Northeast Fisheries Science Center Reference Document 08-19

11th Flatfish Biology Conference
Program & Abstracts

December 3-4, 2008
Water's Edge Resort, Westbrook, CT

by Conference Steering Committee: Renee Mercaldo-Allen (Chair),
Anthony Calabrese, Donald Danila, Mark Dixon, Ambrose Jearld,
Thomas Munroe, Deborah Pacileo, Chris Powell, and Sandra Sutherland

November 2008

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08-12 *47th SAW (a) Assessment Report and (b) Appendixes*, by the 47th Northeast Regional Stock Assessment Workshop (47th SAW). July 2008.

08-13 *Predicted Habor Porpoise Bycatch under Potential Mitigation Measure Scenarios*, by DL Palka and CD Orphanides. August 2008.

08-14 *Predicted Bycatch of Harbor Porpoises under Various Alternatives to Reduce Bycatch in the US Northeast and Mid-Atlantic Gillnet Fisheries*, by DL Palka and CD Orphanides. In press.

08-15 *Assessment of 19 Northeast Groundfish Stocks through 2007: A Report of the 3rd Groundfish Assessment Review Meeting (GARM III), Northeast Fisheries Science Center, Woods Hole, Massachusetts, August 4-8, 2008*, by Northeast Fisheries Science Center. August 2008.

08-16 *Assessment of 19 Northeast Groundfish Stocks through 2007: A Report of the 3rd Groundfish Assessment Review Meeting (GARM III) -- Appendixes*, by Northeast Fisheries Science Center. September 2008.

08-17 *Preparation of the Northeast Fisheries Observer Program Gillnet Data for Use in Bycatch Analyses of Protected Species*, by ML Warden and CD Orphanides. August 2008.

08-18 *A Description of the Allocation Procedure Applied to the 1994 to 2007 Commercial Landings data*, by SE Wigley, P Hersey, and JE Palmer. September 2008.

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by Conference Steering Committee: Renee Mercaldo-Allen (Chair)[1], Anthony Calabrese (retired)[1], Donald Danila[2], Mark Dixon[1], Ambrose Jearld[3], Thomas Munroe[4], Deborah Pacileo[5], Chris Powell (retired)[6], and Sandra Sutherland[3]

[1]NOAA's National Marine Fisheries Service, Milford Laboratory, Milford, CT
[2]Dominion Nuclear Connecticut, Inc., Millstone Environmental Laboratory, Waterford, CT
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[4]NOAA's National Marine Fisheries Service, National Systematics Laboratory, Washington, DC
[5]Connecticut Department of Environmental Protection, Marine Fisheries Division, Old Lyme, CT
[6]Rhode Island Division of Environmental Management, Jamestown, RI

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, Massachusetts

November 2008

Northeast Fisheries Science Center Reference Documents

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11th Flatfish Biology Conference
2008

December 3rd & 4th
Water's Edge Resort and Spa, Westbrook, CT

Oral Presentations
Salons A/B

Wednesday, December 3rd

7:30 a.m. **Registration/Coffee, Continental Breakfast**

8:30 a.m. Welcome and Introduction
Renee Mercaldo-Allen, Chair
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center
Milford, CT

Frank Almeida, Deputy Science and Research Director
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

Session I
Chris Powell, Chair
Rhode Island Division of Environmental Management (Retired)
Division of Fish and Wildlife, Marine Fisheries, Jamestown, RI

8:40 a.m. Changes in Flounder Abundance in Long Island Sound Due to Climate Change
Penny Howell
Connecticut DEP Marine Fisheries, Old Lyme, CT

9:00 a.m. Niantic River Winter Flounder Studies: Transition Between Larval and Juvenile Life Stages and Factors Affecting the Growth and Abundance of Settled Juveniles
Donald Danila and James Foertch
Dominion Resources Services, Millstone Environmental Laboratory, Waterford, CT

9:20 a.m. Otolith Growth and Development is Mediated by Thyroid Hormone in Metamorphosing Flatfish
Alex Schreiber
St. Lawrence University, Biology Department, Canton, NY

9:40 a.m. Using Acoustic Tags to Clarify Movements and Habitat Use of Cultured and Wild Juvenile Winter Flounder (*Pseudopleuronectes americanus)* in a Shallow New Hampshire Estuary
Elizabeth Fairchild, Nathan Rennels, and W. Huntting Howell
University of New Hampshire, Department of Biological Sciences, Durham, NH

10:00 a.m. **Break/Coffee/Refreshments**

Session II

Ambrose Jearld, Chair
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

10:20 a.m. Examining Weaning Success of Cultured Juvenile Winter Flounder Reared on Formulated and Live Diets
Mick Walsh, Elizabeth Fairchild, Nathan Rennels and W. Huntting Howell
University of New Hampshire, Zoology Department, Durham, NH

10:40 a.m. Seasonal Patterns of Winter Flounder (*Pseudopleuronectes americanus*) Abundance and Reproductive Condition on the New York Bight Continental Shelf
Mark Wuenschel[1, 2], Kenneth Able[1], and Don Byrne[3]
[1]Rutgers University, Marine Field Station, Institute of Marine and Coastal Sciences, Tuckerton, NJ, [2]NOAA's National Marine Fisheries Service, NEFSC/Woods Hole Laboratory, Woods Hole, MA, [3]New Jersey Department of Environmental Protection, Nacote Creek Research Station,Port Republic, NJ

11:00 a.m. Ocean Distribution Patterns in Winter Flounder: A Preliminary Analysis of the Response to Climate Change
Joan Pravatiner and Kenneth Able
Rutgers University Marine Field Station, Institute of Marine and Coastal Sciences, Tuckerton, NJ

11:20 a.m. Thermal Effects on the Ontogenetic Rates Expressed in the Early Life History of Flatfishes
Chris Chambers
NOAA's National Marine Fisheries Service, NEFSC/James J. Howard Laboratory, Highlands, NJ

11:40 a.m. Physiological Responses and Tolerances of Adult Summer Flounder (*Paralichthys dentatus*) Experiencing Hypoxia at Two Temperatures
Karen Capossela[1], Richard Brill[1], Mary Fabrizio[1], and Peter Bushnell[2]
[1]Virginia Institute of Marine Science, Gloucester Point, VA, [2]Indiana University South Bend, South Bend, IN

12:00 p.m. **Hosted Buffet Lunch**

Session III

Tony Calabrese, Chair
NOAA's National Marine Fisheries Service (Retired)
Northeast Fisheries Science Center
Milford, CT

1:20 p.m. Mercury Biomagnification and Trophic Transfer in Temperate Flatfishes
Eric Payne and David Taylor
Roger Williams University, Department of Marine Biology, Bristol, RI

1:40 p.m. Describing How Fish Use Habitat: A New Approach Using Geospatial Modeling
Jose Pereira[1], Eric Schultz[2], and Peter Auster[3]
[1]NOAA's National Marine Fisheries Service, NEFSC/Milford Laboratory, Milford, CT, [2]University of Connecticut, Department of Ecology and Evolutionary Biology, Storrs, CT, [3]University of Connecticut at Avery Point, Department of Marine Sciences, Groton, CT

2:00 p.m. Winter Flounder Habitat Use in the New York/New Jersey Harbor: What Can Eight Years of Monitoring Data Tell Us?
David Davis[1], Ronald Pinzon[2], Sarah Zappala[1], Catherine Mulvey[2], and Jenine Gallo[2]
[1]Henningson, Durham and Richardson Engineering, Inc. (HDR), Pearl River, NY, [2]United States Army Corps of Engineer –New York District, New York, NY

2:20 p.m. A Partial Recruitment History of Juvenile *Pseudopleuronectes americanus* in the Norwalk River Estuary From 1991 to the Present
Richard Harris, Gabe Rosen, Alysia Wiener, and Carly Shields
Earthplace, Westport, CT

2:40 p.m. The Reproductive Strategy and Tactics of Female Winter Flounder (*Pseudopleuronectes americanus*): A Review of Biotic and Abiotic Processes
Richard McBride, Mark Wuenschel, Grace Thornton, and Paul Nitschke
NOAA's National Marine Fisheries Service, NEFSC/Woods Hole Laboratory, Woods Hole, MA

3:00 p.m. **Refreshment Break**

Session IV

Mark Dixon, Chair
NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center
Milford, CT

3:20 p.m. Microsatellite and SNP Analyses of the Coastwide Genetic Stock Structure of Winter Flounder
Isaac Wirgin, Nirmal Roy, and Lorraine Maceda
New York University School of Medicine, Department of Environmental Medicine, Tuxedo, NY

3:40 p.m. Divergent Movement Patterns of Winter Flounder in Plymouth Bay, MA
Gregory DeCelles and Steven Cadrin
NOAA/UMass CMER, School for Marine Science and Technology, Fairhaven, MA

4:00 p.m. Predatory Impact on Young-of-the-Year Winter Flounder, (*Pseudopleuronectes americanus)*: Comparative Dietary Analysis of Common Fish Species in Long Island Waters
Skyler Sagarese and Michael Frisk
Stony Brook University, Stony Brook, NY

4:20 p.m. Consequences of Reversed Asymmetry for Southern Flounder Feeding Biomechanics
Austin Francis
Armstrong Atlantic State University, Department of Biology, Savannah, GA

4:40 p.m. Can't Flatfish Perceive What Isn't There?
David Chosid and Michael Pol
Massachusetts Division of Marine Fisheries, New Bedford, MA

5:30 p.m. **Poster Set-up**

6:00 p.m. **Hosted Mixer and Poster Session**

Thursday December 4th

7:30 a.m. **Registration/Coffee/Continental Breakfast**

Session V
Don Danila, Chair
Dominion Resources Services/Millstone Environmental Laboratory, Waterford, CT

8:10 a.m. Population Size and Structure of Yellowtail Flounder in a Closed Area of George's Bank
Jessica Melgey[1], Steven Cadrin[2], Christopher Legault[3], and Kevin Stokesbury[1]
[1]University of Massachusetts-Dartmouth, School for Marine Science and Technology, Fairhaven, MA, [2]NOAA/University of Massachusetts-CMER Program, Fairhaven, MA, [3]NOAA's National Marine Fisheries Service, NEFSC/Woods Hole Laboratory, Woods Hole, MA

