Northeast Fisheries Science Center Reference Document 04-13

Ninth Flatfish Biology Conference, December 1-2, 2004, Water's Edge Resort, Westbrook, Connecticut

by

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

November 2004

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03-17 **Report of the 37th Northeast Regional Stock Assessment Workshop (37th SAW): Advisory Report.** [By Northeast Regional Stock Assessment Workshop No. 37.] September 2003.

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04-03 **Report of the 38th Northeast Regional Stock Assessment Workshop (38th SAW): Stock Assessment Review Committee (SARC) Consensus Summary of Assessments.** [By Northeast Regional Stock Assessment Workshop No. 38.] January 2004.

04-04 **Report of the 38th Northeast Regional Stock Assessment Workshop (38th SAW): Advisory Report.** [By Northeast Regional Stock Assessment Workshop No. 38.] January 2004.

04-05 **Proceedings of the Seventh Meeting of the Transboundary Resources Assessment Committee (TRAC), Woods Hole, Massachusetts, May 27-29, 2003.** By W.J. Overholtz, TRAC chairman. [A report of Transboundary Resources Assessment Committee Meeting No. 7]. February 2004.

04-06 **Stock Assessment of the Gulf of Maine - Georges Bank Atlantic Herring Complex, 2003.** By W.J. Overholtz, L.D. Jacobson, G.D. Melvin, M. Cieri, M. Power, D. Libby, and K. Clark. February 2004.

04-07 **Identification and Description of the Common Sponges of Jeffreys Ledge as an Aid in Field Operations.** By K. McCarthy. April 2004.

04-08 **Revised Procedures for Calculating Regional Average Water Properties for Northeast Fisheries Science Center Cruises.** By D.G. Mountain, M.H. Taylor, and C. Bascuñán. April 2004.

04-09 **Estimation of Striped Bass Discards in the Multispecies Groundfish Fishery during the 2002 Fishing Year (May 2002 - April 2003).** By G.R. Shepherd. June 2004.

04-10a **39th Northeast Regional Stock Assessment Workshop (39th SAW) Assessment Summary Report.** [By Northeast Regional Stock Assessment Workshop No. 39.] July 2004.

04-10b **39th Northeast Regional Stock Assessment Workshop (39th SAW) Assessment Report.** [By Northeast Regional Stock Assessment Workshop No. 39.] July 2004.

04-11 **Bycatch of Sea Turtles in the Mid-Atlantic Sea Scallop (*Placopecten magellanicus*) Dredge Fishery during 2003.** By K.T. Murray. August 2004.

04-12 **Description of the 2003 Oceanographic Conditions on the Northeast Continental Shelf.** By C. Bascuñán, M.H. Taylor, and J.P. Manning. September 2004.

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Ninth Flatfish Biology Conference, December 1-2, 2004, Water's Edge Resort, Westbrook, Connecticut

by

Conference Steering Committee:
Renee Mercaldo-Allen (chair)[1], Anthony Calabrese (retired)[1], Donald J. Danila[2], Mark S. Dixon[1], Ambrose Jearld[3], Deborah J. Pacileo[4], Chris Powell[5], and Sandra J. Sutherland[3]

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[5]Rhode Island Dept. of Environmental Management, Div. of Fish & Wildlife, 3 Fort Wetherill Rd., Jamestown, RI 02835

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

November 2004

Northeast Fisheries Science Center Reference Documents

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Flatfish Biology Conference

December 1st & 2nd, 2004
Water's Edge Resort, Westbrook, CT

Oral Presentations
Salons A/B

Wednesday, December 1st

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

8:45 a.m. Welcome and Introduction
Renee Mercaldo-Allen
National Marine Fisheries Service
Northeast Fisheries Science Center
Milford, CT

