAA Fisheries, Northeast Fisheries Science Center
James J. Howard Marine Sciences Laboratory, Highlands, NJ

3:20 p.m. Long Term Changes in the Growth and Maturation of Winter Flounder and Yellowtail Flounder off Massachusetts
Gregory DeCelles*
Massachusetts Division of Marine Fisheries, New Bedford, MA

3:40 p.m. Maine Atlantic Halibut Tagging Program, 2000-2018
Michael E. Kersula*
Maine Department of Marine Resources, West Boothbay Harbor, ME

4:00 p.m. Interrelationships of Flatfishes (Pleuronectiformes) Revisited: A Reassessment of Chapleau's (1993) Hypothesis Based on Anatomical Characters
Bruno Chanet[1], Jorge Mondéjar-Fernández[1], Guillaume Lecointre[1], and Thomas A. Munroe[2]*
[1]Institut de Systématique, évolution et Biodiversité (ISYEB), UMR 7205 CNRS-MNHN-UPMC-EPHE, Département Origines et Évolution, Muséum National d'Histoire Naturelle, Sorbonne Université, Paris, France, [2]NOAA Fisheries, National Systematics Laboratory, Smithsonian Institution, Washington, DC

4:20 p.m. Winter Flounder Studies at Millstone Power Station
Steve Dwyer*
Millstone Environmental Lab, Dominion Energy, Waterford, CT

4:40 p.m. Acoustic Tracking of Southern Flounder (*Paralichthys lethostigma*) Released in the Charleston Harbor Estuarine System, South Carolina
Morgan P. Hart[1, 3], Fred S. Scharf[2], Gorka Sancho[1], Michael R. Denson[3], and Stephen A. Arnott[3]*
[1]Graduate Program in Marine Biology, College of Charleston, Charleston, SC, [2]Department of Biology and Marine Biology, University of North Carolina Wilmington, Wilmington, NC, [3]Marine Resources Research Institute, South Carolina Department of Natural Resources, Charleston, SC

5:00 p.m. **Hosted Mixer and Poster Session**

Wednesday December 5th

8:00 a.m. **Registration/Coffee/Continental Breakfast**

Session V
Sandra Sutherland, Chair
NOAA Fisheries, Northeast Fisheries Science Center
Woods Hole Laboratory, Woods Hole, MA

8:40 a.m. The Multifunctional Flatfish Urohyal: What One Bone Can Tell Us about Feeding, Ventilation, and Burial
Stacy C. Farina[1]*, Marlynn Rollins[1], and Nick Long[2]
[1]Howard University, Department of Biology, Washington DC, [2]Dickinson College, Department of Biology, Carlisle, PA

9:00 a.m. Using Fishermen's Knowledge to Improve Abundance Estimates for Atlantic Halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine
Alex Hansell[1]*, Greg DeCelles[2], and Steve Cadrin[1]
[1]Department of Fisheries Oceanography, School for Marine Science and Technology University of Massachusetts Dartmouth, New Bedford, MA, [2]Massachusetts Division of Marine Fisheries, New Bedford, MA

9:20 a.m. Animal Forests in Flatfish Habitats: Patterns, Concepts, Issues, and Research Needs
Peter J. Auster [1, 2]* and Christian W. Conroy[1]
[1]University of Connecticut at Avery Point, Department of Marine Sciences, Groton, CT, [2]Mystic Aquarium – Sea Research Foundation, Mystic, CT

9:40 a.m. Comparative Ecology of the Four Species of the Flatfish Genus *Peltorhamphus* (Pleuronectiformes: Rhombosoleidae) from New Zealand Waters
Thomas A. Munroe*
NOAA Fisheries, National Systematics Laboratory, Smithsonian Institution, Washington, DC

10:00 a.m. Sexual Size Dimorphism in United States and Canadian Populations of American plaice *Hippoglossoides platessoides*
Richard S. McBride[1]*, Larry A. Alade[1], Daniel Ricard[2], and Joanne Morgan[3]
[1]NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole, MA, [2]Gulf Fisheries Centre, Fisheries and Oceans Canada, Moncton, NB, Canada, [3]Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada, St. John's NF, Canada

10:20 a.m. **Break/Coffee/Refreshments**

Session VI
Steve Dwyer, Chair
Dominion Energy
Millstone Environmental Laboratory
Waterford, CT

10:50 a.m. Using Fisheries-Dependent Video Data to Assess Southern New England Population Structure of Windowpane Flounder
M. Conor McManus[1]*, Richard J. Bell[2], and Jason E. McNamee[2]
[1]Rhode Island Department of Environmental Management, Division of Marine Fisheries, Jamestown, RI, [2]The Nature Conservancy, University of Rhode Island Bay Campus, Narragansett, RI

11:10 a.m. Spawning Phenology of Flatfishes on the Northeast US Continental Shelf
Mark J. Wuenschel*, Jakub Kircun, and John K. Galbraith
NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA

11:30 a.m. Toxics Source Reduction and Sewage Upgrades Eliminated Winter Flounder Liver Neoplasia (1984-2017) From Boston Harbor, MA, USA
Michael Moore[1]*, Ann Pembroke[2], Eric Nestler[2], Maurice Hall[3], Lisa Lefkovitz[4], Mark Lambert[3], and Kenneth Keay[3]
[1]Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA, [2]Normandeau Associates Inc., Bedford, NH, [3]Massachusetts Water Resources Authority, Boston, MA, [4]Battelle Memorial Institute, Norwell, MA

11:50 a.m. Experimental Identification of Early Life Stage Plasticity to Environmental Factors in Summer Flounder, *Paralichthys dentatus*
R. Christopher Chambers*, Ehren A. Habeck, Delan J. Boyce, Emily A. Olson, and Rita A. Hjelm
NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ

12:10 p.m. **Closing Comments**

12:20 p.m. **Hosted Buffet Lunch**
Adjourn Meeting

Poster Session
Salon C
Tuesday December 4th, 5 p.m.