8:30 a.m. Growth, Mortality and Abundance of Young-of-the-Year Winter Flounder (*Pseudopleuronectes americanus*) in Two Long Island Environments
Melissa Yencho and Mike Frisk
Stony Brook University, School of Marine and Atmospheric Sciences, Stony Brook, NY

8:50 a.m. A Paleontological Perspective on the Evolution of Flatfish Asymmetry
Matt Friedman
University of Chicago and Field Museum of Natural History, Chicago, IL

9:10 a.m. Sensitivity of Stock Assessments of Southern New England Mid-Atlantic Yellowtail Flounder to Alternative Estimates of Discard Mortality
Adam Barkley[1], Steve Cadrin[1], and Larry Alade[2]
[1]NOAA/University of Massachusetts CMER Program, Fairhaven, MA, [2]NOAA's National Marine Fisheries Service, NEFSC/Woods Hole Laboratory, Woods Hole, MA

9:30 a.m. Growth and Movement of Atlantic Halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine Based on Tagging Results (2000-2008)
J. Kohl Kanwit, Christopher Bartlett, and Trisha De Graaf
Maine Department of Marine Resources, West Boothbay Harbor, ME

9:50 a.m. Overwintering Lipid Content in Young-of-the-Year Winter Flounder
Richard Bell
University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

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

Session VI

Sandra Sutherland, Chair

NOAA's National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

10:30 a.m. Genetic Analysis of Alaskan Pacific Halibut (*Hippoglossus stenolepis*)
Jennifer Nielson and Sara Graziano
U. S. Geological Survey, Alaska Science Center, Anchorage, AK

10:50 a.m. Young-of-the-Year Winter Flounder Distribution among Coastal and Estuarine Habitats
Vincent Manfredi[1, 2] and Ken Oliveira[2]
[1]Massachusetts Division of Marine Fisheries, Resource Assessment Project, Quest Center, New Bedford, MA, [2]University of Massachusetts-Dartmouth, Biology Department, Fairhaven, MA

11:10 a.m. Comparison of Growth of Three Species of Flatfish in Seagrass and Bare Sand Habitats in Two Inlets in New Zealand
Kimberley Capone
Rutgers University, Tuckerton, NJ, and University of Otago, New Zealand

11:30 a.m. What Do Winter Flounder Eggs and Sediment Particles Have in Common?
Tahirih Lackey[1] and Douglas Clarke[2]
[1]Coastal and Hydraulics Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS, [2]Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS

11:50 a.m. Simulation of Dredging-induced Sedimentation on Winter Flounder Spawning Habitat
Tahirih Lackey[1], Sung-Chan Kim[1], and Douglas Clarke[2]
[1]Coastal and Hydraulics Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS, [2]Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS

12:10 p.m. Assessment of External Operculum Loop Tags as a Method of Individually Identifying Cage-Cultured Atlantic Halibut (*Hippoglossus hippoglossus*) in Commercial Research Trials
Peter Sykes[1, 2], Henrik Stryhn[1], Cheryl Brooking[2], and Larry Hammell[1, 2]
[1]University of Prince Edward Island, Department of Health Management Atlantic Veterinary College, Charlottetown, PEI, Canada, [2] University of Prince Edward Island, Centre for Aquatic Health Science, Atlantic Veterinary College, Charlottetown, PEI, Canada

12:40 p.m. **Adjourn Meeting**
Hosted Buffet Lunch

Poster Session
Salon C
Wednesday December 3rd, 6:00 p.m.

Deborah Pacileo, Chair
Connecticut Department of Environmental Protection
Marine Fisheries Division
Old Lyme, CT

Long-term Patterns in Use of an Intertidal Salt Marsh Basin by Flatfishes in South Carolina, USA
Mary Carla Curran[1] and Dennis Allen[2]
[1]Savannah State University, Department of Natural Sciences and Mathematics, Savannah, GA,
[2]The Belle W. Baruch Institute for Marine and Coastal Sciences
University of South Carolina, Georgetown, SC

Winter Flounder Stock Enhancement: Examining the Onset of Wild Weaning in Pellet-reared Fish
Stacy Farina, Michelle Walsh, Elizabeth Fairchild, Nathan Rennels, and W. Huntting Howell
University of New Hampshire, Zoology Department, Durham, NH

Ontogenetic Development of the Digestive Tract in Pre- and Post- metamorphic Winter Flounder
Kristin Garabedian, Michelle Walsh, and W. Huntting Howell
University of New Hampshire, Zoology Department, Durham, NH

Abundance and Diet of the Winter Flounder (*Pseudopleuronectes americanus*) in a Long Island Sound Marina
Michael Gilman[1], Sean Grace[2], Todd Massari[1], and Beth Patrizzi[1]
[1]Cedar Island Marina Research Lab, Clinton, CT, [2]Southern Connecticut State University, New Haven, CT

External Tagging Techniques on Summer Flounder for Short-term Studies
Jessica Hoffman
Rutgers University, Institute of Marine and Coastal Sciences, New Brunswick, NJ, and Rutgers University Marine Field Station, Institute of Marine and Coastal Science, Tuckerton, NJ

The Feasibility of Rearing White Worms (*Enchytraeus albidus*) as a Potential Live Diet Feed for Winter Flounder Stock Enhancement
Gregory Howarth, Michelle Walsh, and W. Huntting Howell
University of New Hampshire, Zoology Department, Durham, NH

Summer Flounder Size and Spatial Distribution Patterns in Virginia's Chesapeake Bay and East Coast Waters during 2006 and 2007 Based upon Recreational Fishers Tagging Data
Jon Lucy[1] and Lewis Gillingham[2]
[1]Virginia Institute of Marine Science (VIMS), College of William and Mary, Gloucester Pt., VA, [2]Virginia Saltwater Fishing Tournament, Virginia Marine Resources Commission, Virginia Beach, VA

An RNA:DNA-based Growth Model for Young-of-the-Year Winter Flounder, *Pseudopleuronectes americanus*
Renee Mercaldo-Allen[1], Catherine Kuropat[1], and Elaine Caldarone[2]
[1]NOAA's National Marine Fisheries Service, NEFSC/Milford Laboratory, Milford, CT, [2]NOAA's National Marine Fisheries Service, NEFSC/ Narragansett Laboratory, Narragansett, RI

A Preliminary Look at the Correlation between Water Temperature and Early Life Stage Winter Flounder Abundance and Lengths in New York/New Jersey Harbor
Ronald Pinzon[1], Sarah Zappala[2], Catherine Mulvey[1], Jenine Gallo[1] and David S. Davis[2]
[1]United States Army Corps of Engineer –New York District, New York, NY,
[2]Henningson, Durham and Richardson Engineering, Inc. (HDR), Pearl River, NY

Diet Composition of Wild Juvenile Winter Flounder Collected Near the Piscataqua River Mouth, Great Bay Estuary, New Hampshire
Katie Robertson, Michelle Walsh, and W. Huntting Howell
University of New Hampshire, Zoology Department, Durham, NH

Abundance and Distribution Trends for Four Species of Flatfish Along the Maine and New Hampshire Coasts
Sally Sherman
Maine Department of Marine Resources, West Boothbay Harbor, ME

Using Stable Isotopes of Carbon ($d^{13}C$) and Oxygen ($d^{18}O$) to Differentiate Winter Flounder Nursery Areas
Bryan Taplin[1], Richard Pruell[1], and Jonathan Karr[2]
[1]US EPA, ORD, NHEERL, Atlantic Ecology Division, Narragansett, RI,
[2]Duke University, Department of Biology, Durham, NC

The Blood Chemistry of Fin-rotted Winter Flounder from New Haven Harbor in 1987-1988: The Response of Blood Parameters to Increasing Fin Rot Intensity
John Ziskowski, Renee Mercaldo-Allen, Jose Pereira, Catherine Kuropat, and Ronald Goldberg
NOAA's National Marine Fisheries Service, NEFSC/Milford Laboratory, Milford CT

Abstracts
Oral Presentations

Changes in Flounder Abundance in Long Island Sound Due to Climate Change

Penny Howell

Connecticut Department of Environmental Protection, Marine Fisheries
PO Box 719, Old Lyme, CT 06357

Email: penny.howell@ct.gov

The CT DEP Long Island Sound Trawl Survey (LISTS) abundance indices, generated annually since 1984, indicate compositional changes among six species of flatfish commonly taken in the trawl. Spring LISTS cruises (April-June) have recorded a significant decline in the overall abundance and number of three "cold temperate" species: winter flounder, windowpane flounder, and fourspot flounder (df =22, $r^2 > 0.2$, $p<0.02$). Winter flounder is the only one of the three that is heavily fished, however, the declines in abundance of all three species are statistically correlated (df =22, r =0.414, p =0.05). Continuous temperature records kept at Millstone Power Station since 1976 show that both winter and summer water temperatures have increased significantly since 1976. The affect of this increasing temperature trend is most obvious when expressed as the number of days per year above a high threshold temperature (20ºC was used here).

Rising bottom water temperatures also may have contributed to significant increases in the occurrence of “warm temperate” species in the Sound. Not only have intensively managed species such as summer flounder and striped bass increased significantly in recent years, but so have other warm-water species not subject to any harvest or regulation, such as smallmouth flounder and striped sea robin. The abundance of both summer and smallmouth flounders has significantly increased in both spring and fall (September-October) LISTS cruises (df =22, $r^2 > 0.2$, $p<0.02$). While the percent occurrence of summer flounder in fall Survey cruises increased from an average of 58% in 1985-1995 to 81% in 1996-2007, the percent occurrence of winter flounder in fall Survey catches decreased from an average of 80% to 66% over the same years. The abundance of a third warm-water flounder, the hogchoker, varied without trend in both spring and fall Survey catches over the time series. However, the distribution of this species encompasses more estuarine and fresh water than is covered by the LIS Survey.