Frank Almeida
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

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

9:00 a.m. Movement of Yellowtail Flounder: A Cooperative Tagging Study
Steve Cadrin[1], Azure Westwood[1], Larry Alade[1], Nathan Keith[1], Rodney Rountree[2], Dave Martins[2], Ross Kessler[2], Darin Jones[2], April Valliere[3], Jeremy King[4], John Boardman[4], Heath Stone[5], and New England Fishermen
[1]NMFS/NEFSC/Woods Hole Laboratory, Woods Hole, MA, [2]School for Marine Science and Technology, New Bedford, MA, [3]Rhode Island Division of Fish and Wildlife, Jamestown, RI, [4]Massachusetts Division of Marine Fisheries, Pocasset, MA and [5]Canada Department of Fisheries and Oceans, NB, Canada

9:20 a.m. Variation in Growth of Juvenile Plaice on a British Nursery Beach: How Homogenous Are Flatfish Habitats at Small Temporal and Spatial Scales?
Benjamin J. Ciotti and Timothy E. Targett
University of Delaware, College of Marine Studies, Lewes, DE

9:40 a.m. Annual Movement-Site Fidelity Patterns of Summer Flounder Within Virginia and From State to Mid-Atlantic Waters (2000-2004)

Jon A. Lucy[1] **and Claude M. Bain III**[2]
[1]College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, VA; and [2]Virginia Saltwater Fishing Tournament, Virginia Marine Resources Commission, Virginia Beach, VA

10:00 a.m. Resource Partitioning Between Four Species of Flounder in Narragansett Bay

Kathryn Banahan
University of Rhode Island, School of Oceanography, Narragansett, RI

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

Session II

Donald J. Danila, Chair

Dominion Nuclear Connecticut, Inc., Millstone Environmental Laboratory
Waterford, CT

10:40 a.m. Winter Flounder (*Pseudopleuronectes americanus*) Spawning and Early Life History in the New York and New Jersey Harbor Estuary

Jenine Gallo[1], **Ron Pinzon**[1], **John Duschang**[2], **and Matthew J. Rattenberg**[2]
[1]US Army Corps of Engineers-New York District, New York, NY and [2]Lawler, Matusky and Skelly Engineers, Pearl River, NY

11:00 a.m. Acute and Chronic Stress in Juvenile Summer Flounder *Paralichthys dentatus*: Effects on Plasma Cortisol Concentrations and Growth

Steven Gavlik[1] **and Jennifer L. Specker**[2]
[1]UMASS-Dartmouth, Biology Department, North Dartmouth, MA, and [2]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

11:20 a.m. Environmental Gene Expression in Winter Flounder, *Pseudopleuronectes americanus*

Peter F. Straub[1,2] **and Ashok D. Deshpande**[1]
[1]NMFS/NEFSC/Howard Marine Laboratory, Highlands, NJ and [2]Richard Stockton College, Biology Program, Pomona, NJ

11:40 a.m. Winter Flounder in Western Long Island Sound: Facts, Photos, Fallacies and Fate – It Ain’t Rocket Science!

Arthur Glowka
Fisherman - Western Long Island Sound, Stamford, CT

12:00 p.m. Ecology and Biological Strategies of *Etropus crossotus* and *Citharichthys spilopterus* (Pisces: Bothidae) Related to the Estuarine Plume, Gulf of Mexico

Patricia Sanchez-Gil[1], Alejandro Yañez-Arancibia[2], Margarito Tapia Garcia[3], John W. Day[4], Charles A. Wilson[4], and James H. Cowan[4]
[1]Universidad Autonoma Metropolitana, Doctorado en Ciencias Biologicas, Mexico, [2]Coastal Ecosystem Unit, Institute of Ecology, México, [3]Departamento de Hidrobiología, Universidad Autónoma Metropolitana, Mexico and [4]Louisiana State University, Department of Oceanography and Coastal Sciences, Coastal Ecology Institute, School of the Coast and Environment, Baton Rouge, LA

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

Session III

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

1:20 p.m. Stage-Specific Effects of Cortisol on Growth and Food Consumption by Larval Summer Flounder

Danielle R. Reardon[1,2], David A. Bengtson[2], and Jennifer L. Specker[1]
[1]University of Rhode Island, Graduate School of Oceanography, and [2]University of Rhode Island, Department of Fisheries, Animal and Veterinary Sciences, Kingston, RI