Dave Davis[1] and Chris Powell[2], Co-Chairs
[1]HDR Engineering, Mahwah, NJ
[2]Rhode Island Department of Environmental Management, Marine Fisheries Division Jamestown, RI

Flatfish Distributions in the Context of Finely Resolved Seafloor Habitats and Associated Benthic Communities in Long Island Sound
Christian W. Conroy[1], Peter J. Auster[1, 2]*, and Deb Pacileo[3]
[1]University of Connecticut at Avery Point, Department of Marine Sciences, Groton, CT, [2]Mystic Aquarium – Sea Research Foundation, Mystic, CT, [3]Connecticut Department of Energy and Environmental Protection, Old Lyme, CT

Assessment of Windowpane Flounder Larval Distribution and Growth along the Northeast US Continental Shelf
Alison Frey[1, 2]*, David Richardson[1], Katey Marancik[1, 2] and Harvey Walsh[1]
[1]NOAA Fisheries, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett RI, [2]Integrated Statistics, Woods Hole, MA

Flatfish Catch in Scallop Dredges on Georges Bank
Luisa Garcia*, Amy Carlson, Stephen Davies, and Liese Siemann
Coonamessett Farm Foundation, Inc, East Falmouth, MA

Distribution and Seasonal Behavior of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of St. Lawrence based on data from Pop-up Satellite Archival Tags
Rachel Marshall*, Arnault Le Bris, Jonathan Fisher, Paul Gatti, and Dominique Robert
Memorial University of Newfoundland, Marine Institute, St. John's, NL

Effects of Temperature and pH on Blood-oxygen Affinity of Windowpane Flounder (S*cophthalamus aquosus*)
Maryann McEnroe*, Adiba Khan, Divya Persaud, Danny De La Cruz, Jeffrey Gonzalez, and Chi-Lam Kwok
School of Natural and Social Sciences, Purchase College, State University of New York, Purchase, NY

Prevalence and Intensity of Parasitic Cysts in Yellowtail Flounder, Limanda ferruginea: Preliminary Results Related to Condition and Comparison among Stocks
Emilee K. Tholke[1]*, W. David McElroy[1], and Mark J. Wuenschel[2]
[1]Integrated Statistics, Woods Hole, MA. Under contract to NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole, MA, [2]NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole, MA

Potential Effects of Physical Factors on Juvenile Flatfish Abundance in a Georgia Estuary
Jennie J. Wiggins* and Mary Carla Curran
Savannah State University, Marine Sciences Program, Savannah, GA

Abstracts

Oral Presentations

Session I

Seasonal Differences in Flatfish Assemblages in a Georgia Estuary

Mary Carla Curran[1]* and Dara H. Wilber[2]

[1]*Savannah State University, Marine Sciences Program*
Box 20467, Savannah, GA 31404

[2]*College of Charleston, Graduate Program in Marine Biology*
66 George Street, Charleston, SC 29412

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Subtropical flatfish are not well studied, although these species are important residents of marsh creeks in southeastern USA estuaries. We examined seasonal and interannual variations in flatfish abundance, body size, and species composition over a twelve-year study conducted in Wylly Creek, a tertiary tidal creek in undisturbed salt marsh habitat near Savannah, Georgia. Monthly samples were collected during ebb tide, from January 2004 to February 2016, using a 1 m-wide beam trawl. Six flatfish species, comprising over 1,880 individuals, were collected throughout the study: blackcheek tonguefish *Symphurus plagiusa*, bay whiff *Citharichthys spilopterus*, fringed flounder *Etropus crossotus*, summer flounder *Paralichthys dentatus*, southern flounder *Paralichthys lethostigma*, and ocellated flounder *Ancylopsetta quadrocellata*. The blackcheek tonguefish was numerically dominant and was present year-round, with peak abundances during summer. Bay whiff dominated flatfish assemblages during winter. There were significant seasonal differences in the taxonomic composition of recruit assemblages. In addition, relatively high total abundances of bay whiff and fringed flounder occurred after mild winters and high abundances occurred after cold winters for the other 4 species. Potential shifts in tidal creek occupancy patterns by flatfish may result from climate change, given the observed associations of flatfish with temperature.

Session I

Video from Oyster Cages and Mixed Live Oyster, Shell and Sand Bottom: Preliminary Observations of Habitat Use by Flounders

Renee Mercaldo-Allen[1]*, Peter Auster[2], Paul Clark[1], Erick Estela[1], Yuan Liu[1, 3], Lisa Milke[1], Gillian Phillips[1, 3], Dylan Redman[1], and Julie Rose[1]

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Studies to evaluate ecosystem services provided to fish by aquaculture gear are underway in Long Island Sound. Field trials were conducted during summer 2017 to develop approaches for quantifying fish interactions with oyster aquaculture cages using point-of-view video cameras. Two pilot deployments were conducted within a traditional on-bottom oyster aquaculture lease, comprised of low-relief sand, shell, and live oysters. To compare fish interactions on the extant seafloor to those associated with relatively high-relief oyster cages, 3 cages, 70 meters apart, were placed on the lease area. Two GoPro cameras were mounted to each cage to capture top horizontal and two vertical side views. A T-platform frame system was devised for mounting 2 cameras to view fish activity on the surrounding seafloor while adding minimal structure. Cameras were turned on prior to deployment and recorded continuously for 2 hours. The first 30 minutes of video was discarded to minimize disturbance effects. Noldus Observer XT software was used to aid in quantifying video. Fish abundance was determined as MaxN, the maximum number of each species observed in one video frame within each 1 minute video segment. Preliminary analysis reveal a range of fish behaviors including foraging, station keeping, courtship, and spawning. Summer flounder was the only flatfish species observed on the shellfish lease. Additionally, seawater samples were collected for environmental DNA (eDNA) analysis to evaluate the utility of this method for detecting fish species not observed in video. Initial eDNA results documented a diversity of flatfish species: smallmouth flounder (*Etropus microstomus*), summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus*), windowpane flounder (*Scophthalmus aquosus*) and hogchoker (*Trinectes maculatus*).

Session I

Using Fishermen's Ecological Knowledge to Identify Climate Driven Distribution Shifts in Flatfish and Investigate Their Potential Impact on Population Assessments

John P. Manderson[1]*, Gregory DeCelles[2], David Richardson[3], Mary Hudson[4], and Tyler Pavlowich[3, 5]

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The Gulf of Maine is one of the fastest warming ecosystems on Earth. Fishermen and scientists have observed regional shifts in groundfish distributions that may be related to changing climate. Geographic shifts in species distribution can be associated with range shifts and/or alteration of migration patterns between functional habitats, and may be causing systematic changes in population availability to fishery independent surveys and size-selectivity in fisheries. Fishermen and scientists are concerned about the possible impacts of these changes on assessment accuracy and the soundness of fisheries policy. We are collaborating with fishing industry experts to investigate these impacts and to develop a series of modeling tools to account for them in assessments. We are using in person discussions and workshops with fishermen to develop testable hypotheses about distribution shifts and underlying processes for American plaice, witch flounder, yellowtail flounder, winter flounder, and windowpane flounder in the Gulf of Maine. Our goal is to evaluate the hypotheses using available fishery dependent and independent data, and to validate the model observations using a field experiment. Where appropriate, we will use the information to develop tools to estimate changes in population availability to surveys that can be used to inform the assessment of flatfish stocks in New England.