Niantic River Winter Flounder Studies: Transition between Larval and Juvenile Life Stages and Factors Affecting the Growth and Abundance of Settled Juveniles

Donald J. Danila and James F. Foertch

Dominion Resources Services, Millstone Environmental Laboratory
PO Box 128, Waterford, CT 06385

Email: donald.j.danila@dom.com

From 1984 through 2007 in the Niantic River, CT estuary, calculated dates of peak abundance of pre-metamorphosing Stage 4 winter flounder larvae and observed peak date of newly metamorphosed juveniles at two sampling stations appeared to be temporally related. Two periodicities were found in timing, one group having a mean 32-day difference in peak abundance (n = 17) and another (n = 7) with a 55-day difference. A calculated abundance index of Stage 4 larvae was linearly related to observed peak abundance of settled juveniles at juvenile densities of less than about 200 fish per 100 m^2. In the 2 years having higher densities, the relationship appeared to reach an asymptote of about 250 fish per 100 m^2, which may represent a carrying capacity of the river nursery area. However, 3 other years of relatively high larval abundance resulted in less than expected juvenile densities, which suggested that some factors may be differentially limiting survival after settlement. Peak abundance of juveniles in late spring (May or June) was predictive of abundance in late summer (August-September), with the notable exception of 2006. Juvenile growth, expressed as the mean length achieved in late summer (mid-July through September), was negatively related to both annual median density and the cumulative number of growing degree-days (GDD). With smaller mean lengths found during years of high abundance, growth is likely density-dependent. Also, in general, mean lengths were smaller as GDD increased, indicating sub-optimal growth in warmer years. These two factors were combined in a predictive growth equation. Abundance in late summer was positively related to calculated values of natural mortality (M), suggesting density-dependent mortality in the river. Using stepwise linear regression, a predictive relationship of late summer abundance was determined. Independent variables included annual values of M, Stage 4 larval abundance, peak abundance of juveniles, dates of peak abundance of both larvae and juveniles, mean length in late summer, and GDD calculated for various temporal periods.

Otolith Growth and Development is Mediated by Thyroid Hormone in Metamorphosing Flatfish

Alex M. Schreiber

St. Lawrence University, Biology Department, Canton, NY 13617

Email: aschreiber@stlawu.edu

Flatfish begin life as bilaterally symmetric larvae that swim upright, but abruptly transition to a highly lateralized swim posture during metamorphosis after which one side faces the substrate and the other faces the water surface. We have previously shown that thyroid hormone (TH) acts upon the vestibular system (inner ear) to induce this behavioral change in a manner that is independent of thyroid hormone's effects on eye migration and skull remodeling. Here we show that thyroid hormone exerts a profound effect on one sensory component of the vestibular system, the otolith organs (sacula, utricles, and lagenae). Specifically, treatment of pre-metamorphic larvae with TH up-regulates, with rapid kinetics, several genes that are known to induce otolith-specific development in other vertebrates (Otolith Matrix Protein, Otogelin, Otopetrins 1&2, and Tectorins alpha & beta). Furthermore, TH treatment for just three days results in a several-fold increase in otolith size, and the pharmacological inhibition of endogenous TH production inhibits otolith growth altogether. Lastly, we report that the left and right utricular otoliths (thought to mediate balance) are asymmetrically-shaped in diverse flatfish species. The transition to a lateralized swim posture during metamorphosis may be due, at least in part, to an asymmetric response in growth and development of the otolith organs to TH during metamorphosis.

Using Acoustic Tags to Clarify Movements and Habitat Use of Cultured and Wild Juvenile Winter Flounder *(Pseudopleuronectes americanus)* in a Shallow New Hampshire Estuary

Elizabeth A. Fairchild, Nathan Rennels, and W. Huntting Howell

University of New Hampshire, Department of Biological Sciences, Durham, NH 03824

Email: elizabeth.fairchild@unh.edu

Home ranges, dispersal patterns, and habitat associations of juvenile winter flounder (*Pseudopleuronectes americanus*) were studied using acoustic tags and three tracking systems in the Hampton-Seabrook Estuary in New Hampshire, USA from 2005-2007. This is the first study that we know of to use electronic tags on juvenile winter flounder, and on flatfish ≤ 19 cm.

For the first two tracking periods, both wild and cultured age-1 fish were followed by a combination of handheld hydrophones and a VRAP system. Although both cultured and wild fish maintained similar home ranges, the cultured fish immediately emigrated approximately 1000 m out of the release area while the wild fish maintained high release site fidelity. Cultured fish acclimated to the release site using *in-situ* cages displayed higher site fidelity after release. Cultured flounder habitat use was very similar to wild flounder habitat use in terms of bottom water temperature, dissolved oxygen, salinity, depth, and sediment composition.

For the third tracking period only wild juvenile flounder were followed to discern when and at what size fish leave the estuary. Fish (n=10) were tracked passively by an array of six submersible receivers stationed throughout the estuary. A total of 244,985 fixes were recorded by the receivers during the lifespan of the tags. The majority of these fixes were recorded by the receivers at the release site (72%) and immediately down-estuary (25%). Eighty percent of the fish remained in the immediate release area for the first two weeks, but as time at large increased, several fish dispersed down-estuary, and two individuals left the estuary for the sea. Estuary exits occurred in the winter by the largest individuals. Final positions of the tagged fish indicated that 20% had left the estuary all together, 30% of the tagged fish were still at the release site, 20% were approximately 500 m down-estuary from the release site, and 30% were unaccounted for.

Understanding these movement patterns and habitat associations of both cultured and wild juvenile winter flounder is significant for developing techniques for enhancement programs and for defining essential fish habitats within this important nursery area.

Examining Weaning Success of Cultured Juvenile Winter Flounder Reared on Formulated and Live Diets

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Winter flounder (*Pseudopleuronectes americanus*) are capable of releasing hundreds of thousands of eggs annually but because of the vulnerability of the small, early life-history stages, there is high natural mortality, and few survive to maturity. Captively spawning, rearing, and releasing animals at a size or age beyond this mortality window may enhance natural stocks. A major challenge of any captive rearing program, whether for aquaculture or stock enhancement, is providing the appropriate diet regimes during development. Weaning occurs twice for fish that are used for stock enhancement. The first time occurs when larvae, which are initially fed live food (e.g., rotifers, *Artemia*), are weaned onto formulated diets as they develop digestive tolerance to these artificial feeds. The second time occurs as fish transition from the hatchery feed to natural live diets once released. This research, which is part of a larger study designed to assess the feasibility of winter flounder stock enhancement in New Hampshire, aims to identify rearing diets that optimize weaning success in the hatchery and minimize the effects of subsequent weaning in the wild.

In 4-wk laboratory feeding trials, we analyzed the weaning success of hatchery-reared, juvenile winter flounder raised on different diets (both live and formulated) by quantifying growth, survival, and RNA/DNA condition. Live diets included late-stage nauplii of brine shrimp (*Artemia franciscana*), white worms (*Enchytraeus albidus*) and burying marine amphipods (*Leptochierus plumulosus*). Fish reared on live diets exhibited significantly higher growth than those reared on formulated diets ($p < 0.01$). Survival and RNA/DNA condition were also higher in fish fed live feeds. Subsequently, we examined the weaning success of these hatchery-reared fish once released in the wild. In addition to growth and survival, we determined the onset of feeding post-release, gut fullness, and gut composition by performing controlled cage releases. Preliminary results indicate that fish raised on live diets exhibited a faster onset of feeding in the wild than pellet-reared fish. This research provides information that may promote advances in weaning strategies for stock enhancement.

Seasonal Patterns of Winter Flounder (*Pseudopleuronectes americanus*) Abundance and Reproductive Condition on the New York Bight Continental Shelf

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To resolve varied accounts of spawning and habitat characteristics for winter flounder (*Pseudopleuronectes americanus*), seasonal patterns in abundance and reproductive condition were investigated in the New York Bight, near the southern edge of their reproductive range. Fish were collected from trawl surveys on the inner continental shelf from October 2006 – October 2007. Winter flounder were most abundant during January and April surveys, were rarely collected in August, with intermediate abundances in June and October. Measures of fish condition (hepato-somatic index [*HSI*], condition factor [*K*], and the percent dry weight of muscle tissue [%*DW*]) and reproductive condition (gonado-somatic index [*GSI*]) were determined to evaluate seasonal changes in energy accumulation and depletion and reproduction. Males and females had similar patterns in body and reproductive condition, although the magnitude of change was greater for females. *HSI* values were highest during spring and early summer, suggesting increased feeding following spawning. *K* and %*DW* both increased through spring and summer then declined in the fall and winter concurrent with gonadal development. Gonads began developing in the fall, and in January *GSI* values approached spawning levels, with many spent individuals collected in spring. Within these general patterns, however, there was a large degree of variability among individuals, and a few mature non-reproductive ('skipped-spawning') females were observed. In the period after spawning, increased energy intake, indicated by increased *HSI*, may influence reproductive output, since this energy is gradually transferred to the muscle and used for gonadal development in the upcoming year. The occurrence of ripening individuals on the inner continental shelf in January suggests these fish either rapidly move into estuaries to spawn by February-March, or they remain on the inner shelf to spawn, or some combination of these. Future studies should evaluate these possibilities, as both estuarine and inner shelf habitats are potentially impacted by activities such as dredging, sand mining, and wind energy development.

Ocean Distribution Patterns in Winter Flounder: A Preliminary Analysis of the Response to Climate Change

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Winter flounder (*Pseudopleuronectes americanus*) are historically cited as occurring from Georgia, USA, to Labrador, Canada, but most commonly north of Delaware Bay. Seasonal distribution, reproduction efforts, and duration of development for both eggs and larvae are known to be strongly influenced by temperature. Therefore, the recent increase in estuarine and ocean temperatures might be expected to cause a response in these factors, and influence the distribution and abundance of the species. In an attempt to determine if this is occurring, we are analyzing a long-term trawl survey data set from the Northeast Fisheries Science Center (NEFSC) of the National Marine Fisheries Service (NMFS) from 1982-present. The current southern range of winter flounder, from southern New Jersey to North Carolina, experienced a general decrease in numbers during this period, while some northern waters, particularly around Massachusetts, appeared to increase in abundance. However, declining abundance from overfishing cannot be discounted as a possible contributing factor. Further analysis of other long-term species data sets, including larval abundance from Little Egg Inlet, NJ (1989-present); and juvenile and adult abundance from off NJ (Department of Environmental Protection, 1988-present), will be addressed and should give a better idea of possible response to climate change in winter flounder.

