Northeast Fisheries Science Center Reference Document 16-14
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15th Flatfish Biology Conference 2016
Program and Abstracts

December 6-7 2016
Water's Edge Resort and Spa, Westbrook, CT

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

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Flatfish Biology Conference
Celebrating 30 Years
2016

December 6th & 7th
Water's Edge Resort and Spa, Westbrook, CT

Oral Presentations
Salons A/B

Tuesday December 6th

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. Thomas Noji, Chief Ecosystems and Aquaculture Division
NOAA Fisheries, Northeast Fisheries Science Center
James J. Howard Marine Sciences Laboratory, Highlands, NJ

Session I
Penny Howell, Chair
Connecticut Department of Energy and Environmental Protection
Marine Fisheries Division, Old Lyme, CT

9:00 a.m. Using a Long-term Dataset to Analyze the Effect of Season on the Size and Abundance of Flatfishes in a Georgia Tidal Creek
Hannah Z. Reilly and Mary Carla Curran*
Savannah State University, Marine Sciences Program, Savannah, GA

9:20 a.m. Blue Crab Predation on Juvenile Winter Flounder in New England Waters Assessed Through PCR-based Methods
Kelly J. Cribari[1]*, Abigail K. Scro[2], Kathryn R. Markey[2], and David L. Taylor[1]
[1]Roger Williams University, Department of Marine Biology, Bristol, RI,
[2]Aquatic Diagnostic Laboratory, Bristol, RI

9:40 a.m. Migration Diversity, Spawning Behavior and Temperature Selection of Winter Flounder: Implications for Recovery of a Depleted Species
Catherine Ziegler* and Michael Frisk
Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY

10:00 a.m. The Effects of Sedimentation on the Survival of Winter Flounder Eggs Incubated in the Laboratory
Justin L. Wilkens*, Burton C. Suedel, Alan J. Kennedy, Cheryl R. Montgomery, and Edward O'Donnell
US Army Engineer Research and Development Center, Vicksburg, MS

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

Session II

Steve Dwyer, Chair
Dominion Nuclear Connecticut, Inc.,
Millstone Environmental Laboratory
Waterford, CT

10:50 a.m. Ocean Exploration, Morphological and Molecular Approaches, Contribute to Discoveries of Unrecognized Diversity of Tonguefishes (Pleuronectiformes: Cynoglossidae)
Thomas A. Munroe
NOAA Fisheries, National Systematics Laboratory, National Museum of Natural History, Smithsonian Institution, Washington, DC

11:10 a.m. Considering Fishery Catch Rates for New England Groundfish Assessments: A Case Study in Witch Flounder
Steven X. Cadrin and Brooke L. Wright*
University of Massachusetts Dartmouth, School for Marine Science and Technology, New Bedford, MA

11:30 a.m. Investigating Offshore Habitat of Southern New England Winter Flounder Using Dredge Surveys
Carl Hunstberger, Liese Siemann, Samir Patel*, and Ronald Smolowitz
Coonamessett Farm Foundation, Inc., East Falmouth, MA

11:50 a.m. Role of Norwalk Harbor as a Nursery Ground for Winter Flounder (*Pseudopleuronectes americanus*)
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

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

1:30 p.m. Temporal Changes in Sex Ratio Observed Among Winter Flounder (*Pseudopleuronectes americanus*) in the Northwest Coastal Atlantic
Anne McElroy[1]*, Matthew Siskey[1], Paul Geoghegan[2], Ann Pembroke[2], Michael Moore[3], and Ken Keay[4]
[1]Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY, [2]Normandeau Associates Inc., Bedford, NH, [3]Woods Hole Oceanographic Institution, Woods Hole, MA, [4]Massachusetts Water Resources Authority, Boston, MA

1:50 p.m. Evidence of Spatiotemporal Skew in the Sex Ratio of Winter Flounder in Narragansett Bay, Rhode Island
Joseph A. Langan[1]*, Gavino Puggioni[2], and Jeremy S. Collie[1]
[1]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, [2]University of Rhode Island, Kingston, RI

2:10 p.m. Surviving their First Summer: Winter Flounder Mortality and Growth in Long Island Bays
Tara Dolan*, Matthew Siskey, Anne McElroy, and Michael Frisk
Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY

2:30 p.m. Fecundity of Winter Flounder, *Pseudopleuronectes americanus*, in US Waters: Analysis of Geographic, Environmental, and Physiological Drivers
Mark J. Wuenschel[1]*, W. David McElroy[2], Emilee Tholke[2], Kim Hyde[3], and Richard S. McBride[1]
[1]*NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA,* [2]*Integrated Statistics, Falmouth, MA,* [3]*NOAA Fisheries, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI*

2:50 p.m. **Refreshment Break**

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

3:20 p.m. Diversity and Species Richness of Tonguefishes (Pleuronectiformes: Cynoglossidae) in Chinese Waters
Hairong Luo[1, 3]* and Thomas Munroe[2]
[1]Key Laboratory of Marine Bio-resources Sustainable Utilization, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou,, China, [2]NOAA Fisheries, National Systematics Laboratory, Smithsonian Institution, Washington, DC, [3]University of Chinese Academy of Sciences, Beijing, China

3:40 p.m. Nearshore Sex-specific Dynamics of the Summer Flounder (*Paralichthys dentatus*) in Rhode Island Waters
Corinne Truesdale[1]*, Joseph Langan[1], Adena Schonfeld[2], M. Conor McManus[1], and Jeremy Collie[1]
[1]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, [2]University of Miami, Rosenstiel School of Marine and Atmospheric Science, Miami, FL

4:00 p.m. Prey Consumption and Repeatability of Performance in Winter Flounder
R. Christopher Chambers*, Jacob P. Strock, Raven M. Benko, Ehren A. Habeck, and Kristin M. Habeck
NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ

4:20 p.m. Ebb Light, Flood Light: Red Light, Green Light for Larval Flatfishes
Hannah Z. Reilly and Mary Carla Curran*
Savannah State University, Marine Sciences Program, Savannah, GA

4:40 p.m. **Poster Set-up**

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

Wednesday December 7th

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

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

8:40 a.m. Diet and Trophic Dynamics of Summer Flounder (*Paralichthys dentatus*) in Shinnecock Bay Based on Stomach Content Analysis
Sara Cernadas-Martin
Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY

9:00 a.m. The How and Why of Size Dimorphism in Flatfishes: a Review
Richard S. McBride
NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA

9:20 a.m. Preliminary Evaluation of Variable Pigmentation Features Observed in Populations of the Fringe-lip Tonguefish (*Paraplagusia japonica* Temminck & Schlegel 1846), Inhabiting Coastal Waters of China (*Pleuronectiformes: Cynoglossidae*)
Hairong Luo[1, 3]*, Thomas Munroe[2], Xiaoyu Kong[1], and Jiangxing Dong[1, 3]
[1]*Key Laboratory of Marine Bio-resources Sustainable Utilization, South China Sea Institute of Oceanology, Chinese Academy of Sciences, Guangzhou, China,* [2]*NOAA Fisheries, National Systematics Laboratory, Smithsonian Institution, Washington, DC,* [3]*University of Chinese Academy of Sciences, Beijing, China*

9:40 a.m. Indications that Winter Flounder are Spawning Offshore in the Southern Gulf of Maine
Elizabeth A. Fairchild
University of New Hampshire, Department of Biological Sciences, Durham, NH

10:00 a.m. The Importance of the Saco River Estuary to Winter Flounder (*Pseudopleuronectes americanus*) Life Stages
Lars Hammer* and James A. Sulikowski
University of New England, Marine Sciences, Biddeford, ME

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

Session VI

Thomas A. Munroe, Chair

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

10:40 a.m. Burial Performance in Flatfishes among Species, Size Classes, and Grain Size

Stacy C. Farina[1]*, Katherine A. Corn[2], Amberle McKee[3], Adam P. Summers[4], and Alice C. Gibb[5]