1:40 p.m. Feeding in Larval Summer Flounder: Regulation by Hormones

Jason P. Breves[1], David A. Bengtson[2], and Jennifer L. Specker[1]
[1]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI and [2]University of Rhode Island, Department of Fisheries, Animal and Veterinary Sciences, Kingston, RI

2:00 p.m. Abundance and Distribution of Juvenile Flatfishes in a Near-Shore Shallow Water Habitat in New Haven Harbor

Jose J. Pereira, Ronald Goldberg, and Paul Clark
NMFS/NEFSC/Milford Laboratory, Milford, CT

2:20 p.m. Observing Larval Supply Processes on Coastal Ocean Seascapes: Adaptive Surveys in the New Jersey Shelf Observation System and a Preliminary Description of Pelagic Habitat Associations with Special Reference to Larval Flatfishes

John Manderson[1], John Quinlan[2], and Patricia Shaheen[3]
[1]NMFS/NEFSC/Howard Marine Laboratory, Highlands, NJ, [2]Rutgers University, IMCS, New Brunswick, NJ, and [3]Wagner College, Staten Island, NY

2:40 p.m. Effects of Dredging on the Functional Role of Nursery Habitats for Juvenile Flatfishes. Part I: Distribution of Juvenile Summer and Winter Flounder in the Pre-dredged Assawoman Canal, Delaware, with Reference to Bottom Type
Brian P. Boutin and Timothy E. Targett
University of Delaware, College of Marine Studies, Lewes, DE

3:00 p.m. Assessment of Power Plant Entrainment in Comparison to Long-Shore Ichthyoplankton Transport
Donald Galya[1], Michael Scherer[2], James Herberich[1], Stephanie Kelly[1], and Jacob Scheffer[3]
[1]ENSR Corporation, Westford, MA, [2]Marine Research Inc., Falmouth, MA, and [3]Pilgrim Nuclear Power Station, Plymouth, MA

3:20 p.m. **Refreshment Break**

Session IV

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

3:40 p.m. Observations on the Systematics of *Etropus crossotus* Jordan & Gilbert 1882
Alicia Long
NMFS/National Systematics Laboratory, Smithsonian Institution, National Museum of Natural History, Washington, DC

4:00 p.m. Developmental Changes in Gut, Skin, and Gill Epithelial Glycoconjugates in Summer Flounder (*Paralichthys dentatus* L): A Lectin Histochemical Study
Bruno Soffientino[1], Marta Gomez-Chiarri[2], and Jennifer L. Specker[1]
[1]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, and [2]University of Rhode Island, Department of Animal and Veterinary Science, Kingston, RI

4:20 p.m. The Cortisol Antagonist, RU486, Inhibits Salinity Tolerance in Larval Summer Flounder
Philip A. Veillette, Maricruz Marino, Misty M. Garcia, and Jennifer L. Specker
University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

4:40 p.m. *In Situ* Effects of Suspended Particulate Loads Produced by Dredging on Eggs of Winter Flounder *(Pseudopleuronectes americanus)*
Grace Klein-MacPhee[1], William K. Macy[1], and Walter Berry[2]
[1]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI, and [2]U.S. EPA, Office of Research and Development, National Health and Environmental Effects Laboratory, Atlantic Ecology Division, Narragansett, RI

5:00 p.m. Impacts of Hypoxia on Juvenile Fish Growth: Evidence from Laboratory and Field Studies
Kevin L. Stierhoff and Timothy E. Targett
University of Delaware, College of Marine Studies, Lewes, DE

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

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

Thursday December 2nd

8:15 a.m. **Registration/Coffee/Continental Breakfast**

Session V

Sandra Sutherland, Chair
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

8:40 a.m. Predatory Impact of the Green Crab (*Carcinas maenas)* on Post-Settlement Winter Flounder *(Pseudopleuronectes americanus*) as Revealed by Immunological Dietary Analysis
David L. Taylor
Rutgers University, Marine Field Station, Institute of Marine and Coastal Sciences, Tuckerton, NJ