Thermal Effects on the Ontogenetic Rates Expressed in the Early Life History of Flatfishes

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A predictive understanding of how shifts in thermal regimes might affect event timing in a fish's life cycle is fundamental for establishing expectations for the consequences of climate change on fish populations. As ectotherms, fishes are expected to exhibit increases in virtually all aspects of their 'rates of living' – e.g., metabolic, ontogenetic, and ecological rates – as water temperatures increase. But beyond this general expectation of a direct effect of temperature on rates of living, refined details of these relationships should allow researchers to tailor predictions to the specifics of the species, life cycle features, and environments of particular concern. In this paper we use data on embryonic period duration (EPD) and water temperature (a relationship for which such ontogenetic data are relatively plentiful) and address the following five questions about temperature-ontogenetic rate relationships in flatfishes: 1) What are the general shapes of relationships between water temperature and developmental rate? 2) How might these temperature-developmental rate relationships be best quantified? 3) How can these relationships be used to predict hatching in variable thermal regimes? 4) Do these relationships vary among populations within species? and 5) What are the possible implications of these findings for projected responses of fishes to climate change? We found that: 1) the developmental rate (= 1/EPD) vs. temperature relationship is often nonlinear and thus EPD is predicted with bias if one assumes linearity in the relationship, 2) this relationship can often be adequately quantified as a quadratic regression, 3) a thermal sums approach accurately predicts EPD in a variable thermal regime when water temperature and the developmental rate-temperature relationship is known, 4) these relationships can vary among populations, and 5) trends of increases in the average and variance of water temperatures, as might be expected due to climate change, will often result in shorter EPD than predicted from a degree-day estimate. The implications and generality of these results are highlighted.

Physiological Responses and Tolerances of Adult Summer Flounder (*Paralichthys dentatus*) Experiencing Hypoxia at Two Temperatures

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Summer flounder (*Paralichthys dentatus*) experience both hypoxia and acute temperature change during their summer residency in mid-Atlantic estuaries. The effects of hypoxia on growth, feeding rates and avoidance behavior of juveniles have been assessed, but minimum oxygen requirements (P_{crit}) and cardiorespiratory adjustments made by summer flounder to maintain aerobic metabolism during hypoxic events are not known for any life stages. We therefore used stop-flow respirometry and standard physiological procedures to measure metabolic rate (VO_2), exhalent oxygen (PO_{2E}), ventilation volume (V_g), and heart rate (f_H) of adult summer flounder during normoxia and hypoxia at the fish's acclimation temperature (22°C) and after acute temperature increase (to 30°C). Fish were subjected to four stepwise decreases in oxygen saturation (65-75%, 45-55%, 25-35% and 15-24%). V_g increased and PO_{2E} decreased with declining oxygen levels at both 22°C and 30°C, but bradycardia was not evident until the lowest oxygen saturation level. At 30°C, fish had a higher P_{crit} (~30% saturation) than at 22°C (~20% saturation). Our results show that an acute temperature increase diminishes the ability of summer flounder to tolerate hypoxia. Anthropogenic and climatic influences are likely to increase hypoxic events in coastal waters, with unknown consequences for managed aquatic species. Understanding the tolerances and physiological adjustments of summer flounder to estuarine variability will therefore be required to understand the changing movements, distribution and population dynamics of this economically important species.

Mercury Biomagnification and Trophic Transfer in Temperate Flatfishes

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The summer flounder, *Paralichthys dentatus*, and the winter flounder, *Pseudopleuronectes americanus*, support valuable recreational and commercial fisheries in Narragansett Bay, Rhode Island. A possible human health risk occurs from consuming these flatfish if they bioaccumulate appreciable levels of mercury (Hg) over time. Factors impacting the Hg concentration of fish tissue, however, vary based on species-specific life history characteristics, such as feeding ecology and diet history. In this study, summer and winter flounder were collected throughout the Narragansett Bay Estuary from June 2006 to September 2007. Fish tissue samples were analyzed for total Hg concentration using atomic absorption spectroscopy, and Hg data were analyzed relative to fish body size and predicted age. Moreover, the effect of trophic processes on species-specific Hg bioaccumulation rates were assessed using stomach content and stable nitrogen (15N/14N) isotope analyses of target species. Hg bioaccumulation rates were greater in summer flounder relative to winter flounder, and this was attributed to the feeding ecology of summer flounder and their higher trophic level status in the estuary (as determined by 15N/14N). Moreover, the mean total Hg concentration of fish stomach contents was higher for summer flounder than winter flounder, and the bioavailable prey for summer flounder (squid, forage fish, and macrocrustaceans) had higher concentrations of total Hg than the winter flounder's prey (polychaetes, amphipods, and small decapods).

Describing How Fish Use Habitat: A New Approach Using Geospatial Modeling

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A better understanding of habitat requirements is mandated by recent federal fisheries law. One way to approach this issue is to examine factors that influence distribution. We are investigating how distribution changes with abundance, which is of particular interest in exploited populations that undergo large changes in abundance. Three theories have been proposed for the relationship between marine fish abundance and distribution: the Constant Density Model (CDM), the Proportional Density Model (PDM), and MacCall's Basin Model (MBM). The CDM predicts that the population's range expands and contracts with changes in global abundance while local density does not vary. Habitat quality varies and the best habitats, conferring the highest fitness, remain occupied at lowest abundance. The PDM predicts that range remains constant and that local density varies with changes in abundance. Local density is highest in habitats that confer the highest fitness. The MBM predicts that there is density-dependent habitat use, such that both local density and species range vary with changes in abundance. Fitness should be the same across habitats because of these density-dependent processes. We are testing these theories using geospatial modeling and National Marine Fisheries Service trawl survey data. We test for changes in range by mapping non-zero catches at high and low population levels. We test for fitness changes across habitats by assessing spatial autocorrelation in fitness metrics (weight-at-length, weight-at-age). The analyses are being conducted on a benthivore (yellowtail flounder, *Limanda ferrugineus*), a pelagic planktivore (Atlantic herring, *Clupea harengus*), a piscivore (silver hake, *Merluccius bilinearis*), and a demersal omnivore (haddock, *Melanogrammus aeglefinus*).

Winter Flounder Habitat Use in the New York/New Jersey Harbor: What Can Eight Years of Monitoring Data Tell Us?

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Winter flounder populations along the Atlantic coast of the United States have declined over the last decade. Overfishing and degradation of spawning and nursery habitat are among the factors thought to have contributed to this decline. Previous studies have demonstrated that winter flounder may use different spawning and nursery areas within large coastal estuaries. To better understand how winter flounder use large coastal estuaries and local habitats, particularly channel vs. shallow areas, early life stages of winter flounder were collected in 1999 and from 2001 to 2007 in the New York/New Jersey Harbor. Winter flounder early life stages were found throughout the Harbor; larval size and egg and larval densities differed temporally and among areas of the estuary. This study suggests that spawning and nursery areas may be spatially separated within the estuary; potentially resulting from the influence of various water quality parameters such as temperature, salinity and dissolved oxygen on the different life history stages.

A Partial Recruitment History of Juvenile *Pseudopleuronectes americanus* in the Norwalk River Estuary from 1991 to the Present

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Harbor Watch/River Watch, a Program of Earthplace in Westport Connecticut in conjunction with students from Wilton High School has run a survey of marine, juvenile benthic fish from 1991 until the present in the Norwalk River estuary. The program began in the summer of 1991 under the guidance of the State of Connecticut's Dept of Environmental Protection's (CT DEP) Fisheries Bureau. A trawling program was devised using fishing gear and a grid system which divided the harbor into fishable boxes as devised by the Fisheries Bureau. Trawling in Norwalk Harbor was temporarily suspended due to extended boat repairs in the mid 90's followed by a change in assignment for HW/RW by the Fisheries Bureau toward the end of the decade. Trawling resumed in earnest during the summer of 2002 and has been continuous each year (May through October) to the present.

The early 90's showed a harbor floor rich in diversity serving as a primary breeding ground and nursery for *P. americanus*. Numbers of species ranged from 12 to 15/year. When HW/RW returned to trawling Norwalk Harbor in 2002, no fish of any species were found. From 2003 to mid 2005 a modest recovery of all benthic species began until August 15, 2005 when oxygen depletion in the upper harbor caused a massive fish kill of over 1 million menhaden (*Brevoortia tyrannus*). The dead fish sunk to the bottom of the harbor and the trawling effort had to be suspended for the season as no live fish were found. The problem was further compounded by the spoil from a dredging program which extended into the February 2006 breeding season for P. *americanus*. Since early 2006 only a minimal number of all types of benthic juvenile fish have been caught in the trawl, usually less than 100 total fish/season. The causes for this alarming decline in juvenile benthic fish are unknown, but run the gamut from pesticides to oxygen depletion to the effects of global warming. A reinforced array of marine predators may also be partly responsible for the decline in class zero fish populations. Sorting out the causes and effecting remedial action will be a very long process which may not be a possibility for many years if ever.

The Reproductive Strategy and Tactics of Female Winter Flounder (*Pseudopleuronectes americanus*): A Review of Biotic and Abiotic Processes

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This presentation reviews the published literature for evidence that winter flounder, like most flatfishes (Pleuronectiformes), are iteroparous, have group-synchronous ovary organization, have determinate fecundity, and are batch spawners. At the southern part of their range, winter flounder mature usually as three-year-olds and they may live to 16- years-old. Although they are iteroparous (i.e., repeat spawners), females may not spawn every year ('skipped spawning'), so that estimates of spawning stock biomass probably overestimate reproductive potential. Histological examination of gonads demonstrates group-synchronous oocyte development; pre-vitellogenic oocytes may be set up 2-3 years in advance of spawning. Oocyte atresia is fairly low, so estimation of the number of vitellogenic (i.e., yolked) oocytes should closely approximate annual realized fecundity. Laboratory studies indicate that females spawn, on average, 40 batches of eggs per spawning season. There is considerable evidence that food consumption affects at least three aspects of reproduction: the initiation of maturation; the occurrence/prevalence of 'skipped spawning'; and the number of vitellogenic oocytes produced. Feeding rates are also affected by temperature, and because winter flounder can be found across a wide latitudinal range this abiotic factor can therefore influence the reproductive output of this species. We will present some preliminary data related to these processes as they pertain to the southern stocks of winter flounder: Gulf of Maine, Georges Bank, and southern New England.