[1]Harvard University, Department of Organismic and Evolutionary Biology, Cambridge, MA, [2]University of California Davis, College of Biological Sciences, Davis, CA, [3]University of California Irvine, Department of Ecology and Evolutionary Biology, Irvine, CA, [4]University of Washington, Friday Harbor Laboratories, Friday Harbor, WA, [5]Northern Arizona University, Biology Department, Flagstaff, AZ

11:00 a.m. Nursery Habitat Quality for Winter Flounder (*Pseudopleuronectes americanus*) Linked to Soil Chemistry, Geology and Climate Factors – A Review of the Literature

Timothy C. Visel

The Sound School Vocational Aquaculture Center, New Haven, CT

11:20 a.m. Ocean Acidification Effects on Early Life-Stages of Winter Flounder

R. Christopher Chambers*, Ehren A. Habeck, Kristin M. Habeck, Allison Candelmo, Matthew Poach, Daniel Wieczorek, and Beth Phelan

NOAA Fisheries, Northeast Fisheries Science Center, James J. Howard Marine Sciences Laboratory, Highlands, NJ

11:40 a.m. Reflections on Over 40 Years of Flatfish Seine Surveys and Future Research Survey Needs

Vincent Manfredi

Massachusetts Division of Marine Fisheries, Resource Assessment Project, New Bedford, MA

12:00 p.m. Comparison of Young-of-the-Year Winter Flounder Abundance in 1988-1990 and 2013-2015 at Connecticut Beach Sites

Penny Howell* and David Molnar

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

12:20 p.m. **Closing Comments**

12:30 p.m. **Hosted Buffet Lunch**
Adjourn Meeting

Poster Session
Salon C
Tuesday December 6th, 5:00 p.m.

Douglas Clarke[1] and Christopher Powell[2], Co-Chairs

[1]HDR Engineering, 114 Westwood Drive, Vicksburg, MS
[2]Roger Williams University, Bristol, RI

Protecting Winter Flounder in NY/NJ Harbor Using Long-term Fishery Resource Data: Past, Present, and Future
Catherine Alcoba[1], Doug Clarke[2], David Davis[3], Jenine Gallo[1], Dara Wilber[4]*, and Sarah Zappala[3]
[1]US Army Corps of Engineers New York District, New York, NY, [2]HDR Engineering, Vicksburg, MS, [3]HDR Engineering Inc, Mahwah, NJ, [4]HXFive, Charleston, SC

Effects of Maternal Investment on Anti-Predator Behavior of Larval Southern Flounder (*Paralicthys lethostigma)*
Corinne M. Burns* and Lee A. Fuiman
University of Texas, Marine Science Institute, Port Aransas, TX

Foraging Ecology of Blue Crabs (*Callinectes sapidus*) and Their Potential Impact on Winter Flounder (*Pseudopleuronectes americanus)*
Molly Fehon* and David Taylor
Roger Williams University, Department of Marine Biology, Bristol, RI

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

Spatial Distribution of Larval Winter Flounder as a Proxy for Habitat Use in a Warming Ocean
Robert Krulee[1]*, Joseph A. Langan[2], Eric Schneider[3], and Jeremy S. Collie[2]
[1]University of Rhode Island, Kingston, RI, [2]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, [3]Rhode Island Department of Environmental Management, Marine Fisheries Section, Jamestown, RI

A Preliminary Re-evaluation of Atlantic Halibut Life History in the Western Atlantic

Richard S. McBride[1]*, Emilee K. Tholke[2], and Scott Elzey[3]
[1]NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA, [2]Integrated Statistics, Woods Hole, MA, [3]Massachusetts Division of Marine Fisheries, Gloucester, MA

Determining Natal Sources of Adult Winter Flounder in the Gulf of Maine and Southern New England/ Massachusetts Stocks

Tiffany R. Rich* and Elizabeth A. Fairchild
University of New Hampshire, Department of Biological Sciences, Durham, NH

Preliminary Otolith Analyses Indicate Potential Spawning Diversity and Fine-scale Population Structure in Winter Flounder (*Pseudopleuronectes americanus*)

Matthew Siskey[1]*, Anne McElroy[1], Tara Dolan[1], Karin Limburg[2], and Michael Frisk[1]
[1]Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY, [2]State University of New York, College of Environmental and Forest Biology, Syracuse, NY

Age Determination of Georges Bank Windowpane Flounder (*Scophthalmus aquosus*) Using Otoliths

Sandra J. Sutherland* and Antonie Chute
NOAA Fisheries, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA

Relative Risk and Benefit of Consuming Two Southern New England Flatfish Species

Mary Yurkevicius[1]*, Joshua Jacques[2]*, and David L. Taylor[2]
[1]Roger Williams University, Department of Chemistry, Bristol, RI, [2]Roger Williams University, Department of Marine Biology, Bristol, RI

Abstracts

Oral Presentations

Using a Long-term Dataset to Analyze the Effect of Season on the Size and Abundance of Flatfishes in a Georgia Tidal Creek

Hannah Z. Reilly and Mary Carla Curran*

Savannah State University, Marine Sciences Program
Box 20467, Savannah, GA 31404

Email: hzreilly@gmail.com, curranc@savannahstate.edu

Competition and resource partitioning is common among flatfish species, and often results in temporal segregation. The purpose of this study was to determine whether there was an effect of season on the distribution of flatfishes in a tidal creek near Savannah, GA. Sampling was conducted once a month using a beam trawl during ebb tides from January 2004-June 2016 in Wylly Creek, a tributary of the Herb River. Additional sampling was conducted from December-February during 2014-2016 in an effort to obtain small juveniles based on observed settlement pulses of the bay whiff, *Citharichthys spilopterus*, in previous years. Almost all fishes (98%) were identified to species and measured. The catch per unit effort (CPUE) was determined for each species by season. A total of 6 species were collected and there was a significant seasonal difference in abundance for 4 of them. The most striking patterns were for the bay whiff and blackcheek tonguefish, *Symphurus plagiusa*, which were most abundant in winter (18.5±17.7 CPUE) and summer (11.9±8.0 CPUE), respectively. Flatfish assemblages were different across all seasons except spring and winter. These differences were driven mostly by recruitment of large pulses of recently settled bay whiff in winter. Temporal segregation of flatfishes is partly caused by variations in spawning times and larval transport mechanisms that result in species occupying different habitats during different times of the year.

Blue Crab Predation on Juvenile Winter Flounder in New England Waters Assessed Through PCR-based Methods

Kelly J. Cribari[1]*, Abigail K. Scro[2], Kathryn R. Markey[2], and David L. Taylor[1]

[1]*Roger Williams University, Department of Marine Biology*
One Old Ferry Road, Bristol, RI 02809

[2]*Aquatic Diagnostic Laboratory*
One Old Ferry Road, Bristol, RI 02809

Email: kellycribari@gmail.com

Increasing water temperatures in the Northwestern Atlantic have resulted in blue crabs (*Callinectes sapidus*) extending their geographic range northward to Southern New England waters, including the Narragansett Bay Estuary and associated tidal rivers and coastal ponds. The increased abundance of blue crabs in these areas may have important consequences to resident biota. For example, blue crabs may adversely affect juvenile winter flounder (*Pseudopleuronectes americanus*) populations via trophic interactions. In this study, Polymerase Chain Reaction (PCR)-based methods were used to detect crab predation on juvenile flounder. DNA extractions of crab stomach contents were done using a Qiagen DNeasy Blood and Tissue Kit and then amplified using a winter flounder-specific 208 base-pair primer set, specifically attaching to the U12068 (D-loop) position. A total of 144 crab stomachs were analyzed, of which 36 tested positive for winter flounder DNA. This 25.0% positive detection exceeds predation rates estimated from traditional visual analysis of stomach contents, and further suggests that crabs may be an important source of predator-induced mortality for juvenile flounder. Dynamics in this predator-prey interaction were unrelated to crab/flounder body sizes or flounder densities. Conversely, crab predation on flounder significantly decreased at low dissolved oxygen concentrations, possibly due to reduced crab foraging during hypoxic conditions (< 4 mg DO/L). Future work will include the analysis of the remaining crabs collected in 2015, as well as 2016, and comparison of PCR results with visual analysis of the stomach contents.