9:00 a.m. Study of Class-0 Benthic Fish Species in Norwalk Harbor, CT, Concentrating on Winter Flounder
Elise Brzuska[1], Tom Gethin-Jones[1], Liz Conover[1], Liz Boggs[1], Margot Schloss[1], Aj Pikal[1], Jim Lucey[1],and Dick Harris[2]
[1]Wilton High School, Wilton, CT, and [2]Earthplace-The Nature Discovery Center, Westport, CT

9:20 a.m. Investigations into the Growth of Yellowtail Flounder In and Around a Closed Area
Kathy L. Lang[1], Christopher M. Legault[1], Andrew J. Applegate[2], Heath H. Stone[3], Jay Burnett[1], and Vaughn M. Silva[1]
[1]NMFS/NEFSC/Woods Hole Laboratory, Woods Hole, MA, [2]Northeast Fisheries Management Council, Newburyport, MA, and [3]Department of Fisheries and Oceans, Biological Station, St. Andrews, NB, Canada

9:40 a.m. The Winter Flounder Gender Bender: What Are We Culturing?
Elizabeth A. Fairchild, W. Huntting Howell, Nathan Rennels, and James Sulikowski
University of New Hampshire, Department of Zoology, Durham, NH

10:00 a.m. Spatially Explicit Modeling of the Effects of a Thermal Discharge and Ambient Temperatures on Winter Flounder, *Pseudopleuronectes americanus*
Robert J. O'Neill, Thomas L. Englert, and Jee K. Ko
Lawler, Matusky and Skelly Engineers LLP, Pearl River, NY

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

Session VI

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

10:40 a.m. Flatfishes of Chesapeake Bay: An Overview of Species Diversity, Abundance and Occurrence
Thomas A. Munroe[1], Hank Brooks[2], and Wendy Lowery[2]
[1]NMFS/National Systematics Laboratory, Smithsonian Institute, Washington, DC, and [2]College of William and Mary, Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, VA

11:00 a.m. Scale Formation in Selected Western North Atlantic Flatfishes
Kenneth W. Able and Jennifer C. Lamonaca
Rutgers University Marine Field Station, Institute of Marine and Coastal Sciences, Tuckerton, NJ

11:20 a.m. The Importance of Freshwater Riverine Habitat, Particularly as a Nursery for *Paralichthys lethostigma*, in the Atchafalaya River Delta, Louisiana
Bruce A. Thompson[1], Gary W. Peterson[2], and Jason K. Blackburn[1,3]
[1]Louisiana State University, Coastal Fisheries Institute, Baton Rouge, LA,
[2]Louisiana State University, Coastal Ecology Institute, Baton Rouge, LA, and
[3]Louisiana State University, Department of Geography, Baton Rouge, LA

11:40 a.m. Temporal Trends in Distribution and Abundance of Flatfishes in Lower Chesapeake Bay and its Major Tributaries
Wendy A. Lowery[1], Hank Brooks[1], and Thomas A. Munroe[2]
[1]College of William and Mary, Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, VA and [2]NMFS/National Systematics Laboratory, Smithsonian Institute, Washington, DC

12:00 p.m. Metabolic Acidosis Stimulates Renal Tubular Sulfate Secretion in the Winter Flounder, *Pseudopleuronectes americanus*
Ryan M. Pelis and J. Larry Renfro
University of Connecticut, Department of Physiology and Neurobiology, Storrs, CT

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

Session VII

Thomas A. Munroe, Chair
NMFS/National Systematics Laboratory, Smithsonian Institute, Washington, DC

1:20 p.m. Behavioral Responses of Summer Flounder and Weakfish to Declining Dissolved Oxygen: Inter- and Intraspecific Comparisons
Damian C. Brady and Timothy E. Targett
University of Delaware, College of Marine Studies, Lewes, DE

1:40 p.m. Abundance and Distribution of *Etropus microstomus* and *Etropus crossotus* in Virginia's Portion of Chesapeake Bay and its Major Tributaries
Hank Brooks[1], Wendy A. Lowery[1], and Thomas A. Munroe[2]
[1]College of William and Mary, Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, VA, and [2]NMFS/National Systematics Laboratory, Smithsonian Institute, Washington, DC