Microsatellite and SNP Analyses of the Coastwide Genetic Stock Structure of Winter Flounder

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Winter flounder is managed as three stocks in U.S waters including the Gulf of Maine, southern New England/mid-Atlantic, and an offshore stock that includes Georges Bank and fish harvested outside of state jurisdictions within the EEZ. However, this model has not been empirically evaluated with sensitive modern DNA approaches. We analyzed collections of young-of-the-year winter flounder from 22 Atlantic Coast estuaries from Delaware to Newfoundland and adult fish from New York Harbor and Georges Bank for their genetic stock structure. Fish were screened at 11 winter flounder-specific microsatellite loci and 8 single nucleotide polymorphism loci that were identified in our laboratory. In total, we have analyzed approximately 1550 fish or at least 50 specimens/collection. Heritability of microsatellite DNA fragments was evaluated in the offspring of four controlled laboratory crosses. In total, 210 alleles were observed at the 11 microsatellite loci (19 alleles/locus) and 16 alleles at the SNP loci. We will present results statistically comparing genetic diversity, allelic frequencies, and genetic relationships among our collections. We will also compare the relative sensitivities of the two DNA approaches in distinguishing populations.

Divergent Movement Patterns of Winter Flounder in Plymouth Bay, MA

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Recent observations of winter flounder seasonal movements are not consistent with the current view that spawning in the Gulf of Maine is restricted to estuaries. An acoustic tagging study in the Plymouth Harbor, Kingston Bay and Duxbury Bay estuary in Massachusetts was designed to address uncertainty in the migration and spawning patterns of winter flounder in the Gulf of Maine. Forty-seven adult winter flounder (27-42 cm) were tagged with acoustic transmitters and their movements were monitored using an array of 15 Vemco receivers. In November 2007, 24 fish were caught, tagged and released in Warren Cove, a coastal area outside the estuary. Of the 24 fish tagged in Warren Cove, only five individuals were later detected within the estuary. These fish entered the estuary from mid April to mid May and remained therein for a brief time. Nineteen of the 24 fish tagged in Warren Cove were not detected within the estuary at any time during the study, suggesting that these individuals did not use the estuary as a spawning ground. After an entire winter and early spring of failed attempts to capture adults in the estuary, 23 fish were caught, tagged and released within the estuary from late May to mid June. The majority of these fish emigrated from the estuary between early and late June as water temperatures increased. Results suggest a divergent pattern of spawning migrations in which some winter flounder spawn in coastal areas while others migrate briefly to estuaries from spring to early summer.

Predatory Impact on Young-of-the-Year Winter Flounder *(Pseudopleuronectes americanus)*: Comparative Dietary Analysis of Common Fish Species in Long Island Waters

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Predation on juvenile flatfish is believed to be the primary cause of juvenile flatfish mortality. Upon settling into juvenile existence during late spring and early summer, young-of-the-year flounder become susceptible to decapod crustaceans, demersal fish, and avian piscivores. Predatory impacts on newly born young-of-the-year (YOY) winter flounder (*Pseudopleuronectes americanus*) were investigated by collecting and examining gut contents of common piscivorous fishes found in important feeding and nursery grounds: Great South Bay, Shinnecock Bay, and Port Jefferson Harbor. Samples were collected during otter trawl, beach seine and beam trawl surveys conducted from March to September 2007 in all three study locations. Upon capture, specimens were measured and frozen in the laboratory. Analysis entailed identification, counting, and weighing of all food items. Preliminary results of data collected during year one of this two-year study suggest varying dominance of prey items. Sand shrimp (*Crangon septemspinosa*) dominated striped sea robin (*Prionotus evolans*) stomachs (N=28) by both number and weight while Mysids dominated windowpane flounder (*Scopthalmus aquosus*) stomachs (N=33). Clearnose skate (*Raja eglanteria*) stomachs (N=9) are dominated by rock crabs (*Cancer irroratus*) by weight and sand shrimp by number. The contents of summer flounder (*Paralichthys dentatus*) stomachs (N=60) are more variable and include Mysids, rock and mud crabs (*Panopeus herbstii*), mantis shrimp (*Squilla empusa*), isopods, moonfish (*Selene setapinnis*), menhaden (*Brevoortia tyrannus*), silversides (*Menidia menidia*) and winter flounder. Abundance estimates of all fish were used to quantify the total predatory impacts of piscivores on winter flounder.

Consequences of Reversed Asymmetry for Southern Flounder Feeding Biomechanics

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In aquaculture, a small, but significant, number of flatfishes exhibit incomplete or reversed asymmetry. The southern flounder, *Paralichthys lethostigma*, is most often sinistral with the right eye migrating to the left side of the head during metamorphosis. For sinistral flatfish like the southern flounder, the left side of the head is the ocular side while the right side of the head is the blind side. In this study, fertilized eggs were collected from spawning southern flounder broodstock and maintained in a hatchery through metamorphosis. The resulting juvenile southern flounder included both sinistral and dextral individuals. Both varieties were sacrificed and stored frozen. To characterize individual feeding biomechanics, the flounder were thawed, the head dissected, and cranial muscles examined. Both left and right sides of the head were digitally photographed with all linear and angular measurements determined using image analysis software. Measurements included the origin and insertion of muscles, lever arms responsible for lower jaw depression and elevation, as well as muscle mass. All measurements were made on both the left and right sides of the head. The results were compared between anatomical side of the head (left and right) as well as functional side of the head (ocular and blind). In particular, southern flounder with incomplete or reversed asymmetry (i.e., dextral) were examined for morphological and functional differences from sinistral southern flounder. Observed biomechanical differences in the design of feeding structures between sinistral and dextral individuals are expected to have functional and ecological consequences.

Can't Flatfish Perceive What Isn't There?

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Two innovative species-selective flatfish trawl nets, the Topless and Ribas nets, were designed to maintain catches of legal-sized yellowtail flounder, *Limanda ferruginea,* while reducing catches of sub-legal yellowtail flounder, Atlantic cod, *Gadus morhua*, and other non-target species by exploiting behavioral differences during the herding process. We investigated whether light level, using day and night as a proxy, affected the catch when the top half of a net is removed (Topless) or when the top is replaced with large square meshes (Ribas). The experimental nets were compared against a standard flatfish net using twin and alternate trawling on Georges Bank, USA onboard a commercial fishing vessel working around the clock. Non-parametric paired randomization testing shows that the Topless net significantly reduced catches of Atlantic cod, legal and sub-legal-sized yellowtail flounder, haddock, *Melanogrammus aeglefinus*, monkfish, *Lophius americanus*, American plaice, *Hippoglossoides platessoides*, grey sole, *Glyptocephalus cynoglossus,* and winter flounder, *Pseudopleuronectes americanus*; the Ribas net showed significant reductions in catches of legal and sub-legal-sized yellowtail flounder, haddock, American plaice, and grey sole. Significant diel differences in the Topless net's catching efficiency for legal and sub-legal yellowtail, grey sole, and winter flounder were found. No diel differences were observed using the Ribas net. Our results imply that light levels affect the behavior and reaction of these species to trawl nets, and that currently permitted use of these nets or a similar design in a 24-hour/day flatfish fishery on Georges Bank should be reinvestigated to determine if Atlantic cod catch rates meet management needs.

Population Size and Structure of Yellowtail Flounder in a Closed Area of George's Bank

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In June 2008, a ten-day Petersen tagging experiment was conducted to obtain a population size estimate of the Georges Bank yellowtail flounder stock residing in the southern portion of Closed Area II on the Bank. During the first five days of the experiment, approximately 72,000 yellowtail flounder were caught and externally tagged using double t-bar anchor tags. In the last three days, approximately 44,000 yellowtail flounder were subsequently caught with 159 bearing tags, yielding a population estimate of 19.8 million fish. Length, sex and maturity data were taken from a subsample of the tagged fish. The population estimate from the experiment was compared to the estimate of age-2 and older yellowtail derived from the 2008 stock assessment. Results suggest that the southern portion of Closed Area II contained about 40% of the Georges Bank stock, and that the sex and size composition of the yellowtail in this area were similar to those observed outside the Closed Area in the Northeast Fisheries Science Center spring 2008 bottom trawl survey. A mark-recapture experiment using conventional external tags has never been attempted at this large a scale. The ability of this cooperative study to estimate population size in an area closed to fishing is encouraging for future endeavors.

Growth, Mortality and Abundance of Young-of-the-Year Winter Flounder (*Pseudopleuronectes americanus*) in Two Long Island Environments

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Historically, the waters of Long Island, New York have supported commercial and recreational fishing for winter flounder. However, landings hit record lows in 2004 and have not since recovered. This study aims to quantify growth, mortality and abundance of young-of-the-year (YOY) winter flounder in two contrasting Long Island environments: Port Jefferson Harbor and Shinnecock Bay. Two-hundred foot beach seines were used to study both areas. In addition, a 1-m beam trawl was used in Shinnecock Bay. Each site was sampled by beach seine every other week from March to September, 2007. Beam-trawl sampling occurred once a week from June until September and then once a month until November 2007. A total of 668 YOY winter flounder were caught during beach seining in Port Jefferson Harbor and 213 were caught in Shinnecock Bay. Beam trawling in Shinnecock Bay yielded 368 additional YOY flounder. Catch curve analyses indicates YOY winter flounder experience a daily instantaneous natural mortality rate ranging from 0.04 in Port Jefferson Harbor (seine net) to 0.03 (seine net) and 0.02 (beam trawl) for Shinnecock Bay. Differences in average length by date between Port Jefferson Harbor and Shinnecock Bay indicate differences in spawning dates or growth rates between regions. Additionally, two clear cohorts were observed in Port Jefferson Harbor indicating the possibility of multiple adult spawning groups. Preliminary results for hatching dates based on otolith analysis will also be presented.

A Paleontological Perspective on the Origin of Flatfish Asymmetry

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All living flatfishes (Pleuronectiformes)—including the gastronomically familiar plaice, sole, turbot, and halibut—have highly asymmetrical skulls, with both eyes placed on one side of the head. This arrangement, which is one of the most extraordinary anatomical specializations among vertebrates, arises through migration of one eye during late larval development. While the ontogenetic transformation of symmetrical larvae into asymmetrical juveniles is well-documented, the evolutionary origin of flatfish asymmetry is uncertain because there are no transitional forms linking flatfishes with their symmetrical relatives. The supposed inviability of such intermediates has given pleuronectiforms a prominent role in debates on the mode and tempo of evolution. Darwin and Wallace struggled to defend gradualism and natural selection against attacks citing the problem of flatfish origins, while the hypothetical ur-pleuronectiform became Goldschmidt's first example of a 'hopeful monster' in his arguments for saltatory change. To date, paleontology has failed to illuminate flatfish origins; all extinct pleuronectiforms have been placed within the crown group. Using data from newly prepared fossils and computed tomography, I show that †*Amphistium* and a new genus †*Heteronectes*, both from the Eocene (56-40 Ma) of Europe, are the most primitive pleuronectiforms known. These two taxa have asymmetrical skulls, like living flatfishes, but display primitive characters unknown in extant forms. The most remarkable feature of these fossils is incomplete orbital migration, with eyes remaining on opposite sides of the head in post-metamorphic individuals. This condition is intermediate between that of living pleuronectiforms and other fishes, indicating that the evolution of the profound cranial asymmetry of extant flatfishes was gradual in nature. †*Amphistium* occurs as both right- and left-handed morphs at near-equal frequency, establishing antisymmetry as the primitive condition for the clade. This corresponds to a general pattern in the evolution of asymmetries arising late in development, where an antisymmetric phase precedes fixation of one chiral morph.