Migration Diversity, Spawning Behavior and Temperature Selection of Winter Flounder: Implications for Recovery of a Depleted Species

Catherine Ziegler* and Michael Frisk

Stony Brook University, School of Marine and Atmospheric Sciences
Stony Brook, NY 11794

Email: catherine.ziegler@stonybrook.edu

Winter flounder have declined to less than 11% of their historical abundance in offshore areas and have experienced severe declines and inbreeding in coastal subpopulations. Overfishing, unfavorable environmental conditions and predation have been suggested as drivers of this species' decline. Stocks that migrate inshore to spawn exhibit metapopulation structure, migration diversity and localized responses to large-scale environmental drivers. Understanding metapopulation structure and disparate migratory behavior is vital to understanding the species' dynamics in the region. We used acoustic telemetry to evaluate migratory types and natal homing in adult winter flounder (n = 72) in Mattituck Creek, NY. Telemetry results showed 18% of tagged individuals displayed resident behavior and remained in the creek despite temperatures reaching 28°C, which exceeds their thermal tolerance. Alternatively, the migratory group (~82% of the tagged individuals), started to leave the system when average water temperature reached 12°C. Natal homing was demonstrated in 50% of the migratory individuals, returning to the creek only five months after leaving. While in the creek, tagged winter flounder exhibited limited movements spending over half of their residency at one station (radius 500m). Additionally, in order to determine if winter flounder can find temperature refuge in the creek during periods when temperatures exceed the species' tolerance, we evaluated internal body temperature relative to ambient temperatures (n = 18) by utilizing temperature sensing acoustic tags. These results provide further insight into winter flounder movements, residency, and spawning behavior in the mid-Atlantic region and provide vital information for management of this depleted species.

The Effects of Sedimentation on the Survival of Winter Flounder Eggs Incubated in the Laboratory

Justin L. Wilkens*, Burton C. Suedel, Alan J. Kennedy, Cheryl R. Montgomery, and Edward O'Donnell

US Army Engineer Research and Development Center
3909 Halls Ferry Road, Vicksburg, MS 39180

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Dredging activities near fish spawning habitat may result in the settling of suspended sediment which can bury fish eggs that are important for maintaining local fisheries. This study was performed to determine the effects of sedimentation on hatch of winter flounder (*Pseudopleuronectes americanus)* eggs incubated under laboratory conditions. Experiments were conducted using sediment collected from three Connecticut waterways. Overall, burial depths of 0.3, 0.6, and 1.2 mm resulted in 86.6, 81.1 and 73.9% average survival, while 3 mm burial resulted in 10% survival of hatched eggs on average across the three sediments. Results of our experiment corroborated closely with prior research on winter flounder egg burial hatch success and demonstrated that egg hatching success was similar between the three sediments evaluated. Our results suggest that a flounder egg (≈ 0.75 mm diameter) may be 80% buried (0.6 mm) without substantially affecting hatching success. Before sedimentation risk can be appropriately assessed and managed, field measurements of the incremental contribution to sediment layers attributable to dredging operations, as well as other environmental factors such as timing of burial (with respect to egg development) and local hydrodynamic conditions need to be considered.

Ocean Exploration, Morphological and Molecular Approaches, Contribute to Discoveries of Unrecognized Diversity of Tonguefishes (*Pleuronectiformes: Cynoglossidae*)

Thomas A. Munroe

NOAA Fisheries, National Systematics Laboratory
National Museum of Natural History, Smithsonian Institution
PO Box 37012, MRC-153, Washington, DC 20013

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Members of the flatfish family Cynoglossidae are small to medium-sized, sinistral flatfishes found worldwide in temperate and tropical seas. The majority of tonguefishes are small-sized species usually reaching adult sizes under 30 cm SL. Tonguefishes are found in a diversity of marine and estuarine habitats ranging from subtidal estuarine waters to deepwater habitats on the outer continental shelf and upper continental slope to about 1500 meters. With 164 valid species recognized in three genera (*Cynoglossus*, *Paraplagusia* and *Symphurus*), the Cynoglossidae is one of the most diverse of the 14 families of flatfishes (Pleuronectiformes). Among the genera, *Symphurus* is the most diverse (96 species), followed by *Cynoglossus* (60 species) and *Paraplagusia* (7 species). During the past 30 years, the recognized species diversity of tonguefishes has increased steadily with new species being discovered in a variety of marine habitats including those in shallow, tropical seas to deepwater habitats at hydrothermal vents. At present, 26 species representing 15.9% of the standing diversity of the family awaits description. Among these 26 species are 17 nominal species of *Symphurus*, eight species of *Cynoglossus*, and at least one species of *Paraplagusia*. Increases in diversity within this family are being discovered in specimens collected in recent ocean exploration, through re-examination of historical collections of specimens, and in the identification of species complexes and cryptic species using molecular and morphological techniques. Several representative examples of species discovery are discussed.

Considering Fishery Catch Rates for New England Groundfish Assessments: A Case Study in Witch Flounder

Steven X. Cadrin and Brooke L. Wright*

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We developed several series of standardized catch per unit effort (CPUE) and landings per unit effort (LPUE) indices for witch flounder off New England. CPUE/LPUE indices can supplement survey indices of relative abundance, particularly when sample size is low, survey gear is inefficient, or when fishermen's perception of stock trends is inconsistent with survey trends. Changes in fishing fleet characteristics, fishing behavior, management, and economic conditions affect fishing data in ways that scientific surveys are unaffected, but standardization can account for some of these changes so that catch and landings data can still be considered in assessments. We explored dealer records from trips in which landings were at least 40% witch flounder and observer records of a target fleet in the western Gulf of Maine and developed generalized linear models (GLMs) of LPUE and CPUE. Temporal trends were similar between CPUE and LPUE series. The models of observer data had better statistical diagnostics than those of the dealer data, but the observer data sample size was too low in several years. Based on our results, we conclude that fishery catch rates have valuable information that should be considered in stock assessments.

Investigating Offshore Habitat of Southern New England Winter Flounder Using Dredge Surveys

Carl Hunstberger, Liese Siemann, Samir Patel*, and Ronald Smolowitz

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Coonamessett Farm Foundation collaborated with offshore scallop fishermen to conduct scallop dredge and video surveys in southern New England waters to assess the presence of commercially valuable fish species and determine habitat types during the winter. From December 2015 through April 2016, we conducted a total of five trips and dredged at the same 32 stations during each trip, with trip 2 including seven extra stations and trips 3 and 4 including one additional station. We mapped catch numbers for three principal fish species - winter flounder, windowpane flounder and monkfish - for each month and observed changes in the presence and relative abundance for each species. We annotated the video footage to document the habitat types and found that we generally towed in areas of sandy bottom with varying densities of sand dollars, shell hash, gravel and boulders. Habitat was categorized based on the dominant habitat type, and we performed regression models to determine if fish were found in association with a particular dominant bottom type. This analysis revealed different habitat preferences for the three species.

Role of Norwalk Harbor as a Nursery Ground for Winter Flounder (*Pseudopleuronectes americanus*)

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]

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An investigation was conducted to determine the efficacy of Norwalk Harbor, CT as habitat for juvenile winter flounder (*Pseudopleuronectes americanus*). This work is a continuation of a 26- year ongoing study, conducted by a team from Harbor Watch in Westport, CT, in cooperation with students from Wilton High School. The study involved trawling weekly in a subset of 20 quadrants in Norwalk Harbor from May through October. The abundance and length of winter flounder were recorded in each trawl, as well as the abundance and species composition of other finfish and invertebrates. The catch data were analyzed and compared to previous years. Analyses included a comparison of catch per unit effort, the size and location of flounder within the harbor, as well as other factors. Dissolved oxygen and temperature data were collected and considered as 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 26 years, which may have broader implications for both the health of the adult population and the ecosystem as a whole. Additionally, dissolved oxygen has declined and water temperature has increased over the course of the study. Juvenile fish can serve as indicators of estuarine health and this long-term study can assist in our understanding of changes in Norwalk Harbor and other Long Island Sound embayments.