Session I

Genomic Signatures of Environmental Selection Despite Near-Panmixia in Summer Flounder

Jennifer A. Hoey* and Malin L. Pinsky

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Rapid environmental change is altering the selective pressures experienced by marine species. While adaptation to local environmental conditions depends on a balance between dispersal and natural selection across the seascape, the spatial scale of adaptation and the relative importance of mechanisms maintaining adaptation in the ocean are not well understood. Here, using population assignment tests, Approximate Bayesian Computation (ABC), and genome scans with double-digest restriction-site associated DNA sequencing data, we evaluated population structure and locus–environment associations in a commercially important species, summer flounder (*Paralichthys dentatus*), along the U.S. east coast. Based on 1,137 single nucleotide polymorphisms across 232 individuals spanning nearly 1,900 km, we found no indication of population structure across Cape Hatteras, North Carolina (FST = 0.0014) or of isolation by distance along the coast using individual relatedness. ABC estimated the probability of dispersal across the biogeographic break at Cape Hatteras to be high (95% credible interval: 7%–50% migration). However, we found 15 loci whose allele frequencies were associated with at least one of four environmental variables. Of those, 11 were correlated with bottom temperature. For summer flounder, our results suggest continued fisheries management as a single population and identify likely response mechanisms to climate change. Broadly speaking, our findings suggest that spatial balancing selection can manifest in adaptive divergence on regional scales in marine fish despite high dispersal, and that these conditions likely result in the widespread distribution of adaptive alleles and a high potential for future genetic adaptation in response to changing environmental conditions.

Session II

Elemental Signatures in Winter Flounder Otoliths Can Help Determine Natal Grounds

Elizabeth A. Fairchild[1]*, Linda Kalnejais[2], and David Bailey[3]

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Winter flounder coastal stocks are not as robust as the offshore Georges Bank (GB) stock, and this may be due to differences in their life history strategies; GB fish complete their life cycle offshore whereas SNE/MA and GOM fish utilize shallow inshore waters as nurseries. Year class strength of winter flounder is determined primarily during this time spent in the nursery. Despite very low fishing pressure in the last decade, winter flounder biomass and recruits have not significantly increased implying that overfishing has not been the sole reason why winter flounder stocks crashed, but that their decline has been due to changes in the ecosystem, especially to their natal nurseries. If fewer estuaries are yielding winter flounder recruits, habitat alternations and/or (incidental) fishing pressure to those few but productive nurseries could have an unintended and enormous negative impact to the offshore population. Therefore, it is critical to determine which nurseries are most productive so that they can be protected better and so the key ingredients for successful winter flounder recruitment in this changing ecosystem can be identified. In order to do this, a direct way to measure the number of recruits nurseries produce is needed. One possible method is using the elemental tag in fish otoliths to track their origin. To determine if this method is viable, the otolith microchemistry of age 0 winter flounder from 16 populations from New Jersey through New Hampshire are being analyzed to determine how they differ spatially and temporally, and which natal estuaries contribute the greatest number of recruits to 7 offshore adult populations. An overview of this project and the most recent results will be presented.

Session II

Effects of Climate Change on Winter Flounder and its Impacts on Fisheries in Narragansett Bay

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Winter flounder (*Pseudopleuronectes americanus*) has historically supported large commercial and recreational fisheries as a dominant finfish in the Narragansett Bay, Rhode Island ecosystem. However, its abundance has declined to an all-time low during the past three decades. As a cold-water, estuarine-dependent species, winter flounder has been shown to experience poor recruitment due to increased predation related to warming winters. Through this mechanism, climate change, in addition to past harvest pressure, is thought to be responsible for this population decline. While there are other stressors that could impact winter flounder survivability at different points in its life cycle, there has yet to be a comprehensive assessment of such factors or how they may interact with exploitation and environmental change. This work seeks to collate multiple long-term data sets from Rhode Island waters to determine the life-cycle stages at which winter flounder experience increased mortality and identify stressors, including harvest, climate change, predation, and pollution, that best explain this decreased survival through key factor analysis and structural equation modeling. In seeking to build an understanding of life stage-specific mortality and its drivers, the results of this work can be used to evaluate the potential of adaptive fishery management methods to enhance survival and ultimately determine the feasibility of recovering one of Narragansett Bay's most important species.

Session II

The Maximum Swimming Speed and Startle Response of Windowpane Flounder (*Scophthalmus aquasus*), and Applications in Reducing Their Bycatch in Scallop Dredges

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Modern fishing gears are successful in capturing target species because they are designed to exploit the behaviors of these organisms. However, many fishing gears are not as successful in reducing bycatch of non-target species. Accordingly, understanding the behavior and physiology of discarded species could help reduce their interactions with fishing gear. Swimming physiology has been extensively studied in a few “model” species, but data is lacking for numerous commercial and non-commercial species. This study examined the swimming physiology of windowpane flounder (*Scophthalmus aquosus*) in an effort to inform bycatch reduction strategies in the Atlantic sea scallop (*Placopecten magellanicus*) fishery. Specifically, the startle response and maximum swimming speed were evaluated as a function of fish length and temperature. High-speed videography was used to measure position and swimming speed as fish reacted to an external stimulus. To evaluate a fishes maximum swimming speed, contraction times of white muscle, stimulated via an electrical pulse, were measured. Our results indicate that swimming characteristics are temperature and length dependent. Given these findings, we will evaluate conditions that are favorable to fish escape including towing speed and gear design. This study illustrates the potential bycatch reduction strategies that are produced by harnessing aspects of fish behavior.

Session II

Size and Abundance of Juvenile Winter Flounder, *Pseudopleuronectes americanus*, in a Long Island Sound Embayment

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The size and abundance of juvenile winter flounder, *Pseudopleuronectes americanus*, were studied in Norwalk Harbor, CT during the summer of 2018. The continuation of a long-term demersal fish study spanning 28 years, staff from the Harbor Watch water quality program worked in cooperation with students from Wilton High School to conduct weekly trawls in the harbor from May through October. The abundance (number of fish per trawl) and length (to the nearest millimeter) of winter flounder were recorded in each trawl, as well as the abundance and species composition of other finfish and invertebrates. Those catch data were analyzed and compared to the composition and abundance from previous years. Catch per trawl, fish size, and location of individuals caught within the harbor, and other factors were assessed. Dissolved oxygen and temperature data were also studied in the harbor over the same time period and were used to consider potential drivers of trends in winter flounder abundance. A decline has been observed in the juvenile winter flounder population in the harbor over the past 28 years, with implications for both the health of the adult population and the ecosystem as a whole. Additionally, mean water column dissolved oxygen has declined and water temperature has increased over the course of the study. This long-term study can assist in our understanding of changes in Norwalk Harbor and other Long Island Sound embayments.