Sensitivity of Stock Assessments of Southern New England Mid-Atlantic Yellowtail Flounder to Alternative Estimates of Discard Mortality

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Survival of discarded fish is unknown in many fisheries, posing a large source of uncertainty in stock assessments and fisheries management. Lacking quantitative information on discard survival, most assessment models assume a discard mortality rate of 100% as an upper bound. The trawl fishery in Southern New England has a high rate of by-catch and discards of yellowtail flounder due to regulations on trip catch limits. In 2007, observer data indicate that almost 50% of the catch of yellowtail flounder in the Southern New England-Mid-Atlantic stock area was discarded. As part of a larger study designed to estimate discard mortality, we conducted sensitivity analyses to evaluate the impacts of alternative assumptions of discard mortality on the assessment of Southern New England-Mid Atlantic yellowtail flounder. Total removals (i.e., dead catch numbers-at-age) were calculated using a range of assumed discard mortality rates, and used in a series of calibrated virtual population analyses. Preliminary results indicate nonlinear, positive relationships between discard mortality rates, abundance estimates, and fishing mortality estimates. The sensitivity analyses demonstrate the implication of assuming 100% discard mortality and the need for more accurate and representative estimates of discard mortality.

Growth and Movement of Atlantic Halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine Based on Tagging Results (2000-2008)

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This paper presents information on the growth and movement of Atlantic halibut (*Hippoglossus hippoglossus*) in the Gulf of Maine based on tagging results from nine years of cooperative research projects. These data show both localized movements within the study area and long-distance emigrations of juveniles. Thirty-one percent of the tag recoveries from this study were made in Canadian waters, demonstrating an interchange between fish in the Gulf of Maine and those considered part of the Scotian Shelf/Southern Grand Banks stock unit. These data also indicate an average growth rate of 13 cm per year and a significant relationship between size at release and annual growth rates.

Overwintering Lipid Content in Young-of-the-Year Winter Flounder

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Winter flounder is an important commercial and recreational species that has declined substantially in Southern New England over the last twenty years. Several strong year classes in Narragansett Bay including the largest year class on record in the last twenty years (1992, RIDEM young-of-the-year survey) experienced extremely high mortality during their first winter, while some of the weaker year classes had survival three times higher then the average. Year class strength is largely determined during the first two years of life in flatfish, thus understanding the mechanisms that regulate survival during the early life stages are important for determining the future spawning stock biomass. Larger juveniles typically have a higher percentage of energy stores and a higher over wintering survival then smaller individuals because they can mobilize metabolites over a longer time span. We collected YOY winter flounder (<15 cm) every week at two stations in Narragansett Bay from October 2007 to April 2008. Whole body crude lipid content and overall length were measured for each fish. We examined whether larger fish had higher lipid content and if there was any seasonal trend in lipid stores.

Genetic Analysis of Alaskan Pacific Halibut (*Hippoglossus stenolepis*)

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Pacific halibut (*Hippoglossus stenolepis*) collected offshore of the Aleutian Islands, Bering Sea and Gulf of Alaska were used to test the hypothesis of genetic panmixia for this species in Alaskan marine waters. Nine microsatellite loci and sequence data from the mitochondrial (mtDNA) control region were analyzed. Eighteen unique mtDNA haplotypes were identified with no evidence of geographic population structure. Significant microsatellite heterogeneity was detected between Aleutian Island halibut and fish from the other two regions (F_{ST} range= 0.007-0.008). Significant F_{ST} values represent the first genetic evidence of locally adapted groups of halibut in the western Aleutian Archipelago. Previous studies have reported Aleutian oceanographic conditions in deep canyons leading to an ecological discontinuity and unique population structure for several marine species. Unique Aleutian specific halibut genetic structure may result from oceanographic mechanisms acting as dispersal barriers reducing gene flow with halibut from other Alaskan waters.

Young-of-the-Year Winter Flounder Distribution among Coastal and Estuarine Habitats

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Spatially and temporally synoptic fish surveys may yield biased data when used for the determination of habitat preference. A study of post-metamorphic winter flounder, *Pseudopleuronectes americanus* (Walbaum 1792), was conducted to investigate this possibility. Sites were selected to determine if densities of juvenile flounder differ between eelgrass bed edge (*Zostera marina*) and dynamic, sandy substrate both inside and outside a Massachusetts estuary. Sites were sampled monthly to characterize settlement, migrations and possible shifts in habitat use over the first year. Representative sites were chosen within the Plymouth Harbor / Kingston Bay / Duxbury Bay (PKD) estuary and outside the PKD inlet in Cape Cod Bay (CCB). Habitat was classified on SCUBA transects, collecting sediment cores and digital quadrat photographs at each site. Fish collections were accomplished using a 1-meter beam trawl towed on three fixed transects at each site (June 2006 - May 2008). Temperature data revealed temperature differences between PKD and CCB, particularly during the growth season. Two-Way ANOVA was used to test for differences in flounder catch between habitats (eelgrass edge vs. sand) and locations (CCB vs. PKD) when flounder were present (July – December 2006 and 2007). A significant interaction between location and habitat was identified. The pattern of dependence between location and habitat effects is synergistic. The effects of habitat and location act together to promote a positive deviation in mean catch. Winter flounder catch was greater in eelgrass edge and sandy habitats within the PKD estuary and lower among comparable habitats in CCB. Post-hoc analysis confirmed that catches were greatest within the estuary in eelgrass edge habitat. Young-of-the-year winter flounder departed the estuary by December and newly settled young-of-the-year did not appear until July. Very small numbers remained in the shallows during winter. Individuals encountered during these months were in poor condition.

Comparison of Growth of Three Species of Flatfish in Seagrass and Bare Sand Habitats in Two Inlets in New Zealand

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Seagrass beds in estuaries and inlets may serve as nursery areas for juvenile fish by supporting increased abundance, growth, survival or recruitment to adult habitats. Although the importance of seagrass habitat has been established for a range of fish species, its importance as flatfish nurseries is unclear. The present study examined size-frequency and growth of juvenile flatfish in an inlet with seagrass and bare sand habitat, Papanui Inlet, and an inlet with only bare sand habitat, Purakaunui Inlet. Three species of flatfish were collected; *Rhombosolea tapirina*, *R. plebeia* and *Peltorhamphus latus*. Juveniles of all three species were significantly smaller in seagrass than in bare sand habitat and the highest proportions of the smallest juveniles occurred in seagrass habitat. Increased abundance of the smallest juveniles was particularly evident in spring and summer. Juveniles of all three species were significantly smaller in Papanui Inlet compared with Purakaunui Inlet. Otolith growth increments were used to estimate age, and thus periodicity of increment formation was examined. Increments were deposited daily in *R. tapirina*, but increment formation in *R. plebeia* and *P. latus* was not confirmed. Growth estimates for these two species were based on the production of one increment per day. Growth rates of juvenile *R. plebeia* and *P. latus* were higher in bare sand, while growth of juvenile *R. tapirina* was slightly higher in seagrass. Growth rates of juvenile *R. tapirina* and *R. plebeia* between inlets were similar.

Examination of biological and environmental variables in relation to juvenile growth indicated sediment characteristics and foraging efficiency may be more important than prey availability in distribution and growth of juveniles. For juveniles of all three species, seagrass offered little benefit in terms of growth, but appeared to be essential habitat for the smallest juveniles possibly due to increased burying capabilities and protection from predation. Limited distribution and the presence of larger juveniles in Purakaunui Inlet suggested transient usage of this inlet compared with Papanui Inlet. The findings of this study indicate the importance of studying the nursery role on an inlet-by-inlet and species-by-species basis to determine appropriate conservation and management strategies for flatfish populations.

Session VI *11:30 p.m.*

What Do Winter Flounder Eggs and Sediment Particles Have in Common?

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In spite of the attention drawn to winter flounder in recent years due to progressive population decline, important aspects of their early life history remain poorly understood. One knowledge gap pertains to delineation of spawning habitat in urbanized estuaries. Most harbors within their range are highly modified from historical bathymetry contours, water quality conditions, and distributions of hard bottoms and submerged aquatic vegetation. Discerning comparative values of existing habitat types such as navigation channels, shoreline margins, marinas and piers, and shoals as spawning habitat poses technical challenges. Conventional ichthyoplankton sampling to date has proven to be inadequate to confirm precise locations of primary spawning habitat. Consequently, viable spawning habitat attributes are poorly defined. Based on existing knowledge of the physical properties of winter flounder eggs, we propose that newly developed modeling capabilities represent a promising area of research linking physical and biological processes. Beginning with an assumption that the negative buoyancy and highly adhesive characteristics of newly fertilized winter flounder eggs are adaptive means of retaining eggs in favorable habitats through hatching, we explored this using sophisticated hydrodynamic and particle tracking models to predict habitat associations for eggs represented as particles. A hydrodynamic model of appropriate grid resolution is used to map bottom shear stresses. In theory, areas of low shear would be depositional areas for both sediment and egg particles. Retention of eggs would be dependent on bottom shear stresses remaining below a critical threshold, above which eggs would be transported by prevailing flows. The interaction between the egg and the substrate would change in nature as the degree of adhesiveness declined through time. The friction parameter of the egg particle could be accommodated within the particle tracking component of the modeling application. Egg trajectories from primary spawning habitats could then be used to estimate temporal shifts in egg distribution among habitat types, e.g., from shallow shoals into deep channels. The modeling approach may serve as a screening tool to guide conventional ichthyoplankton sampling, which in turn could be used to calibrate model applications in a given harbor. Confidence in model output could be gained by laboratory investigations of interactions between eggs and the sediment bed, including quantification of the friction, or adhesion parameter. To illustrate a typical spawning habitat mapping and egg transport application, a hypothetical scenario of egg deposition and fate on shoals in Newark Bay, New Jersey is presented.