Temporal Changes in Sex Ratio Observed Among Winter Flounder (*Pseudopleuronectes americanus*) in the Northwest Coastal Atlantic

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State-supported long-term monitoring programs provide a wealth of data on fish populations rarely evaluated by other investigators. Using data collected by the combined efforts of the Massachusetts Water Resources Authority, the University of Rhode Island, the National Marine Fisheries Service and state fisheries agencies (ME, NH, MA, CT, and NJ), the sex ratio of $\geq$30 cm total length, spring-caught winter flounder was evaluated for temporally variable female bias. Data collected over the period of 1985-2015 containing records on 72,879 individual flounder were examined. Female biased sex ratios were observed within each coastal survey which averaged from 71 to 90 percent female. In contrast the sex ratio of offshore flounder captured on Georges Bank was only 47%. Temporal analysis revealed statistically significant increases in the percent female over time in the entire data set, but when each survey was considered individually, significant increases were observed only in MA and the MWRA datasets, while no significant temporal trends were observed in the CT, ME/NH, or RI datasets, and a significant decrease in percent female flounder in this size was observed in the NJ and Georges Bank datasets. Further analysis will be needed to identify probable causes for these trends, but given the strong dependency of sex ratio on size and hence age, environmental factors, predator prey relationships, and fishing pressure are all likely to play a role.

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Evidence of Spatiotemporal Skew in the Sex Ratio of Winter Flounder in Narragansett Bay, Rhode Island

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Sex-specific life history characteristics and spatial distributions are viewed as important considerations for the understanding of fish population dynamics. Although the sex ratio for many populations is expected to be relatively invariant, recent evidence suggests that this assumption is not always accurate. Winter flounder (*Pseudopleuronectes americanus*) in Southern New England and the Gulf of Maine, for example, have been observed to exhibit strongly female-skewed sex ratios around spawning that are not present during other seasons. In addition to this pattern, however, data from the University of Rhode Island Graduate School of Oceanography weekly fish trawl survey in Narragansett Bay, Rhode Island (1985-present) indicate further variability in the recorded sex ratio of this species over spatial, seasonal, and inter-annual scales that have not been previously described. Specifically, fluctuations have been documented within individual years by season and survey station as well as over multiple years, where a significant masculinization of the population appears to have occurred during the past decade. This study uses statistical models to investigate these patterns in an attempt to identify underlying causes influencing the sex ratio of the winter flounder population in Narragansett Bay. These sources of variation will then be combined with historic flounder abundance in this area and further examined for linkages, either through causation or correlation, to their long-term decline. Ultimately, improved understanding of the sex composition of this depleted population will allow for more informed management measures designed to mitigate harvest pressure and promote recovery.

Surviving Their First Summer: Winter Flounder Mortality and Growth in Long Island Bays

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Winter flounder (*Pseudopleuronectes americanus*), a coastal finfish species of economic and cultural importance, have declined to less than 11% of their historic abundance in the Southern New England/Mid-Atlantic region of the United States. Post-settlement mortality is thought to be a critical bottleneck to the recovery of winter flounder populations in NY coastal waters. Possible drivers of mortality include predation and sub-optimal water quality conditions over the first summer of their juvenile estuarine residence. To evaluate these threats, young-of-the-year (YOY) flounder were collected from four sites along the south shore of Long Island from May through August in 2016 including Jamaica Bay, Moriches Bay, Shinnecock Bay, and Napeague Harbor. These sites have varying degrees of urbanization and contaminant loadings which decrease from the extreme west to eastern end of Long Island. We compare survey-based indices of post-settlement mortality in these bays, determining that Shinnecock Bay had the greatest survivorship. In Shinnecock Bay, YOY flounder were collected at early settlement and kept in predator-exclusion cages at three sites from June until early September. Dissolved oxygen, temperature and salinity were monitored continuously at each site and we compared mortality rates of caged fish to wild fish from the co-located weekly trawl survey. Survivorship in caged flounder exceeded that observed in wild caught fish. Comparisons among sites within Shinnecock Bay highlight the importance of environmental conditions to growth rate and survivorship in experimental cages. Results of this study will inform potential restoration efforts for winter flounder in Long Island bays.

Fecundity of Winter Flounder (*Pseudopleuronectes americanus*) in US Waters: Analysis of Geographic, Environmental, and Physiological Drivers

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The autodiametric (AD) method has streamlined the acquisition of annual fecundity data for winter flounder across multiple stocks. This method automates the measurement of mean oocyte diameter (OD) for a subsample, which is converted to oocyte density (number/ g ovary) and scaled up to total fecundity. Recent analyses of winter flounder fecundity have demonstrated 1) significant stock and year effects, and 2) the utility of modeling approaches that include aspects of the AD method (mean OD) along with physiological and condition metrics in lieu of stock and year effects. Here, we expand on these efforts to develop predictive fecundity models that include environmental (temperature, chlorophyll a, and primary productivity) drivers. Fecundity data over 5 years and across three stocks (Gulf of Maine, Georges Bank, and Southern New England Mid-Atlantic) was modeled using generalized additive models (GAMs). Winter flounder are total spawners, releasing the entire annual clutch of eggs in a brief period, following almost 12 months of development. As such, their fecundity is thought to be related to their condition prior to the time of sampling for fecundity. Although the fecundity of individuals is determinable, their prior condition is unknown; therefore we explore the utility of environmental variables at/over various prior periods as predictors of annual fecundity. Time lags in environmental variables greater than the period of oocyte development (~1 year) could indicate longer term flow of productivity up through the food chain to impact fish condition, while shorter time lags would indicate the importance of conditions during oocyte development.

Diversity and Species Richness of Tonguefishes (*Pleuronectiformes: Cynoglossidae*) in Chinese Waters

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According to recent estimates, the systematic diversity of the Pleuronectiformes includes approximately 164 species of tonguefishes (Cynoglossidae). This represents about 20.0% of the total diversity of the world's flatfishes. The Cynoglossidae comprises three genera, *Symphurus*, *Cynoglossus* and *Paraplagusia*. Members of *Symphurus* live from temperate to tropical waters worldwide. In contrast, species of *Cynoglossus* and *Paraplagusia* live mostly in subtropical and tropical waters. Species of *Paraplagusia* occur in the Indian and western Pacific oceans; members of *Cynoglossus* occur in the eastern Atlantic to Indo-West Pacific oceans. All three genera are found in Chinese waters (including Taiwan), and are diverse with about 47 nominal species known from this region. Of these, 14 valid species have been described from waters off China, while another 23 valid species also occurring in China were described from specimens collected in different countries. Based on present estimates, approximately 37 valid species are known to occur in coastal waters of China. The species of Cynoglossidae found in Chinese waters represent over 24.7% of the total (worldwide) species diversity of this family. The majority of tonguefish species occur in the eastern and southern coastal waters of China; relatively few species are found in northern (cooler) environments. Species richness in these waters undoubtedly is influenced by the extensive (nearly 18000 km) coastal margin of mainland China that ranges through different biogeographical provinces, including temperate, subtropical and tropical provinces. These regions have diverse benthic and hydrological environments, which also influence the species diversity of Cynoglossidae living there.

Nearshore Sex-specific Dynamics of the Summer Flounder (*Paralichthys dentatus*) in Rhode Island Waters

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The summer flounder, *Paralichthys dentatus*, supports the most economically valuable fishery in the state of Rhode Island. Documented long-term increases in abundance of *P. dentatus* in Narragansett Bay may benefit the local economy, but may negatively impact resident prey and competitor species. In addition to such ecological consequences, management of summer flounder is complicated by sexually dimorphic growth and sex-specific spatial distributions. These sex-specific dynamics together may increase the risk of disproportionate removal of females via fishing and diminish the reproductive capacity of the population. Specifically, females are believed to significantly outnumber males in inshore areas, where fishery dependent and independent data are generally lacking.