2:00 p.m. An Evaluation of Summer Flounder, *Paralichthys dentatus*, Estuarine Habitat Use Using Acoustic Telemetry
Dana Rowles, Ken Able, and Thomas Grothues
Rutgers University, Marine Field Station, Tuckerton, NJ

2:20 p.m. Ulcerative Dermatitis in Massachusetts Bay Winter Flounder, *Pseudopleuronectes americanus*
Michael Moore[1], Roxanna Smolowitz[2], Kevin Uhlinger[2], Lisa Lefkovitz[3], John Ziskowski[4], George Sennefelder[4], Jeremy King[5], Maurice Hall[6], Jack Schwartz[5], and David Pierce[5]
[1]Woods Hole Oceanographic Institute, Woods Hole, MA, [2]Marine Biological Laboratory, Woods Hole, MA, [3]Battelle, Duxbury, MA, [4]NMFS/NEFSC/Milford Laboratory, Milford, CT, [5]Massachusetts Division of Marine Fisheries, Boston, MA, and [6]Massachusetts Water Resources Authority, Environmental Quality Department, Boston, MA

2:40 p.m. Reduction in Organic Contaminant Exposure and Resultant Hepatic Hydropic Vacuolation in Winter Flounder (*Pseudopleuronectes americanus*) Following Improved Effluent Quality and Relocation of the Boston Sewage Outfall into Massachusetts Bay, USA: 1987-2003

Michael Moore[1], Lisa Lefkovitz[2], Maury Hall[3], Robert Hillman[2], David Mitchell[4], and Jay Burnett[5]

[1]Woods Hole Oceanographic Institution, Woods Hole, MA, [2]Battelle Duxbury Operations, Duxbury, MA, [3]Massachusetts Water Resources Authority, Boston, MA, [4]ENSR International, Westwood, MA, and [5]NMFS/NEFSC/Woods Hole Laboratory, Woods Hole, MA

3:00 p.m. **Adjourn Meeting**

Poster Session
Salon C

Wednesday, December 1st, 6:00 p.m.

Winter Flounder, *Pseudopleuronectes americanus,* Hatching Success as a Function of Burial Depth in the Laboratory

Walter J. Berry[1], Elizabeth K. Hinchey[1], Norman I. Rubinstein[1], and Grace Klein-MacPhee[2]

[1]U.S. Environmental Protection Agency, Office of Research and Development, National Health and Environmental Effects Research Laboratory Atlantic Ecology Division, Narragansett, RI, and [2]University of Rhode Island, Graduate School of Oceanography, Narragansett, RI

Effect of Contaminated Sediments on Mortality and Predation Avoidance in Winter Flounder

Andrew F. J. Draxler[1], Daniel Wieczorek[1], Lori Davias[2], Michael Schafer[1], Yan Waguespack[3], and Bashir Balogun[3]

[1]NMFS/NEFSC/Howard Marine Laboratory, Highlands, NJ, [2]North Carolina State University, Raleigh, NC, and [3]University of Maryland Eastern Shore, Princess Anne, MD

A Comparison of the Use of Estuarine Habitats by Flatfishes in South Carolina and Georgia

Guy' DuBeck and Mary Carla Curran

Savannah State University, Department of Natural Sciences and Mathematics, Savannah, GA

Bay Whiff Distribution and Abundance in Galveston Bay, Texas

Lindsay Ann Glass

Texas A & M, Galveston TX

The Abundance of Flatfishes in Country Club Creek, GA

Karen Harris and Mary Carla Curran

Savannah State University, Department of Natural Sciences and Mathematics, Savannah, GA

Differential Effects of Preservative Methods on American Plaice and Atlantic Cod Ovarian Tissue
Nikolai Klibansky and Francis Juanes
University of Massachusetts, Department of Natural Resources Conservation, Amherst, MA