Session VI *11:50 p.m.*

Simulation of Dredging-Induced Sedimentation on Winter Flounder Spawning Habitat

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This study investigates the fate of sediment suspended due to dredging at Newark Bay, New Jersey as an exposure characterization for winter flounder spawning habitat. Winter flounder, a recreationally and commercially significant fish, has recently become of interest due to its steady population decline over the last twenty years. This decrease has several perceived sources, including threatened habitat due to egg burial near dredging operations. The Particle Tracking Model (PTM), a USACE developed model, was utilized to study dredged sediment transport and deposition in this area. The development of tools which predict sediment transport due to dredging operations is a critical advance to the field of dredged material management. It has become crucial that quantitative predictions of the fate of fine-grained and other sediments suspended during dredging and placement be determined prior to dredging. These predictions are used to assess the impact of dredging and placement operations on contaminant transport, sensitive habitat, endangered species, rehandling, and beneficial use activity. PTM is designed specifically to predict the far-field fate of sediment suspended during dredging and placement. PTM is a Lagrangian particle tracking model which simulates sediment movement of multiple sediment types in a flow field, while including processes such as erosion, transport, settling, deposition, and resuspension. Given the time-dependent hydrodynamics of a system, PTM tracks particles through the flow field. The particle movement is a function of not only the velocity components of the flow, but also other additional characteristics that affect sediment transport such as particle-bed interactions, particle settling rates, and a multitude of other influences. In this project, PTM is used in combination with dredging source models, which provide predictions of dredging resuspension rates as sediment sources in the model. PTM results were evaluated to determine predicted sediment transport and deposition in suspected winter flounder spawning habitat regions.

Assessment of External Operculum Loop Tags as a Method of Individually Identifying Cage Cultured Atlantic Halibut (*Hippoglossus hippoglossus*) in Commercial Research Trials

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Atlantic halibut production is in the early commercialization stages in Atlantic Canada. Robust health and productivity monitoring is required to continue improvements of farming methods and establish reliable production figures for further financial investment. Fish implanted with passive integrated transponder (PIT) tags were used to track individual fish performance in a longitudinal growth trial under commercial cage culture conditions in the lower Bay of Fundy, New Brunswick. A subset of the population was randomly assigned to receive operculum FT-4 lock-on tags which are routinely used by investigators to identify halibut in growth trials. Tag retention was 77.6% over 554 days. Operculum tagging did not significantly influence survival rates under normal conditions. However, immediately following a stressful handling event operculum-tagged halibut were 1.3 (*95% CI*: 1.1, 1.5) times more likely to die than controls. The final weight of externally-tagged halibut was 19.9% *(95% CI: 14.0, 25.4%)* lower than non-tagged controls indicating that FT-4 Lock-on tags can negatively bias growth measures of halibut in commercial scale trials.

Abstracts
Poster Presentations

Long-term Patterns in Use of an Intertidal Salt Marsh Basin by Flatfishes in South Carolina, USA

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Collection of nekton using identical sampling methods over long periods is not always possible. Here we describe efforts to assess patterns of flatfish habitat use and growth, and their relationships with environmental conditions over 19 years. Flatfishes were collected from an intertidal salt marsh basin in North Inlet estuary, South Carolina, USA using a bag seine during low tide. Semi-monthly samples from 1984 to 2002 yielded six species of flatfishes that were mostly juveniles. The most abundant species was the blackcheek tonguefish, *Symphurus plagiusa*, which experienced a significant long-term increase over the years that was correlated with an increase in water temperature. The second-most abundant species was the southern flounder *Paralichthys lethostigma*, which experienced no significant change in abundance over the course of the study. The bay whiff, *Citharichthys spilopterus,* was the third-most abundant species, but there was high annual variability with no overall trend over time or with temperature. The fourth most abundant species was the summer flounder, *Paralichthys dentatus*. There was no long-term pattern found for this species. Overall, multiple species used the intertidal habitat during the warmest months and, although arrival times generally coincided, abundances were not correlated suggesting that independent factors affected recruitment to the estuary.

Winter Flounder Stock Enhancement: Examining the Onset of Wild Weaning in Pellet-reared Fish

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The commercially and recreationally important winter flounder (*Pseudopleuronectes americanus*) is commonly found from Labrador, CAN to Georgia, USA, but is most abundant in the Gulf of Maine. Like most groundfish species off the NE coast of North America, catches have steadily declined over the past 25 years. Natural winter flounder stocks may be enhanced through captive rearing programs, in which fish are raised in hatcheries and released once they are large enough to avoid most natural mortality. The appropriate diet must be selected for cultured fish to ensure that they will be able to transition to feeding in the wild. We conducted a caging study in 2007 wherein laboratory-reared, juvenile winter flounder (45-65 mm TL) were released into the wild and retrieved over a series of time intervals (3-51 hrs post-release). Stomach contents of preserved specimens were quantified and identified. Analyses indicate that winter flounder raised on a formulated diet in a laboratory will first begin to wean onto a wild diet after 12 hrs. After 33 hrs post-release, almost all released flounder contained food in their stomachs. The most common food items detected were polychaetes and copepods. Other less commonly observed, but still prevalent, prey items included amphipods, nematodes, and bivalves, such as mussels. Small stones were also found in the stomachs of some specimens. This research will allow us to evaluate the success of releasing captively-reared fish into the wild and will provide a foundation for comparative studies with fish reared on live diets in the laboratory or wild fish.

Ontogenetic Development of the Digestive Tract in Pre- and Post- metamorphic Winter Flounder

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Winter flounder are a commercially and recreationally important species in the Gulf of Maine, and due to large declines in catches, they have become the focus of stock enhancement research at the University of New Hampshire. Typically in marine fish culture, larvae are initially fed live food (e.g., rotifers, *Artemia*) and are then weaned onto formulated diets as they attain a size or developmental state that supports consumption of these artificial feeds. Although past studies have examined the digestive development of winter flounder during the first weeks of life and described gut morphology and function at adult stages, few have detailed the digestive state between metamorphosis and maturity. Since this is the size/age/stage when reared flounder are generally weaned onto formulated feeds, this presents a gap in our knowledge that can be potentially vital in our understanding of fish weaning strategies. Pre- and post-metamorphic juvenile winter flounder (7-30 mm TL, 20-80 DPH) will be sampled and observed to describe morphological changes of the digestive tract. This study presents a more complete description of winter flounder digestive development and provides a basis for formulating optimal weaning strategies.

Abundance and Diet of the Winter Flounder (*Pseudopleuronectes americanus*) in a Long Island Sound Marina

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Clinton Harbor, Connecticut has been historically known as a nursery habitat for juvenile winter flounder (*Pseudopleuronectes americanus*). Lasting from June through December 2007, 10 sites per month were beam-trawled within Cedar Island Marina, Clinton Harbor Connecticut. In total, 212 winter flounder specimens were captured. In addition, 1 windowpane (*Scopthalmus aquosus*) and 2 flounder (*Paralichthys spp.)* were captured. All *P. americanus* were considered Young-of-the-year with total lengths ranging from 9 – 129 mm. Mean total length did increase per month and was at its highest in November (94.1 mm TL) and December (93.6mm TL). Mean total length of all *P. americanus* was 46.1 mm. Winter flounder were most abundant during June, July and August (N = 169), however, at least one specimen was caught in every month of the project.

Fifty-one specimens were randomly chosen for diet analysis. At least one identifiable prey item was found in 22 specimens, 18 had unidentifiable detritus within their guts while 11 specimens were completely empty. Crustaceans were the most prominent taxa. The invasive crab *Hemigrapsus sanguineus*, with few known predators in Long Island Sound, was found within the contents of one *P. americanus*.

External Tagging Techniques on Summer Flounder for Short-term Studies

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We tried several techniques to enhance development of fish tagging and sex determination for flatfishes. To do this we examined retention time of external transmitters attached to summer flounder, *Paralichthys dentatus,* with a single anchor, and used ultrasonography to assess the sex.

Transmitters are used to track fish, and are usually surgically implanted or double anchored (Bridger and Booth 2003). Intra-muscular single anchor attachment is needed as an alternative to surgery for short-term studies requiring rapid tagging of numerous fish, but might bias behavior or fall out.

Two holding tanks each held 8 fish, 4 tagged and 4 untagged. Over a two-week period, tagged and untagged fish were compared for behavior and tag retention. Approximately 94% of the experimental fish retained their dummy transmitter tags while still exhibiting natural characteristics. Summer flounder responded well to this tagging technique so it can be used for fast processing of numerous fish.

Paralichtys dentatus are an economically and ecologically important flatfish abundant in the mid-Atlantic Bight from Cape Cod to North Carolina (Grosslein and Azaravitz 1982). Flatfish are not easily implanted with tags due to the orientation of their stomach and body cavity size.

External tagging, by means of intra-muscular t-bar attachment, has the benefit of being quick, easy and leads to sufficiently high retention times without negatively affecting normal fish physiology or behavior, which is key to any successful biotelemetry study.

The Feasibility of Rearing White Worms (*Enchytraeus albidus*) as a Potential Live Diet Feed for Winter Flounder Stock Enhancement

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White worms (*Enchytraeus albidus*) are frequently cultured by aquarists and fish hobbyists in order to provide a nutritious source of live food to fish. The cultivation of white worms is fairly easy and inexpensive, but the extent of reproduction and growth can vary according to the culture conditions provided. In this study, white worms were reared in a variety of experimental conditions including different container types (wood or plastic), growth media (soil or coconut fiber), and temperatures (10 or 20ºC) while under a stable food ration. The increase in worm population number and mean weight was measured over a 12-week period. Worms reared at 20ºC were significantly more abundant ($p < 0.05$) than those reared at 10ºC. The most productive treatment consisted of worms raised in plastic containers containing soil at 20ºC. This study elucidates conditions for obtaining maximum abundance, weight and nutritional content in white worm culture. Mass culture of white worms may be beneficial in the feeding of reared winter flounder (*Pseudopleuronectes americanus*) for stock enhancement.