To determine nearshore sex-driven population dynamics of summer flounder in Rhode Island waters, specimens were collected on the University of Rhode Island weekly fish trawl and Rhode Island Department of Environmental Management monthly fish survey between April and October. Individuals were then dissected to determine their sex and gut content. The proportion of full stomachs was analyzed between the sexes to identify differences in feeding behavior, which could render differential vulnerability to the inshore recreational hook-and-line fishery. To investigate and characterize spatial sex segregation in *P. dentatus*, relationships between total length and sex were examined, along with differences in sex ratios between sampling locations. Our findings indicate that summer flounder larger than the minimum legal size for recreational harvest are predominantly female, and that sex ratios exhibit significant spatial trends within Rhode Island state waters. These results suggest the importance of incorporating sex-specific dynamics into management strategies for summer flounder in inshore waters throughout their range.

Prey Consumption and Repeatability of Performance in Winter Flounder

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Understanding the pattern and sources of variation in fish performance under a given set of environmental conditions is critical for predicting the consequences of this variation and its relationship to a population's adaptive potential. Although inter- and intra-individual variation underpins many ecological and evolutionary inferences, these sources of variation and even the distinction between them are often overlooked in ecological studies. Knowledge of the variance structure in life-history and performance traits for at-risk life-stages is particularly important when predicting effects of large-scale environmental processes like climate change and ocean acidification. We used laboratory experiments to assess the role of inter- and intra-individual repeatability of performance by young winter flounder, *Pseudopleuronectes americanus*, an ecologically and economically important flatfish from Atlantic coastal habitats. The consumption rate of recently metamorphosed winter flounder was quantified by using a one-on-many predator-prey trial protocol. Short-term (6 hr) trials were run to quantify individual consumption rates then run again on the same individuals after a brief (2 d) interlude. In addition, repeated trials were also run after a longer interval (10 to 40 d) in order to evaluate longer term consistency of performance. Although age accounted for most of the inter-individual variation in prey consumption across the longer intervals, a significant amount of variance in performance was unexplained at all interval durations and is attributed to intra-individual variability in performance. Our analyses allow for a more insightful inspection of the sources and therefore potential consequences of phenotypic variation and can help optimize future experimental designs.

Ebb Light, Flood Light: Red Light, Green Light for Larval Flatfishes

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Larvae of some flatfish species use selective tidal stream transport to travel into and/or remain in small estuarine creeks. In this K-12 activity, students play the game "Red Light, Green Light" to learn about how larval flatfishes use their position in the water column, as well as tides and currents, for movement within an estuary. Students put this knowledge to practice by drawing pictures and answering questions about larval flatfishes and their movement. Flatfishes are an interesting topic for K-12 activities because of their unusual shape and they can be used to teach students about habitat utilization and ecology; we will share some other example lessons during the presentation. This activity addresses the Next Generation Science Standard of using a model to show the relationship between animals and their habitat.

Diet and Trophic Dynamics of Summer Flounder (*Paralichthys dentatus*) in Shinnecock Bay Based on Stomach Content Analysis

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Diets of 72 summer flounder (*Paralichthys dentatus*), that had been collected as part of the annual Shinnecock Bay bottom trawl survey, were examined during June to October of 2014 and 2015. The gut content of collected specimens (89-650 mm) was weighted and classified to the lowest taxon possible. The intensity of feeding was estimated using the stomach fullness index (SFI%) and the diet composition was calculated as the percent by weight of prey item (Wp). SFI% was on average higher on the eastern side of the bay and in areas characterized by seagrass habitat. SFI% variations were highly correlated with temperature changes. These results indicate that summer flounder feeding intensity follows prey availability and thus, it is ultimately regulated by water quality, habitat type and temperature. The prey item most consumed by summer flounder was the winter flounder (*Pseudopleuronectes americanus*; 11.32 ± 0.55%), followed by sand shrimp (*Crangon septemspinosa*; 8.60 ± 0.57%) and unknown fish (8.12 ± 0.38%). Ontogenic changes in diet composition were apparent, with smaller summer flounder targeting sand and mysid shrimp and piscivory importance increasing with specimen age/size.

The How and Why of Size Dimorphism in Flatfishes: A Review

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Sex-specific secondary characters are widespread in animals, as evident in our backyards (e.g., colors [dichromism] of mature songbirds) and in popular culture (e.g., dimorphism in body size and horns of rutting mammals). They are also common in aquatic animals and take many forms in fishes. Sexual dimorphism is evident in flatfish. It occurs, for example, in sex-specific scale or fin morphology. Size dimorphism, which is the focus of this review, is particularly well documented. As stated by Joseph Cunningham (1900), in his neo-Lamarkian treatment of *Sexual Dimorphism in the Animal Kingdom*, "the [flatfish] males are invariably smaller than the females." The recent, 2nd edition (2015) of 'Flatfishes: Biology and Exploitation' provides a number of additional examples of sexual dimorphism, particularly for species in the eastern North Atlantic Ocean and China. I will demonstrate this is (unsurprisingly) true for flatfishes on the western side of the North Atlantic Ocean, specifically with data from the Northeast Fisheries Science Center's trawl survey. I survey a number of selection processes (sexual, fecundity, and natural selection) that support size dimorphism in fishes and evaluate these in the context of flatfish ecology and evolution.

Preliminary Evaluation of Variable Pigmentation Features Observed in Populations of the Fringe-lip Tonguefish, (*Paraplagusia japonica* [Temminck & Schlegel 1846]), Inhabiting Coastal Waters of China (*Pleuronectiformes: Cynoglossidae*)

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Previous descriptions of *Paraplagusia japonica* (Temminck & Schlegel 1846*)* concentrated more on meristic characters than on features of their coloration. According to earlier records, populations from Japan (type locality) compared with those from China possess different background coloration on their ocular side (OS). In Japanese populations, adults feature dark-brown background coloration with small black spots and blotches. Juveniles (<130 mm SL) have the OS brown with numerous roundish or elliptical light-brown blotches, which disappear in adults. In contrast, adult *P. japonica* from coastal waters off Shanghai, Zhejiang, Guangxi and Guangdong, China, have very different yellowish-brown or greenish-brown background coloration. To determine if these various pigmentation features have taxonomic significance, this study analyzed morphological and genetic characters of specimens identified as *P. japonica* collected from fish landing ports located in north to south coastal regions of China. Three distinctively different color patterns (black spots; pale ocelli; pale ocelli and black spots) were present on the OS body of both adult and juvenile of *P. japonica* from these collections. Traditional morphological characters and molecular fragment methods indicate these populations overlap in morphological characters and also have a similar COI fragment (Genetic distance: 0–0.4%). Therefore, preliminary data confirm that populations in coastal waters of China, tentatively identified as *P. japonica* but possessing different pigmentation features, are the same species as that occurring in waters of Japan, Korea and Taiwan. Based on results of this study, it is important to use caution when considering pigment features as diagnostic characters to distinguish species of *Paraplagusia.*

Indications that Winter Flounder Are Spawning Offshore in the Southern Gulf of Maine

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It has long been thought that Gulf of Maine (GOM) winter flounder (*Pseudopleuronectes americanus*) migrate inshore into shallow bays and estuaries to spawn, followed by a return to offshore areas. In the past 10 years, several studies have shown that GOM winter flounder are not estuarine dependent for spawning. Furthermore, it appears that these fish may spawn in much deeper and offshore waters than previously known. Three areas in the southwestern GOM (southern Jeffrey's Ledge, southwest of Tillies Bank, and the southwest corner of Stellwagen Bank), identified by commercial fishermen as locations where adult winter flounder are present during the spawning season, were studied from March to May 2016 to evaluate the reproductive status of winter flounder. A total of 1,383 winter flounder were caught by trawl in 70 30-minute tows using standard legal groundfish gear. All captured winter flounder were measured, tagged, and sex and reproductive condition (developing, ripe, running ripe, spent, or recovering) determined, if possible. Generally, in all three sites, the proportion of developing and ripe females decreased by May. Conversely, the proportion of spent and recovering females increased from March to May. Catch-per-unit-effort of winter flounder decreased over time, and there were indications that fish were moving east and inshore from the study areas. Given that peak spawning occurs in April in these areas, by May, winter flounder likely were shifting from spawning to feeding areas.