Session III

The Flatfishes of New York/New Jersey Harbor: A Summary of 10 Years of Bottom Trawl and Ichthyoplankton Sampling

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Ten years of intensive bottom trawl and ichthyoplankton sampling conducted by the U.S. Army Corps of Engineers – New York District from 2002 to 2011 as part of the New York/New Jersey Harbor Deepening Project (HDP) and its project-sponsor (Port Authority of New York and New Jersey) has resulted in a comprehensive data set that has been used to support agency consultations and Essential Fish Habitat (EFH) evaluations. Much of the focus has been on winter flounder (*Pseudopleuronectes americanus*) but what have we also learned about the spatial and seasonal occurrences of the other less common flatfishes collected? Within the Harbor, distribution and abundance varied from the more common winter flounder and windowpane (*Scophthalmus aquosus*) to seasonal residents, such as summer flounder (*Paralichthys dentatus*) and smallmouth flounder (*Etropus microstomus*) collected in the Lower Bay, to the less common fourspot flounder (*Hippoglossina oblonga*), hogchocker (*Trinectes maculatus*), and rare yellowtail flounder (*Pleuronectes ferrugineus*).

Session III

Evaluation of Alternative Management Strategies for the Recreational Summer Flounder Fishery

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This work used a Management Strategy Evaluation (MSE) framework to test the performance of current and potential alternative F-based management approaches for the recreational summer flounder fishery. Our intent was to show the relative value of both current and potential management actions for satisfying management objectives. F-based management alternatives were constructed in the context of application to the existing specification setting process for summer flounder. An age-structured operating model of summer flounder population and fishery dynamics was constructed that explicitly included implementation uncertainty associated with application of management measures in the recreational fishery. Available data on the responses of recreational fishers to summer flounder management measures was synthesized to construct a set of plausible alternatives for these fleet dynamics and their associated uncertainty. Additionally, historical effects of various management measures on harvest and catch at various levels of refinement (e.g. state, wave, mode) based on MRIP data were used to quantify the most appropriate levels of effect and uncertainty to associate with the management choices made in the MSE analysis.

The management approaches tested within the MSE sought to replicate the steps associated with data collection, interpretation, and decisions about whether and how to adjust recreational fishing measures. Simulations considered several broad sets of alternative management approaches including: 1) Status quo, where recreational harvest limits are compared to estimates of current recreational harvest based on the MRIP statistical sampling program, with adjustment measures to include: season length, minimum size, bag limits, and combinations thereof; 2) Risk-based status quo, where a percentile of the estimated uncertainty is used rather than point estimates of recreational harvest; 3) F-based management, where the stock assessment estimate of the current fishing mortality is compared to the target F, with one or more of the management measures described above being adjusted accordingly, alternatives within this approach will include incremental adjustments to encourage stability in advice and overfishing threshold projections based on expected probabilities of overfishing given different management measures; 4) Risk-based F-based management where similar approaches as for 3. are applied but percentiles of uncertainty estimates are used to determine appropriate adjustments instead of point estimates. The performance of the various management options was evaluated by comparing the projections of recreational harvest to prescribed limits (for options that retain RHLs), as well as projected stock biomass and fishing mortality rates relative to reference points and risk tolerances. The relative performance of these measures is presented.

Session III

Two Species of Flounder in the Baltic Sea: Can They Be Distinguished Based on Otolith Microchemistry?

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Flounder is one of the most common flatfish in the Baltic Sea and is of great economic importance to the fishing industry in the Baltic region. Flounder in the Baltic Sea have been considered to belong to a single species, the European flounder (*Platichthys flesus*), that had two distinct ecotypes in the Baltic. The two ecotypes were distinguished based on their spawning strategies, with a coastal spawning ecotype that produces small demersal eggs in the central and northern part of the Baltic Sea and an off-shore spawning ecotype that produces larger pelagic eggs in the deep basins in the southern and central part of the sea. Recently, a comparison of genome-wide genetic data of the two ecotypes revealed that the coastal spawning ecotype can be distinguished as a separate species, *Platichthys solemdali* sp. nov. Alternative habitat use tactics of the two species in their early life history may be reflected in the chemistry of their sagittal otoliths. In the present study, otolith samples were taken from young-of-year flounder from nurseries in southern mainland Sweden and the Swedish island of Gotland and along the Latvian coast. The results of otolith chemical analyses of trace elements (strontium, barium, magnesium, etc.) using LA-ICPMS are presented. Differences between the two species in micro-elemental signatures will be discussed as they reflect differences in spawning habits.

Session III

Flatfish Habitat Use near North America's First Offshore Wind Farm

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Demersal trawl surveys were conducted to examine whether construction of the Block Island Wind Farm (BIWF) off the coast of Rhode Island affected fish and invertebrates in the area. BIWF's five wind turbine generators were sited based on coordination with state and federal resource agencies in an attempt to minimize environmental impacts. Demersal trawl monitoring was conducted in two reference areas and near the wind farm to allow an examination of whether flatfish abundances, size, and condition differed between baseline, construction, and operation time periods. Seven flatfish, (American plaice *Hippoglossoides platessoides*, fourspot flounder *Paralichthys oblongus*, Gulf stream flounder *Citharichthys arctifrons*, summer flounder *Paralichthys dentatus*, windowpane flounder *Scophthalmus aquosus*, winter flounder *Pseudopleuronectes americanus*, and yellowtail flounder *Pleuronectes ferruginea*) were collected in the study area. Winter flounder, windowpane and fourspot flounder accounted for 83% of all flatfish collected. Flatfish exhibited spatial and temporal variation in abundance, size, and condition, but this variation was not consistent with either positive or negative effects of wind farm construction or operation. Lower winter flounder abundances during the pile-driving time period and higher abundances during the cable-laying time period in the reference and wind farm areas suggest region wide population fluctuations occurred. Although noise from pile driving may have been detectable in the reference areas, other flatfish abundances were not lower during this time period. Although no artificial reef effect was found for flatfish, negative impacts from construction activity and wind farm operation also were not evident.