Summer Flounder Size and Spatial Distribution Patterns in Virginia's Chesapeake Bay and East Coast Waters during 2006 and 2007 Based upon Recreational Fishers Tagging Data

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The tightening of recreational fishery regulations on summer flounder appear to be positively impacting the occurrence of multiple year classes of fish in the recreational fishery, particularly in Virginia's Chesapeake Bay and coastal inlet waters. The Virginia Game Fish Tagging Program (VGFTP) is an angler-assisted tagging program cooperatively operated using saltwater fishing license funds by VIMS Sea Grant Marine Advisory Program and the Virginia Saltwater Fishing Tournament under VMRC. The program's database includes over 1,800 and 2,500 tagged flounder records for 2006 and 2007, respectively. These fish typically range in total length from 152 to 470-483 mm, the length distribution of the tagged fish "artificially truncated" at the maximum legal size limit set annually for Virginia's recreational fishery. A 9-10% recapture reporting rate of tagged fish has produced approximately 800 and 1,000 tagged flounder recapture records, respectively, for the two years. The database enhances fishery independent survey data for the species. Regarding the timing and size classes of fish entering the angling fishery, tagged fish data document differences occurring between ocean inlet waters, lower Bay waters, and lower Bay estuaries. In 2006 and 2007, single and multiple recaptures of flounder at select fishing piers and other sites documented the strong seasonal association of flounder with such sites. Multiple recapture records at select sites documented benefits of responsible catch and release fishing as the same fish were sometimes recaptured two, even three times over periods of 5-90 days post tagging. A few tagged flounder were recaptured five times post tagging, further documenting the hardiness of the species under angling fishing conditions. Recaptures of flounder tagged in a given year throughout the lower Bay and waters behind certain ocean inlets showed some flounder moving offshore during subsequent winter months. However, some tagged flounder over-wintered in bay and nearshore waters. Some fish tagged in a given year were recaptured in Bay/Inlet waters the following year. However, other flounder recaptures showed the fish dispersing significantly north and south the year after having been tagged in Virginia waters, i.e., recaptures occurred from North Carolina to Rhode Island waters. The Game Fish Tagging Program is helping anglers take an active role in improving data used to manage the summer flounder fishery.

An RNA:DNA-based Growth Model for Young-of-the-Year Winter Flounder, *Pseudopleuronectes americanus*

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A laboratory calibration experiment was conducted to determine the relationship between nucleic-acid based parameters and growth rate in young-of-the-year winter flounder (*Pseudopleuronectes americanus*). Three temperatures and three feeding levels were used to produce a variety of growth rates. Nucleic acid analyses were conducted on white muscle tissue using an ultraviolet absorption assay. RNA concentration (µg mg^{-1} wet tissue weight) and the ratio of RNA:DNA (R/D) were positively correlated with a weight-based instantaneous growth coefficient (G_W) ($r = 0.42$ and 0.72, respectively). Fifty-one percent of the variability in growth rate was explained by the simple linear regression $G_W = -0.02615 + (0.00848)\ R/D$ ($p < 0.0001$). This model can be used to estimate recent growth rates for early juvenile winter flounder (27-52 mm standard length) at temperatures ranging from 11 to 24ºC.

A Preliminary Look at the Correlation Between Water Temperature and Early Life Stage Winter Flounder Abundance and Lengths in New York/New Jersey Harbor

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Winter flounder spawning generally occurs in shallow estuaries during winter and early spring at water temperatures between 1 and 10°C with primary egg production occurring between 2 and 5°C in New England waters. Cold water spawning may be a mechanism to avoid heavier spring predation and previous studies have shown that elevated water temperatures may lead to increased predator activity and consequent predation. Aquatic biological surveys of New York/New Jersey Harbor were conducted from 2002 to 2007 in which early life stage (eggs and larvae) winter flounder were collected and corresponding water temperatures recorded. In this study, monthly average densities of eggs and larvae were plotted against average monthly water temperatures in three areas of the Harbor: Lower Bay, Upper Bay and Newark Bay/Arthur Kill. Laboratory measurements of yolk-sac and post-yolk sac larvae, using microscopy imaging analysis technology, were then used to compare mean monthly lengths of the larvae to changes in water temperature. Preliminary analysis may suggest that winter flounder spawning success and growth can be related to water temperature.

Diet Composition of Wild Juvenile Winter Flounder Collected Near the Piscataqua River Mouth, Great Bay Estuary, New Hampshire

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The habitats of winter flounder (*Pseudopleuronectes americanus*) include intertidal, subtidal, and offshore areas, but among these, perhaps the most important are the estuarine and inshore areas used for spawning and early development. Juvenile flounder will spend their initial, formative 1-2 years in these areas feeding on small benthic organisms. Diets of juvenile winter flounder are often characterized differently than that of larger individuals. Understanding the feeding ecology of these smaller, wild individuals may provide insight for stock enhancement rearing and weaning strategies. Juvenile winter flounder collected via seine from a cove surrounding the University of New Hampshire Coastal Marine Laboratory in Newcastle, NH were examined for stomach content analysis. Diet composition, abundance and Index of Relative Importance (IRI) were analyzed to describe predominant taxa. In addition, we examined the relationship between body size and food type. Primary food choices included polychaetes, copepods, and amphipods. This study provides a valuable basis for comparative research with captive winter flounder reared for stock enhancement in New Hampshire.

Abundance and Distribution Trends for Four Species of Flatfish along the Maine and New Hampshire Coasts

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The Maine-New Hampshire Inshore Trawl Survey was initiated in 2000 to fill a significant information gap on approximately two-thirds of the inshore portion of the Gulf of Maine. Now in its 9th year, the MENH Inshore Trawl Survey is the longest continuous time series on the approximately 80% of the U.S. Gulf of Maine's inshore waters where fishery independent stock assessment had been virtually absent. Conducted biannually, the survey completes 85-115 tows along the coastal waters off the coast of Maine and New Hampshire out to the 12 mile limit. Its overall goal is to provide a quantitative time-series on the distribution and relative abundance of benthic marine resources in these waters and is a successful collaboration between Maine's and New Hampshire's commercial fishermen and state resource scientists. The survey catches significant numbers of roughly 30 species of finfish and 10 invertebrate species. Spring and fall yearly abundance indices, seasonal catch at length data, bubble plots of species distribution, and maturity stage estimates are provided for four flatfish species, winter flounder, *Pseudopleuronectes americanus,* American plaice, *Hippoglossoides platessoides,* witch flounder, *Glyptocephalus cynoglossus,* and yellowtail flounder, *Limanda ferruginea.*

Using Stable Isotopes of Carbon (d^{13}C) and Oxygen (d^{18}O) to Differentiate Winter Flounder Nursery Areas

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Elemental fingerprinting has become a powerful tool in fisheries science for identifying fish migration patterns and seasonal changes in habitat use, and for delineating the nursery origins of adult fish populations. In this study we investigated the temporal variability in isotopic signatures of oxygen (d^{18}O) and carbon (d^{13}C) in fish otoliths and whether these signatures could be used as natal fingerprints for juvenile winter flounder *(Pseudopleuronectes americanus*) populations.

Juvenile winter flounder (45-65 mm) were collected (2002-2004) from different locations and habitats (unvegetated, macroalgae, and eelgrass) within Narragansett Bay, RI (USA), surrounding coastal ponds, and from a tidal river system. Sagittal otoliths were removed from the vestibular apparatus, cleaned, and analysed for d^{18}O and d^{13}C using a ThermoFinnigan MAT Delta Plus XL Mass Spectrometer connected to a Gas Bench II carbonate device.

Mean δ^{18}O values in juvenile winter flounder otoliths ranged from -0.75 ± 0.14 to -4.83 ± 0.35 parts per thousand (‰) among nursery areas. Salinity measurements were relatively constant from year-to-year at each of the stations. There were significant positive correlations between salinity and mean d^{18}O values in otolith carbonate for each year (2002: r=0.93; 2003: r=0.80; 2004: r=0.97). Stable isotopes of oxygen in otolith carbonate were more depleted at sites with freshwater inputs compared to sites having higher salinity. Recorded temperatures varied at each station and there were negative correlations (2002: r=0.36; 2003: r=0.22) between d^{18}O and temperature for 2 out of the 3 years sampled. Our results suggest that differences in d^{18}O were related more strongly to salinity than they were to temperature.

Measured d^{13}C values in juvenile winter flounder otoliths followed a similar trend year-to-year at each of the stations and ranged from -3.87 ± 0.70 to -0.44 ± 0.33 ‰. Fish collected from sites receiving more terrestrial and anthropogenic inputs had the lowest d^{13}C values. In comparison, fish collected from sites dominated by more marine sources of carbon had the highest d^{13}C values. It is unclear what sources (diet, temperature, metabolic rate, or dissolved inorganic carbon) were responsible for the differences in d^{13}C values in otolith carbonate. We speculate that the carbon isotopic composition was derived from the dissolved inorganic carbon of the water or food sources at each of the stations. Based on these results, d^{18}O and d^{13}C values in otolith carbonate may help differentiate juvenile winter flounder nursery areas.

The Blood Chemistry of Fin-rotted Winter Flounder from New Haven Harbor in 1987-1988: The Response of Blood Parameters to Increasing Fin Rot Intensity

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The intensity of fin rot was scored on winter flounder from New Haven Harbor based on the percentage of fin loss into six categories: 0, 10, 25, 50, 75, and 100. The blood parameters bilirubin, calcium, hematocrit, phosphate, osmolality, and total protein were then placed into the six disease intensity categories and tested statistically in a pair-wise manner to determine significant differences between Category 0 values and those falling within the remaining intensity categories. The strongest response to increasing disease intensity was elicited by hematocrit, which fell away to very low values as disease intensity progressed, allowing the fitting of a Linear Regression plot. Calcium values were shown to increase significantly when fin loss reached 25%. Bilirubin values also declined with progressing fin loss. Muscular emaciation of fin-rotted fish was demonstrated by ANCOVA analysis of female and male linear regressions: body thickness at the spine near the pectoral girdle versus standard length. A significant statistical relationship was demonstrated between the occurrences of fin rot and the Bent Fin Ray syndrome by logistic regression testing. Muscle emaciation is confirmed in affected flounder. The relationship between the Bent Fin Ray syndrome and the presence of fin rot is explored.

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