The Importance of the Saco River Estuary to Winter Flounder (*Pseudopleuronectes americanus*) Life Stages

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Due to the effects of overfishing and habitat loss, winter flounder stocks have drastically declined since the 1980's. Although strict fishing regulations have stabilized populations, they are still below sustainable harvesting levels. In order to better manage and further promote the rebuilding of winter flounder stocks, essential fish habitat (EFH), such as nursery grounds and spawning areas, need to be identified. While previous EFH have been documented in the southern most US range of the species, very little information has been gathered in their northern most US range. Previous studies have suggested the Saco River estuary system (SRES), in southern Maine, has the potential to serve as a nursery ground for winter flounder based on the presence of YOY and juvenile individuals. However, the extent to which winter flounder utilize the SRES needs to be addressed. In order to assess the importance of this northern estuary to winter flounder, a multifaceted study was initiated in 2016. Thus far, a total of 61 beach seines and 17 otter trawls have been conducted between May and August. Fish captured ranged in size from 25mm-400mm TL. Flounder captured in seine nets had an average total length of 53.3mm ± 25mm, while flounder captured by otter trawling averaged 156.8mm ± 80mm. These methods yielded CPUE's of 0.3115 (fish/seine) and 0.15044 (fish/minute towed) respectively. Based on the wide size distribution range of sampled specimens, it would appear that this estuary not only has value as a nursery ground, but for other life history stages as well.

Session VI *10:40 a.m.*

Burial Performance in Flatfishes among Species, Size Classes, and Grain Size

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A key feature in the biology of flatfishes is the ability to bury beneath the sediment to hide from predators. Burial behavior is likely a determining factor in substrate preference among different species and size classes of flatfishes, which has implications for ecology and fisheries management. For our studies, we used high-speed video to record kinematics of burial, including frequency of body undulations and duration of burial behavior. We quantified performance by measuring percent surface area covered by sediment at the end of burial. In our first set of experiments, we studied burial performance in five species found in the San Juan Islands in Washington State. While most species showed very similar burial performance, we found an increase in sediment coverage with increased undulation frequency among species. We used a physical model of flatfish burial to show that body undulations alone are sufficient for burying (although they are augmented by fin flicking in living fishes) and that there is an optimal range of undulation frequency. In our second study, we looked at scaling of burial kinematics in English Sole (*Parophrys vetulus*) by recording burial of individuals over a range of body sizes and a range of sand grain sizes. We found that larger individuals took longer to bury and undulated at lower frequencies, but covered themselves equally as effectively as small individuals. Burial performance (percent sediment coverage) decreased with increasing particle size.

Nursery Habitat Quality for Winter Flounder (*Pseudopleuronectes americanus*) Linked to Soil Chemistry, Geology and Climate Factors – A Review of the Literature

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It has been a half century since Saul Saila (1962) reported winter flounder tagging studies for Rhode Island Salt ponds – Charlestown (Ninigret) and Green Hill. At that time, Saila estimated that 25% of the Block Island Sound winter flounder fishery came from shallow water "nursery" habitats contained in these two salt ponds. According to Saila and others, these glacial tidal lagoons and kettle holes, once connected to the sea, provided key habitat for winter flounder including spawning adults and young of the year (YOY).

Most of the habitat studies that followed looked at winter flounder behavior, movement, reproductive capacity, growth, entrance into capture fisheries, as well as pollutant impacts (Lee 1980, Crawford 1990). Few researchers looked at coastal marine soil characteristics of ground water/oxygen exchange, soil and pore water chemistry or the impact of bacterial sulfate reduction and geochemicals -biochemicals such as aluminum, ammonia and sulfides and possible effects on winter flounder.

Shallow water estuaries are recognized as those most susceptible to climate and energy cycles (Quiatt 2004, Brodziak and O'Brien 2005, Li and Shackell 2012). Recent investigations have highlighted the significance of the climate pattern called North Atlantic Oscillation (NAO). This climate feature describes both a negative and positive phase dependent on the position of the semi-permanent low pressure system located off Iceland. A negative phase in New England and Polar Vortex (Willett 1953) typifies cooler than average temperatures with increased storm frequency and intensity.

In the ten years prior to the Saila study, the southern coast of Rhode Island experienced impacts from six hurricanes. Marine soils in these areas could be described as cultivated or worked by energy (waves tides, currents) generated by these storms. In the 1990s and later, the dominant pattern was a positive NAO phase, consisting of warmer conditions and fewer storms, resulting in changes to marine soils and chemistry. These changes may have repercussions for winter flounder which are site-specific, living in close association with sediments. Marine soil chemistry may provide some answers to important questions regarding winter flounder habitats.

Ocean Acidification Effects on Early Life-Stages of Winter Flounder

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The early life-stages (ELS) of some marine fish are sensitive to elevated levels of CO_2 occurring now and especially to levels that are expected to be ever more common as excess atmospheric CO_2 is absorbed by ocean waters. The effects of ocean acidification (OA) vary across species and during ontogeny with the ELS being most sensitive. Evidence is also accumulating of variation in OA effects between habitats and populations of the same species. We have conducted experiments on multiple populations of winter flounder (*Pseudopleuronectes americanus*) in which ELS (gametes, embryos, and larvae) were exposed to multiple, constant pCO_2 and temperature levels. We evaluated a range of responses (e.g., fertilization rates, survival, size, condition, development, and prey consumption) of winter flounder offspring from different source habitats including ones where adults spawn inshore (southern Gulf of Maine, Mid-Atlantic Bight) and offshore (Stellwagen Bank), and predicted that offspring of inshore-spawning fish would be more tolerant of elevated water acidity than those that spawn in more stable offshore waters. Our results show direct effects of elevated pCO_2 on fertilization rate with some inter-population differences, and effects on developmental rate through the larval period. These results will be contrasted with results from our lab on another flatfish, summer flounder (*Paralichthys dentatus*) that spawns exclusively in offshore waters. Intra- and interspecific differences in response to variations in ocean chemistry during these ELS may affect a population's ability to adapt and persist in habitats predicted to result from near-future climate change.

Reflections on Over 40 Years of Flatfish Seine Surveys and Future Research Survey Needs

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Seine surveys for juvenile flatfish are used by many states to monitor recruitment along the eastern US coast each year. Massachusetts' Division of Marine Fisheries conducts a seine survey with a 41 year time-series in six estuarine systems. The survey utilizes a stratified fixed station design and encounters natural processes or coastal development projects that compromise the consistency of fixed stations. Replacement of stations that become unfit for sampling is necessary at times, although a rare occurrence overall. Stratified random sampling would be a great improvement to current survey design, but proves to be difficult to implement due to a lack of potential sampling sites in the survey area. We present a comparison of spatial and ecological factors germane to seine and trawl surveys to consider when designing a new survey and evaluate the efficacy of the new design. We desire to learn more from those that use beam or small otter trawls in similar systems that have mooring fields and dense human development along the shores. It is our hope to develop and test a new sampling effort using these methods. We look forward to input from those who have conducted similar work.