Use of Shallow Habitats by Juvenile Winter Flounder, *Pseudopleuonectes americanus*, along the Maine Coast
Mark Lazzari
Maine Department of Marine Resources, Boothbay Harbor, ME

Impacts of Size on Growth and Early Maturity in Female Yellowtail Flounder, *Limanda ferruginea* (Storer)
Anthony J. Manning, Margaret P.M. Burton and Laurence W. Crim
Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL, Canada

Real-time PCR Analysis of Steroid Enzyme Gene Expression during Atlantic Halibut (*Hippoglossus hippoglossus*) Development
Makoto Matsuoka[1], Solveig van Nes[2], Øivind Andersen[2], Tillmann Benfey[3], and Michael Reith[1]
[1]National Research Council of Canada, Institute for Marine Biosciences, Halifax, NS, Canada, [2]Norwegian Institute of Aquaculture Research, Aas, Norway, and [3]University of New Brunswick, Department of Biology, Fredericton, NB, Canada

PLEUROGENE: Genomics for the Enhancement of Commercial Production of Atlantic Halibut and Senegal Sole
Makoto Matsuoka[1], Michael Reith[1], Joan Cerdà[2], Harry M. Murray[1], Debbie Martin-Robichaud[3], Brian Blanchard[4], and Susan E. Douglas[1]
[1]Institute for Marine Biosciences, Halifax, NS, Canada, [2]Institut de Ciències del Mar, Consejo Superior de Investigaciones Científicas (CSIC), Barcelona, Spain, [3]Department of Fisheries and Oceans Canada, Biological Station, NB, Canada, and [4]Scotian Halibut Limited, Clarks Harbour, NS, Canada

Effects of Contaminants on Winter Flounder Living in a Sewage-Impacted Estuary-Jamaica Bay, NY
Lourdes Mena[1], Lucia Cepriano[2], Nancy Denslow[3], Martin Schreibman[4], and Anne E. McElroy[1]
[1]Stony Brook University/MSRC, Stony Brook, NY, [2]State University of New York, Farmingdale, NY, [3]University of Florida, Gainesville, FL, and [4]Aquatic Research & Environmental Assessment Center, Brooklyn, NY

Habitat For Flatfish: The Relative Importance of Depth, Temperature and Substrate
Elizabeth T. Methratta, Brian E. Smith, and Jason S. Link
NMFS/NEFSC/Woods Hole Laboratory, Woods Hole, MA

Development of Digestive Capacity in Larval Atlantic Halibut: A Preliminary Survey
Harry M. Murray, Jeffrey W. Gallant, Stewart C. Johnson, and Susan E. Douglas
National Research Council of Canada, Institute for Marine Biosciences, Halifax, NS, Canada

Fish Community Structure of Intertidal Habitats of the Mount Hope Bay Estuary with Emphasis on Juvenile Winter Flounder, *Pseudopluronectes americanus*

Adrienne Pappal
University of Massachusetts-Dartmouth, School for Marine Science and Technology, New Bedford, MA

Regulation of Carbonic Anhydrase-Dependent Renal Sulfate Secretion by Cortisol in Winter Flounder, *Pseudopleuronectes americanus*

Ryan M. Pelis[1,2], James E. Goldmeyer[1], Joseph Crivello[1], and J. Larry Renfro[1]
[1]University of Connecticut, Department of Physiology and Neurobiology, Storrs, CT, and [2]Mount Desert Island Biological Laboratory, Salisbury Cove, ME

A Flatfish Perspective on Asymmetry: What Genes Mediate Southern Flounder Metamorphosis?

Alex M. Schreiber and Yan Tan
Carnegie Institution of Washington, Department of Embryology, Baltimore, MD

Benthic Food Webs on Georges Bank: Where Do Flatfish Fit into the Picture?