Session IV

Long Term Changes in the Growth and Maturation of Winter Flounder and Yellowtail Flounder off Massachusetts

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Growth and maturation are important components of productivity for fish populations, and changes in these life history traits can impact population dynamics and sustainability, with significant implications for fisheries management. For exploited fish stocks, long term changes in maturity schedules and growth rates have been observed across a range of taxa. The objective of this study was to use observations obtained during the Massachusetts Division of Marine Fisheries spring trawl survey (1978-2017) to investigate long term trends in the growth rates and maturation of winter flounder (*Pseudopleuronectes americanus*) and yellowtail flounder (*Limanda ferruginea*) off the coast of Massachusetts. The data were aggregated into ten year periods to examine decadal trends in life history traits for each stock. Three asymptotic growth models (von Bertalanffy, Gompertz, and Logistic) were fit to the length and age data. Sex specific maturity schedules were estimated using Generalized Linear Models. Substantial changes were observed in the growth of both species, as the growth rates (K) generally increased over time, while the asymptotic size (L_{inf}) decreased. Over the 40 year period both species also exhibited a decline in L_{50} and A_{50}, and changes were more pronounced in males. These life history changes may be a population response to temperature fluctuations, density dependence, mortality, or a combination of the three factors. Regardless of the mechanism(s) responsible, the results have ramifications for fisheries management and stock assessment.

Session IV

Maine Atlantic Halibut Tagging Program, 2000-2018

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Stock assessment and related fisheries management rely on the key assumption that a fish stock boundary is well-defined, but the migratory behaviors of large, long-lived species with complex life histories can be difficult to delineate without prolonged study. This study reports on almost two decades of conventional tag returns for Atlantic halibut (*Hippoglossus hippoglossus,* L.), the largest of the flatfishes and the object of a large commercial fishery in the Northwest Atlantic. Fish were tagged in the U.S. portion of the Gulf of Maine by fishermen and researchers between the years of 2000-2018. Of 412 recaptures from 2,573 releases to date, over 43% are from Canadian fisheries. This proportion has increased substantially since results from this tagging study were first reported on in 2006, and many other key statistics have changed as the study has continued. Most fish appear to display site fidelity, and 76% were recaptured no further than the Western Scotian Shelf. There is, however, evidence for dispersive behavior, with season and time at large appearing to be the most important factors for determining distance at recapture. These results suggest that most of the tagged fish are part of a metapopulation unit that stretches across both the U.S. and Canadian EEZs from the Gulf of Maine to the Scotian Shelf. This result contrasts the previously defined stock assessment and management boundaries for both countries.

Session IV

Interrelationships of Flatfishes (Pleuronectiformes) Revisited: A Reassessment of Chapleau's (1993) Hypothesis Based on Anatomical Characters

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Chapleau (1993) was the first cladistic work on interfamilial relationships of flatfishes (Order Pleuronectiformes) based on anatomical data. This work has been, and still remains, a cornerstone for phylogenetic works dedicated to understanding the systematic relationships and evolution of the flatfishes. Nevertheless, this valuable work suffers from the absence of suitable outgroups and from a scarcity of data for some characters. We propose herein the results of a new analysis of Chapleau's matrix including re-examination and re-evaluation of some characters and with the addition of two fossil species, *Heteronectes* and *Amphistium*, plus two extant genera as outgroups. These extant taxa were chosen as outgroups on the basis of results of multiple recent studies using molecular analyses to assess Pleuronectiform relationships. This re-assessment based on morphology leaves the monophyly of the Pleuronectiformes ambiguous, whereas the interfamilial relationships within flatfishes as originally proposed by Chapleau (1993) are not really modified. Additionally, a review of the polarity of one character sheds a different light for interpreting the first steps in the evolution of the flatfishes.

Session IV

Winter Flounder Studies at Millstone Power Station

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Winter Flounder (*Pseudopleuronectes americanus*) have been the subject of environmental impact studies at Millstone Power Station (MPS) since 1973. Objectives of these studies are to describe the local population dynamics and to assess whether any long-term effects of MPS operations are occurring. Multiple sampling programs and analytical methods are used to examine abundance of various Winter Flounder life history stages, densities of larvae entrained, and trends in the Niantic River (NR) spawning population. Similar to other regional estimates and unrelated to power station operations, adult abundance in the NR peaked in the mid-1980s and have declined to record lows since. In contrast, annual larval abundance in the NR has fluctuated dramatically, with no overall trend. Generally, larval abundances in the NR were two to six times greater than those in Niantic Bay (NB), likely due to proximity to historically preferred spawning areas in NR. In recent years, higher larval abundance in NB suggests spawning occurs outside NR in Long Island Sound. Late-stage larval abundances were strongly correlated with early summer juvenile abundance in NR beam trawl samples. As demonstrated by MPS studies and several other long-term, regional abundance indices, losses during juvenile life stages (not susceptible to entrainment by MPS) have disproportionately reduced recruitment of mature, spawning adults from larger year-classes of young Winter Flounder. Greater than average predation on pre-recruit sizes may account for the disappearance of abundant young before they become spawning adults. These processes occur independently of MPS operation.

Acoustic Tracking of Southern Flounder (*Paralichthys lethostigma*) Released in the Charleston Harbor Estuarine System, South Carolina

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Southern flounder (*Paralichthys lethostigma*) occur along the Atlantic (NC-FL) and Gulf of Mexico coastlines. Although there is little mixing between these regions, extensive mixing does occur within them. The patterns of within-region mixing are poorly understood, and this lack of information was identified as a research need by a recent stock assessment of the Atlantic population. To address this issue, we investigated movements of acoustically tagged fish in the Atlantic. Laboratory trials showed that surgically implanted transmitters had a higher retention than externally attached transmitters, and that survival of surgery was impaired above 25°C. Using this optimized procedure, 118 southern flounder (> 275 mm total length) were acoustically tagged, released into the Charleston Harbor estuarine system, and tracked for up to 1 year using both mobile and fixed-station receivers. Eighty-eight percent of fish were only ever detected inside the estuary of release, although some of these fish 'disappeared' (i.e. were not detected) during winter and then 'reappeared' the following spring. The remaining twelve percent of fish were detected in coastal waters up to 263 km away, mostly during winter spawning months. The probability of being detected in coastal waters increased significantly with fish total length. Coastal fish were only ever observed moving toward the south (off SC, GA and FL), and none was observed returning in a northerly direction. Our results suggest that spawning occurs in southerly coastal areas, but specific spawning locations have yet to be identified.

Session V

The Multifunctional Flatfish Urohyal: What One Bone Can Tell Us about Feeding, Ventilation, and Burial

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The urohyal is a sesamoid bone that develops within the tendon of the sternohyoideus, a major suction feeding and ventilation muscle. In most acanthomorph fishes, the urohyal is attached to the hyoid, but in flatfishes, it is positioned between the hyoid and pectoral girdle, suspended by the sternohyoideus and its tendons. It is also typically a broad and flat bone, but in flatfishes, it is sickle-shaped. The unique shape and position of the urohyal creates a canal between the left and right gill chambers through which flatfishes can likely shunt water during burial. While flatfishes bury within the sediment primarily by using body undulations and fin flicking, preliminary evidence shows that, like many other fishes, they also use jets of water from their gill openings to help fluidize sediment. Because flatfishes lay on their side, only one gill opening is in contact with the substrate, which could reduce their potential jetting capacity. However, the urohyal canal may allow them to shunt water from the eyed-side to the blind-side to enhance the blind-side opercular jet. This new function of the urohyal now implicates this bone in three functions: feeding, ventilation, and burial. Using dissections and micro-CT scans, we characterize the considerable variation in urohyal and sternohyoideus shape across 10 species from 6 families, and we discuss the implications of the multifunctionality of this structure for the evolution and ecology of flatfishes.