Comparison of Young-of-the-Year Winter Flounder Abundance in 1988-1990 and 2013-2015 at Connecticut Beach Sites

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Six coastal sites sampled monthly June-September in 1988-1990 were resampled in 2013-2015 to examine changes in the seasonal timing of recruitment of winter flounder to Connecticut's prime nursery areas. For both sampling programs, an eight-meter (25 ft.) bag seine with 6.4mm (0.25 in.) bar mesh was used. Area swept was standardized to 4.6 m (15 ft.) width by means of a taut spreader rope and a 30m (98 ft.) measured distance. At each site, six seine hauls are taken within two hours before and after low slack tide during daylight hours. Finfish and macro-invertebrates taken in each sample were identified to species or lowest practical taxon and counted. Additionally, winter flounder were measured to total length (mm) and classified as young-of-year (YOY) if less than 12 cm and age 1+ if 12cm or larger. The age of flounder near this size was verified in 1990-1992 by examination of the sagittal otolith.

Although abundance in June was similar for both time periods, attrition from July-September in 2013-2015 was more than five times greater (slope= -0. 66, r^2=0.99) compared to the same months in 1988-1990 (slope = -0.11, r^2=0.98). This increasing decline in abundance over the summer months reduced moderate June abundance to extremely low abundance recorded in September 2013-2015. The average size of YOY winter flounder captured in June 2013-2015 (mean=39.8mm, SE=5.9) was smaller than those captured in June 1988-1990 (mean=43.7mm, SE=5.7), but this 9% decline was not statistically significant due to the large variance in the data. Average size of juveniles captured in September in the later years were also smaller on average than in the earlier period (57.2mm, SE=6.3 versus mean 60.6mm, SE=4.0, respectively) but again the two data sets are not statistically distinguishable. The decline in abundance is consistent with increased predation exposure in this vulnerable size class, especially with no evidence of an increase or decrease in growth. This population may be responding to an increase in the abundance of predatory or competitive mid-Atlantic species brought about by increasing water temperature. These second order effects may have chronically hindered stock rebuilding over the last decades.

Abstracts

Poster Presentations

Protecting Winter Flounder in NY/NJ Harbor Using Long-Term Fishery Resource Data: Past, Present, and Future

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The US Army Corps of Engineers, in partnership with the Port Authority of New York and New Jersey, has completed the congressionally authorized Harbor Deepening Project (HDP). The scale of the HDP required extensive interagency coordination to ensure that environmental impacts were minimized. Prior to construction, knowledge gaps related to the protection of biological resources in the Harbor were identified with NOAA, and the states of New York and New Jersey. Long-term sampling programs were established to ensure sustainability of key habitats in the harbor. The Aquatic Biological Survey (ABS) was developed to assess the seasonal distributions and abundances of aquatic species with a focus on winter flounder. Initiated in 1998, the ABS has characterized winter flounder essential fish habitat (EFH) using systematic ichthyoplankton and trawling surveys. The ABS program has improved our understanding of when and where winter flounder eggs and larvae are present in the harbor and how their presence is related to environmental factors. Because all winter flounder life history stages are demersal, they are susceptible to benthic impacts, such as dredging. A harbor wide dredge-plume characterization study was conducted to quantify spatial scales of potential impacts. Investment in these long-term studies has provided enhanced and more effective resource protection within the harbor as dredging requirements transition from deepening to maintenance of the navigation infrastructure.

Effects of Maternal Investment on Anti-Predator Behavior of Larval Southern Flounder, *Paralicthys lethostigma*

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Docosahexaenoic acid (DHA, 22:6(*n*-3)) is an essential fatty acid that is critical for the normal development of neural and visual systems in fishes. Marine fishes are not able to synthesize DHA, so developing embryos and newly hatched larvae rely on nutrients supplied in the yolk, which ultimately come from the maternal diet. Recent studies of red drum have demonstrated behavioral effects on larvae due to variations in maternal investment of eggs with DHA. The objective of this study was to determine whether a similar response occurs in Southern flounder, *Paralichthys lethostigma*. DHA content of spawns was measured and spawns were divided into low (<30 mg/g DW) and high groups (>35 mg/g). Larvae were reared on a common diet and behavioral performance was measured as routine swimming speed, routine swimming path tortuosity, and responsiveness to a visual predatory stimulus at 15 and 35 days post-hatching (dph). At 15 dph, larvae from eggs containing higher levels of DHA were significantly more responsive (mean = 34% responding) to the visual predatory stimulus than larvae from eggs containing lower levels of DHA (mean = 10% responding). However, there was no difference in responsiveness of larvae at 35 dph. At 35 dph, larvae from eggs containing higher levels of DHA swam along significantly straighter paths (tortuosity = 0.27) than larvae from eggs containing lower levels of DHA (tortuosity = 0.14). These preliminary results suggest that variations in maternal diet that alter egg DHA levels can affect foraging and anti-predator performance of larvae, and possibly their survival.

Foraging Ecology of Blue Crabs (*Callinectes sapidus*) and Their Potential Impact on Winter Flounder (*Pseudopleuronectes americanus)*

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The blue crab, *Callinectes sapidus*, is a temperate species that is expanding its geographic range northward, thus possibly altering benthic community structure in Southern New England waters. This study examined the potential impact of blue crabs on local fauna by analyzing their abundance, size-structure, and diet. Potential crab predation on winter flounder, *Pseudopleuronectes americanus*, was of particular interest due to locally declining populations of this flatfish species. Crabs were collected from the Seekonk River (RI) and Taunton River (MA) from May to August 2012-2016, and subsequently preserved in 95% ethanol. In the laboratory, crabs were measured for carapace width, and prey contents were extracted from stomachs and identified to the lowest practical taxon. Crab abundance exhibited both spatial and temporal variations in the rivers, but overall estimates were consistent with southern Mid-Atlantic populations. Moreover, decomposition of crab length-frequency distributions revealed three distinct cohorts, suggesting that multiple life history stages utilize the riverine habitat. Direct visual analysis of stomach contents indicated that crabs undergo ontogenetic dietary shifts. The main prey of small crabs were crustaceans (e.g., amphipods/isopods, shrimp, and crabs), whereas larger conspecifics preferentially consumed bivalves. There was also evidence of crabs consuming fish, including winter flounder, with rates of predation positively related to predator-prey size ratios. The incidence of crab predation on flounder was minimal, however, and thus crabs may not be an important source of mortality for juvenile flounder.

Acoustic Tracking of Southern Flounder (*Paralichthys lethostigma*) in the Charleston Harbor System

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Southern flounder is an economically important fish in the southern US Atlantic and Gulf of Mexico coastal regions, but population numbers are declining. Genetic and morphometric studies have shown that the Atlantic population is distinct from the Gulf of Mexico population, but there is little evidence of stock structure along the Atlantic coast due to extensive mixing (North Carolina to eastern Florida). At present, fisheries within the Atlantic are managed separately by individual states, but there is increasing pressure for an integrated single stock approach. There is, however, a lack of basic information on regional fish movement and mortality patterns.

The aim of this study was to address these research requirements by tracking the movement and fate of individual southern flounder using acoustic telemetry. We first tested several methods of acoustic tag attachment to optimize fish survival and tag retention. We found that most fish (95 %) survived tagging at water temperatures below 25^{o}C, but survival was poor (40-85 %) at higher temperatures. Also, fish with surgically implanted tags had better tagging recovery and tag retention than those with externally attached tags. After optimizing tag attachment, we released 119 acoustically tagged southern flounder (>275 mm total length) into the Ashley River (Charleston, South Carolina) and are currently tracking fish movement using a combination of fixed receivers and active tracking. Preliminary movement results show that 96% of the fish have been detected, 88% fish stayed within the river of release, and 12% moved into the Atlantic Ocean in the fall months.

Spatial Distribution of Larval Winter Flounder as a Proxy for Habitat Use in a Warming Ocean

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Sex-specific life history characteristics and spatial distributions are viewed as important considerations for the understanding of fish population dynamics. Although the sex ratio for many populations is expected to be relatively invariant, recent evidence suggests that this assumption is not always accurate. Winter flounder (*Pseudopleuronectes americanus*) in Southern New England and the Gulf of Maine, for example, have been observed to exhibit strongly female-skewed sex ratios around spawning that are not present during other seasons. In addition to this pattern, however, data from the University of Rhode Island Graduate School of Oceanography weekly fish trawl survey in Narragansett Bay, RI (1985-present) indicate further variability in the recorded sex ratio of this species over spatial, seasonal, and inter-annual scales that have not been previously described. Specifically, fluctuations have been documented within individual years by season and survey station as well as over multiple years, where a significant masculinization of the population appears to have occurred during the past decade. This study uses statistical models to investigate these patterns in an attempt to identify underlying causes influencing the sex ratio of the winter flounder population in Narragansett Bay. These sources of variation will then be combined with historic flounder abundance in this area and further examined for linkages, either through causation or correlation, to their long-term decline. Ultimately, improved understanding of the sex composition of this depleted population will allow for more informed management measures designed to mitigate harvest pressure and promote recovery.

A Preliminary Re-evaluation of Atlantic Halibut Life History in the Western Atlantic

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Atlantic halibut (*Hippoglossus hippoglossus*) are considered a single stock in the western Atlantic based on extensive migratory patterns and a lack of genetic structure. Abundance trends are increasing but abundance is still considered low in the US EEZ – supporting listing it as a species of concern under the Endangered Species Act. The demographics and reproductive potential of this stock, both key components for assessing recovery, are poorly known. Atlantic halibut grow to approximately 100 cm in 8-10 years, after which growth slows considerably. Aging methods using otolith thin sections, which we employ here, have been validated up to 50 years. Spawning in the Gulf of Maine has been reported, but spatially-explicit data are largely historic and anecdotal, and very limited data exist using gonad histology, which we pursue here. In response to this, 90 Atlantic halibut samples have been collected from two seasons and three years (spring, autumn; 2014-2016) by two sampling programs: the Northeast Fisheries Science Center bottom trawl survey and the Northeast Cooperative Research Program bottom longline survey. Preliminary results from these samples will be based on fish ages 1-11 years, including immature and mature specimens of both sexes. Fish under 100 cm are well represented while larger fish make up a small portion of the sample. These samples and preliminary data are only the beginning; they will also be included in a newly-funded Saltonstall-Kennedy project. This new study will combine tagging and life history approaches to estimate vital rates and examine the nature of meta-population structure of Atlantic halibut.

Determining Natal Sources of Adult Winter Flounder in the Gulf of Maine and Southern New England/ Massachusetts Stocks

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Trace metal chemical signatures of winter flounder (*Pseudopleuronectes americanus*) are being utilized to identify the natal areas of adult fish caught from offshore locations. Pilot studies indicate there are discernable differences in young-of-the-year (YOY) otolith trace metal compositions between estuaries. These signatures are site specific, in a range of 5-10 km. As otoliths are biologically inert, the otolith core signatures of adult fish could be compared to signatures of a known nursery to identify an individual's origin. For this study, YOY specimens from 15 estuaries ranging from New Jersey to Maine and adults of unknown natal origin, caught in multiple offshore locations in the GOM and SNE/MA management areas, prior to spawning season, are being examined. Right sagittal otoliths are being analyzed for trace metal composition. Left sagittal otoliths are being analyzed for age verification and stable isotope analysis of δ13C and δ18O. Using the signatures from the Bailey et al. (2012) study, annual variability of natal estuarine signatures will be checked. After assessing the annual variability from the pilot study signatures to newly collected samples, temporal variation and trends may be identified in some estuaries and used to identify the sources of adults. If successful, the natural, lifelong available natal signature can be used to identify which estuaries yield better recruitment and from which specific year classes. This information can in turn be used for a variety of stock management methods such as protecting successful estuaries or providing mitigation and recovery efforts to less successful estuaries.

Preliminary Otolith Analyses Indicate Potential Spawning Diversity and Fine-scale Population Structure in Winter Flounder (*Pseudopleuronectes americanus*)

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Winter flounder (*Pseudopleuronectes americanus*) has declined precipitously over the past 30 years in the coastal bays of Long Island, NY. Lack of recovery is highlighted by a decline in stock productivity and a recruitment bottleneck, whereby strong year-classes undergo high mortality and fail to recruit into the population. Several hypotheses have been proposed to explain this bottleneck: (1) climate change is imposing physiological constraints due to rising water temperatures, (2) rising temperatures have amplified young-of-the-year (YOY) predation through increased spatial and temporal overlap of predators and YOY winter flounder, and (3) metapopulation dynamics and/or localized population structuring exist in the population, yet are not accounted for by management. Using catch data from a 2016 1-meter beam trawl survey in Shinnecock Bay, NY, bimodality was observed in the length distribution, suggesting two separate spawning events. Divergent spawning events could be the result of variable spawning times with (1) age or (2) contingent structure in the population (existence of resident and migrant subgroups, termed partial migration). To explore these hypotheses, otoliths from YOY fish collected in the survey were aged to estimate hatch date and infer spawning events for the two modes evident in the catch data. These calculated spawning times will be used to sample spawning adults and test hypotheses associated with the divergent spawning modes. Finally, using archived adult otoliths, profile analyses of strontium, barium, and calcium were conducted via laser ablation-inductively coupled plasma-mass spectrometry to generate preliminary data and explore the possibility of detecting partial migration.

Age Determination of Georges Bank Windowpane Flounder (*Scophthalmus aquosus*) Using Otoliths

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The windowpane flounder stock assessment could be improved by using an age-based model. However, historical age determinations were limited in number and based on scales, which were never validated. With this in mind, a new ageing methodology was developed. We present a protocol for ageing this species using otoliths. Windowpane otoliths were aged whole and immersed in liquid. The left otolith is longer, and seems to show better resolution along the rostrum; however, the right otolith may have fewer checks. For large fish with thick otoliths, the right otolith was sliced longitudinally to view the internal structure. All samples were aged at least twice, and, if these ages disagreed, a third examination attempted to resolve the first two ages. Precision tests were used to measure repeatability of ages. Thus far, otolith ages have been determined for Georges Bank fish from six NEFSC autumn surveys across 14 years. Initial results indicate that windowpane flounder live up to 11 years. Growth was consistent across the years examined, with females growing faster and to larger sizes than males.

Relative Risk and Benefit of Consuming Two Southern New England Flatfish Species

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Marine fish are an excellent source of omega-3 fatty acids (n3) that provide numerous health benefits to human consumers. Conversely, fish-derived omega-6 fatty acids (n6) are pro-inflammatory and may adversely affect human health. Moreover, some fish may have sufficiently high concentrations of toxicants that that pose risk to human health (e.g., mercury, Hg). In this study, fatty acid profiles (n3 and n6) and Hg concentrations were measured in two commonly consumed flatfish species (winter flounder *Pseudopleuronectes americanus* and summer flounder *Paralichthys dentatus*) to evaluate their relative health benefit-risk for human consumers. These data were then compared to other important fisheries, including black sea bass *Centropristis striata*, striped bass *Morone saxatilis*, scup *Stenotomus chrysops*, and bluefish *Pomatomus saltatrix*. Omega-3 fatty acid percentages were significantly higher in both flounder species relative to black sea bass and scup (SF = 31.1%, WF = 26.3%, BSB = 12.1%, SCP = 8.3%). Further, ratios of omega-6-to-omega-3 (n6:n3) fatty acids were reduced in flounder and striped bass (n6:n3 = 0.14-0.23) in comparison to scup, bluefish, and black sea bass (n6:n3 = 0.30-0.36); suggesting the former species provides greater health benefits for human consumers. Mean (± 1 standard deviation) Hg concentrations were significantly lower in winter flounder (0.060 ± 0.076 ppm) and scup (0.109 ± 0.072 ppm), followed by summer flounder (0.124 ± 0.0697 ppm), black sea bass (0.155 ± 0.091 ppm), bluefish (0.194 ± 0.099 ppm), and striped bass (0.269 ± .164 ppm). The cumulative results indicate that winter flounder and summer flounder are optimal choices for human consumption given their preferred fatty acid profiles and relative low Hg contamination.

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