Session V

Using Fishermen's Knowledge to Improve Abundance Estimates for Atlantic Halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine

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Atlantic halibut (*Hippoglossus hippoglossus*) is a data-poor stock in U.S. waters, and the 2017 assessment was unable to determine stock status. Fishery catch per unit effort (CPUE) data can be standardized to provide an index of abundance, which can be applied to stock assessment and fishery management. A secondary advantage of using CPUE in stock assessment is that fishermen may have increased faith in the results. Fishermen can also provide valuable information on factors affecting catch rates and fish abundance. Atlantic halibut fishermen from Maine are being interviewed to determine factors that influence halibut catch rates, and identified factors will be incorporated as predictor variables in the CPUE standardization process. Different analytical approaches, including generalized linear models, generalized additive models, and zero inflated distributions are being explored for CPUE standardization. Preliminary results revealed stable catch rates from 2002–2016, and the influence of longitude, sediment type, depth and location on halibut CPUE. The results from this study are expected to provide valuable information for management as a relatively empirical indicator, or the CPUE series could serve as an input for future analytical assessment models.

Animal Forests in Flatfish Habitats: Patterns, Concepts, Issues, and Research Needs

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Marine animal forests are composed of sessile benthic species in high density aggregations, forming three-dimensional structures that echo terrestrial vegetated forests when scaled to the size of fishes. These complex structures are known to affect habitats by altering the movement of water and increasing spatial complexity, providing vagile fauna with refuge from flow and predation while possibly increasing the likelihood of local larval settlement. Such "forests" commonly occur in habitats occupied by species of flatfish off the northeast US, but their potential influence on fish populations has yet to be investigated. Forests are found on a range of seafloor substrates, from fine-grained sediments to boulders and exposed ledge. In areas of fine-grained substrate, dense patches of suspension feeding hydroids, tube-building amphipods, and tubiculous polychaetes form dense meadows utilized by crustaceans, gastropods, and other small invertebrates. Sponges, cold-water corals, hydroids, and erect colonial bryozoans attach to hard substrates, embedded within and surrounding fine-grained sedimentary habitats, similarly increasing structural complexity. The role of forest patch structure, life-history of structure-forming species, variation in threat of predation, species interactions (predation, competition) and variation in distribution of prey resources may influence patterns of habitat use and individual fitness, and the demography of flatfish species. Research to assess the role of animal forests within flatfish habitat, and the role such habitat attributes play in population dynamics, can be linked to broader ecological theory as a way to design studies and interpret results.

Session V

Comparative Ecology of the Four Species of the Flatfish Genus *Peltorhamphus* (Pleuronectiformes: Rhombosoleidae) From New Zealand Waters

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Depending upon where specimens of *Peltorhampus* are collected around New Zealand, 2, 3, or all 4 species of this genus may be collected simultaneously. Sympatric distributions present an opportunity for comparative study of life histories and ecologies of these interesting flatfishes. Morphological and ecological data were extracted for 1868 museum specimens examined in the present study and from literature sources where identifications were deemed reliable. Four members of *Peltorhamphus* are found nearly exclusively in shallow (0.5 m) to deeper waters (usually to about 50 m) on the continental shelf off both major islands of New Zealand. Juveniles of two species occur at similar depths occupied by adults; data are too limited to determine juvenile habitats for the other species. With exception of *P. novaezeelandiae*, which attains sizes of ca. 550 mm SL, the remaining three species, *P. tenuis*, *P. latus*, and *Peltorhamphus* n. sp., are relatively small-sized, reaching only to about ≤160 mm SL. Males and females reach similar maximum sizes in three of four species; only *P. latus* is sexually dimorphic with females attaining greater (to 144 mm SL) size than that (126 mm SL) of males. Although no differences were found in the present study, some literature indicates that female *P. novaezeelandiae* reach larger sizes than do males. Size and maturity data collected for each species reveal differences among species in female size at maturity. Information on depths of occurrence, sizes at depth, and habitat utilization were also assessed and compared among the four species.

Session V

Sexual Size Dimorphism in United States and Canadian Populations of American plaice *Hippoglossoides platessoides*

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Flatfishes are well known for sexual size dimorphism (SSD) – typically females being larger than males – which has implications for monitoring and predicting fishery yields. Here, we describe the sex-specific length, weight, and age differences of American plaice for 3 populations, one US stock area (NAFO area 5YZ: Georges Bank and Gulf of Maine) and two Canadian stock areas (4T: southern Gulf of St. Lawrence; 3LNO: Grand Bank), across a nearly 10^o latitudinal range. Females were observed as large as 77 cm total length (TL) and 5.4 kg body weight (BW), whereas males were as large as 65 cm TL and 3.25 kg BW. The heaviest fish were observed on the Grand Bank and the lightest fish were observed in US waters. Females lived longer than males: a 34-year-old female was the oldest fish observed, collected in the Gulf of St. Lawrence during 1985; the oldest males, 3 23-year-olds, were collected from that same stock area, in 1979, 1986, and 1989. Maximum size, estimated asymptotic length (L_∞), and maximum age declined over decades but females persisted at larger sizes and older ages than males. Detailed work on SSD in flatfishes appears to be limited to a few 'model' species (e.g., North Sea plaice [*Pleuronectes platessa*], turbot [*Scophthalmus maximus*]), so use of the comparative method with species such as American plaice may be fruitful to investigate the association of SSD with individual growth and maturation, population density, and environmental factors.

Session VI

Using Fisheries-Dependent Video Data to Assess Southern New England Population Structure of Windowpane Flounder

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Windowpane flounder are a managed species in the northwest Atlantic whose regulations limit the ability to catch target species. Through a collaborative program with commercial fishing boats, we were able to utilize individual vessel data collected by video to understand local populations of windowpane flounder. Video monitoring data from three Rhode Island fishermen's vessels were analyzed to understand distribution, relative abundance, size/age structure, and habitat associations for the stock. These data were compared to other fisheries independent and dependent data to get a complete picture of local densities, distribution and to understand the strengths and weakness of the numerous different data sources. Fisheries independent data are from a statistically designed sampling methodology, but have a low density of sampling stations in the area. Fisheries dependent data have a high spatial and temporal density, but are not chosen randomly. The project intends to examine the high-resolution data available from a collaborative electronic monitoring program to inform management processes for the Northeast Multispecies Fisheries Management Plan in the context of windowpane flounder's impact on the program and accountability area controls.

Session VI

Spawning Phenology of Flatfishes on the Northeast US Continental Shelf

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The NEFSC spring and fall bottom trawl time series includes macroscopic reproductive stage for flatfishes from the 1970s-1990s depending on species, and individual weights, (since 1992) that provide a measure of relative condition. The surveys cover a broad region that includes areas experiencing increasing temperatures and lengthening warm seasons which may affect when species spawn, but occur at similar times each year (notwithstanding weather and/or vessel delays). Survey timing is especially important in spring, when many species are near, actively, or just finished spawning. Since flatfish gonads can be a high percentage of total body weight, temporal shifts in spawning and reproductive state can impact perceived condition determined by weight at length. The stock-specific spawning phenology of six flatfishes – American plaice, summer, yellowtail, winter, witch, and windowpane flounders - was evaluated. The stocks vary in historic spawning period, from February-March for Southern New England winter flounder to October-November for summer flounder. Specifically, patterns in the proportions of pre-spawning, spawning, and post-spawning females were analyzed over time and related to the date and temperature of sampling each stock. Not surprisingly, deeper (i.e. witch flounder) and/or later spawners (e.g Gulf of Maine yellowtail) showed little variation in spring macroscopic maturity stage over time, while shallower and earlier spawners (e.g. winter flounder and American plaice) showed evidence of earlier spawning in recent years. Summer flounder primarily spawn in fall, but spring spawning was also evident in the 1980s- mid-1990s. The results indicate stock-specific patterns in spawning phenology that may influence weight-based condition metrics.

Session VI

Toxics Source Reduction and Sewage Upgrades Eliminated Winter Flounder Liver Neoplasia (1984-2017) From Boston Harbor, MA, USA

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Chemical carcinogen biomarkers can validate public investment in environmental remediation. A major factor driving the clean-up of Boston Harbor, MA, U.S.A., induced by the Clean Water Act (1972), was the high prevalence of petroleum and halogenated aromatic hydrocarbon contaminant-associated liver neoplasia in winter flounder in the harbor in the 1980's. Toxics source reduction, sewage treatment and sludge removal in the 1990's and outfall relocation offshore (2000) enabled a decreasing prevalence of persistent toxic chemicals in flounder, effluent and sediment, and consequent disappearance of liver neoplasia and reduction of neoplasm-associated, hydropically vacuolated biliary epithelial cells to background levels. This supports long term investment in elimination and treatment of anthropogenic waste streams and the value of federal regulatory mandates to maintain and improve regional environmental quality.

Session VI

Experimental Identification of Early Life Stage Plasticity to Environmental Factors in Summer Flounder, *Paralichthys dentatus*

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Many life-history traits are plastic in their expression and vary with environmental conditions, and this is especially true for traits expressed in the early life-stages (ELS) of fishes. In nature, environmental driver(s) contribute to trait variation and the trait patterns may represent adaptive responses to these environmental factors, e.g., thermal regimes (climate change), elevated CO_2 (ocean acidification), and reduced dissolved oxygen. Many drivers translate to an aquaculture context where plasticity motivates investigators to identify optimal conditions for production. Response optima occur in a subset of the environmental factor range and can be evaluated with respect to the factor's likelihood in nature and to the economic costs of providing optimal conditions in aquaculture. A first step in this chain of inference is to move from testing the null hypothesis that an environmental driver has no effect on biological response, to an advanced null-hypothesis study that examines the extent and shape of the response. We used high-treatment frequency experimental methods to reveal the shape and extent of ELS plasticity in summer flounder, *Paralichthys dentatus*. Responses include rates of fertility, development, growth, and survival, and were found to be highly plastic. Fertilization rate decreased with increasing temperature and increasing CO_2; embryonic period duration decreased exponentially with increasing temperature; hatching size decreased with increasing temperature; survival decreased with increasing CO_2 and at the thermal tolerance extremes; and settlement size decreased with increasing temperature and CO_2. Consequences of these responses are being analyzed but it is the high-treatment frequency approach thus makes such analyses possible.

Abstracts

Poster Presentations

Flatfish Distributions in the Context of Finely Resolved Seafloor Habitats and Associated Benthic Communities in Long Island Sound

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The habitats marine fishes occupy can strongly influence the vital rates of individuals with population-level consequences. The distributions and densities of fish in part reflect the relative quality of available habitats, both through individual responses in the form of behavior and spatially heterogeneous mortality and recruitment, and are used in developing definitions of essential fish habitat. Within Long Island Sound, common flatfish species- fourspot flounder *Paralichthys oblongus*, summer flounder *Paralichthys dentatus*, windowpane flounder *Scophthalmus aquosus*, and winter flounder *Pseudopleuronectes americanus*- are associated with particular physical characteristics of the seafloor, such as sand or mud substrates. Past analyses of flatfish distributions within the Sound revealed patterns in abundance and condition related to sediment grain size and depth. Inferences resulting from these analyses, however, were inevitably limited by the resolution and detail of available seafloor habitat data. Recent efforts to map the ocean floor in Long Island Sound as part of the LIS Mapping Initiative have produced finely resolved benthic habitat maps covering a large area (462 km^2) spanning the central Sound. These maps characterize bathymetry, sediment composition, and benthic epifaunal and infaunal communities. The newly available data provided the opportunity to explore flatfish spatial dynamics over the past 5 years, using fisheries independent trawl survey data, in the context of both physical habitats and associated ecological communities across multiple spatial scales. As Long Island Sound's flatfish populations continue to decline in abundance, improved understanding of how these species relate to habitat may provide insight to inform management and aid population recovery.

Assessment of Windowpane Flounder Larval Distribution and Growth along the Northeast US Continental Shelf

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Windowpane Flounder, *Scophthalmus aquosus,* is an abundant flatfish found along the shallow water shoals of the northeastern US continental shelf. It is a managed species, yet not of significant commercial value due to its thin body shape. Because of low catch quotas, windowpane flounder bycatch can constrain more commercially important groundfish and scallop fisheries. Currently there are two recognized stocks, the Gulf of Maine/ Georges Bank stock and the Southern New England/ Middle Atlantic Bight stock. The stocks have noted differences in spawning behavior with a bimodal spring and fall spawning pattern in the SNE/ MAB stock and a unimodal summer spawning period in the GOM/GB stock. This project aims to fill in the gap of knowledge about the life history of this species. We will develop age/length curves for the early life history stages of windowpane flounder from different regions and seasons to be used as an input in future analytical modeling. Such information will allow for characterization of spawning behavior and the timing and distribution of spawning events, as well as the development of indices of larval abundance. Ultimately, the goal is to develop a broader understanding of the stock population dynamics, and to evaluate the degree to which the seasonal and spatial dynamics of the species have responded to a changing climate.

Flatfish Catch in Scallop Dredges on Georges Bank

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Since 2011, Coonamessett Farm Foundation has been conducting seasonal bycatch surveys on Georges Bank to document the presence of all species caught by scallop dredges. This includes several species of flatfish: summer (*Paralichthys dentatus*), winter (*Pseudopleuronectes americanus*), and witch (*Glyptocephalus cynoglossus*) flounder, and American plaice (*Hippoglossoides platessoides*), but undoubtedly, the two most important bycatch species in this fishery are yellowtail (*Limanda ferruginea*) and windowpane (*Scopthalmus aquosus*) flounder because excess catch of these two choke species can trigger accountability measures. To date, a total of 3715 hauls have documented spatiotemporal variation for each species. For example, catches of yellowtail and windowpane flounder were highest in Closed Area II in autumn and winter, respectively. In addition to recording catch totals, yellowtail, winter, and windowpane flounder are also sampled for sex and reproductive staging (i.e. gonad stage and weight). The results from this work suggest that these species have two peaks of maturity - one in spring and one in autumn - although this result was not consistent in all sampling years. The results from this multi-year seasonal survey of these flatfish species may help managers to identify the optimal strategies for managing both the flatfish and scallop fisheries.

Distribution and Seasonal Behavior of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of St. Lawrence Based on Data from Pop-up Satellite Archival Tags

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Atlantic halibut supports the most valuable groundfish fishery per unit weight in Atlantic Canada, and the total landed value has increased from $16M CAD in 2006 to $57M in 2016. The fishery is currently managed as two separate stocks, the Gulf of St. Lawrence (GSL) stock, and the Scotian shelf and Southern Grand Banks stock. However, precise knowledge of population structure remains elusive, partly because seasonal distributions, migration routes, and feeding and spawning areas remain largely unknown. To gain knowledge of stock structure, spawning, and feeding behaviors, more than 100 Atlantic halibut were equipped with pop-up satellite archival tags (PSATs) since 2013 in the GSL. Data returned by the PSATs was used in a geolocation model to reconstruct migration tracks. Results suggest that Atlantic halibut complete their annual migration cycle within the GSL, supporting the current management of Atlantic halibut as two separate stocks. Furthermore, putative winter spawning and summer feeding behaviors were observed in relatively deep waters (300-450m) and shallow inshore waters (<100m) respectively. However, further work is required to characterize these putative spawning and feeding behaviors with electronic tag data and inform the spatial management of this important fishery resource.

Effects of Temperature and pH on Blood-oxygen Affinity of Windowpane Flounder (*Scophthalamus aquosus*)

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Hemoglobin takes up and transports oxygen in the blood of fishes but blood-oxygen affinity (P_{50}) varies widely among species. We measured the blood-oxygen affinity at 10, 15, 25 and 33 ^{0}C. The Oxygen Equilibrium Curve (OEC) of windowpane whole blood was sigmoidal with Hill Coefficients > 1. There was a right shift (negative ΔH) in the oxygen equilibrium curve with increased temperature, indicating decreased blood oxygen affinity. Similarly, decreased pH resulted in a decline in blood-oxygen affinity (calculated as the Bohr coefficient, ϕ). Implications for the eco-physiology of windowpane will be discussed.

Prevalence and Intensity of Parasitic Cysts in Yellowtail Flounder, *Limanda ferruginea*: Preliminary Results Related to Condition and Comparison among Stocks

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Yellowtail flounder, *Limanda ferruginea*, weight at age has declined in recent years for some stocks. One contributing factor could be the presence of infections reducing their general condition. *Ichthyophonus sp*. has been documented in the Georges Bank yellowtail flounder stock and large scale outbreaks have been observed in other species. This study examined the relative condition, percent dry weight of muscle and liver, and presence (prevalence and intensity) of parasitic cysts (potentially of *Ichthyophonus sp*.) on pre-spawning yellowtail flounder in the two inshore stocks, the Gulf of Maine (GOM) (*n*=208) and Southern New England (SNE) (*n*=179). The relative condition and percent dry weight of liver and muscle tissue for both males and females was lower in the GOM compared to SNE. The macroscopic presence and relative intensity of the cysts was recorded for the liver, viscera, gonads, and fins. The intensity and prevalence was higher in the GOM than in SNE for both sexes. In general, fish with the highest intensity of infection had lower condition. Females with the highest intensity of infection sampled from the GOM had a lower percent dry weight of the liver than females with no infections observed, but both sexes were below that of SNE females. Histological analysis of liver and gonad samples to identify parasites is underway. Continued sampling is planned to track the prevalence and understand the pathways of infection through different tissues, which may help clarify whether infection is a cause, or an effect of poor condition in yellowtail flounder.

Potential Effects of Physical Factors on Juvenile Flatfish Abundance in a Georgia Estuary

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Physical factors such as wind, temperature, and salinity can often influence the distribution and abundance of flatfishes within a habitat. The purpose of this study was to determine which physical factors, if any, had an effect on the seasonal abundance of flatfish species in a small tidally influenced creek near Savannah, GA. Sampling was conducted monthly at ebb tide using a beam trawl from January 2015-August 2018. All fish were identified to species and measured to the nearest mm TL. Temperature and salinity were measured monthly using a refractometer and thermometer, respectively. A total of 1,189 flatfish were collected representing 7 species: the bay whiff *Citharichthys spilopterus*, blackcheek tonguefish *Symphurus plagiusa*, fringed flounder *Etropus crossotus,* gulf flounder *Paralichthys albigutta*, summer flounder *Paralichthys dentatus,* southern flounder *Paralichthys lethostigma*, and ocellated flounder *Ancylopsetta quadrocellata*. The bay whiff, blackcheek tonguefish, and fringed flounder were collected every season, while the other 4 species were only collected in the winter and spring. The bay whiff was the most abundant flatfish in the winter and spring at 25.0 ± 15.67 CPUE and 6.4 ± 8.00 CPUE, respectively, while the blackcheek tonguefish was the most abundant in the summer at 7.0 ± 5.58 CPUE. The other 5 species were collected in much smaller quantities throughout the year. Salinity was generally consistent from season to season, but temperature varied seasonally ranging from 14.1 ± 2.56 °C to 29.0 ± 1.79°C. Seasonal shifts in temperature may be one potential factor influencing flatfish abundance in the region.

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