Brian. E. Smith, Elizabeth T. Methratta, and Jason S. Link
NMFS/NEFSC, Woods Hole Laboratory, Woods Hole, MA

Elemental Fingerprints of Juvenile Winter Flounder Otoliths From Narragansett Bay, RI and Surrounding Coastal Ponds

Bryan K. Taplin[1], Richard J. Pruell[1], John Brazner[2], Ross Kean[3], and Jennifer Yordy[4]
[1]US EPA, Atlantic Ecology Division, Narragansett RI, [2]US EPA, Mid-Continent Ecology Division, Narragansett, RI, [3]Research and Productivity Council, Fredericton, NB, Canada, and [4]Medical University of South Carolina, Charleston, SC

Fin Rot in Winter Flounder from New Haven Harbor, CT: The Clinical Profile of a Wasting Disease

John J. Ziskowski, Jose Pereira, Renee Mercaldo-Allen, and Catherine Kuropat
NMFS/NEFSC/Milford Laboratory, Milford, CT

Axial Skeletal Anomalies in Commercially Important Fish from the North Atlantic

John Ziskowski
NMFS/NEFSC/Milford Laboratory, Milford, CT

Abstracts
Oral Presentations

Movement of Yellowtail Flounder: A Cooperative Tagging Study

Steve Cadrin[1], Azure Westwood[1], Larry Alade[1], Nathan Keith[1], Rodney Rountree[2], Dave Martins[2], Ross Kessler[2], Darin Jones[2], April Valliere[3], Jeremy King[4], John Boardman[4], Heath Stone[5], and New England Fishermen

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During 2003 and 2004, New England fishermen and fishery scientists collaborated to tag approximately 25,000 yellowtail flounder (*Limanda ferruginea*) in the Gulf of Maine, Cape Cod, Georges Bank, southern New England and mid-Atlantic areas using conventional disc tags and data-storage tags. The principle objectives were to 1) estimate movement among stocks, 2) determine fishing mortality rates within stock areas, and 3) assess growth. The project coordinates several concurrent field studies with a common tagging protocol, a single experimental design and tag return system as well as comprehensive outreach efforts. The study was planned to reduce uncertainty in yellowtail flounder stock assessments, thereby improving fishery management. Preliminary results indicate frequent movements within stock areas, and infrequent movements among stocks. Data-storage tags indicate distinct off-bottom behavior, typically in evening hours, lasting an average of about four hours. The frequency of off-bottom movements does not appear to vary seasonally, but vertical movements are more frequent on Georges Bank than on the Cape Cod grounds. Further details on the project design and results are available online at cooperative-tagging.org.

Variation in Growth of Juvenile Plaice on a British Nursery Beach: How Homogenous are Flatfish Habitats at Small Temporal and Spatial Scales?

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Although there is evidence of a link between growth rate and survival through the 'critical' nursery stage, it is uncertain which environmental factors control growth in juvenile plaice (*Pleuronectes platessa*). It is often assumed that temperature alone dictates growth rate and that prey is not limiting. However, previous studies have taken measurements at scales that may be inappropriate to link growth with environmental factors, such as benthic prey communities, that vary over smaller spatial and temporal scales. Evidence of site fidelity in juvenile plaice suggests that finer resolution growth measurements are required to understand the link between growth of juvenile plaice and such features of the nursery environment.

We are using RNA:DNA ratio-based growth indices to examine small-scale variation in individual growth of juvenile plaice collected from a single Scottish nursery beach. Growth rate (estimated from RNA:DNA) and diet characteristics (prey-type, gut fullness) were quantified and related to environmental features of the nursery environment measured at the time of sampling. Comparisons were made between variations over smaller (100's of meters, days) and larger (500's of meters, weeks) spatial and temporal scales using a fully nested, orthogonal design.

Measuring variability in the growth of juvenile plaice over these small spatial and temporal scales and testing the degree of habitat heterogeneity allows a) an evaluation of the occurrence of prey limitation, b) an understanding of the potential importance of growth heterogeneity for overall nursery productivity, and c) development of more powerful predictive relationships between growth and features of the nursery habitat.

Annual Movement-Site Fidelity Patterns of Summer Flounder within Virginia and from State to Mid-Atlantic Waters (2000-2004)

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Summer flounder, *Paralichthys dentatus*, is consistently among the top-ranked fish targeted by Virginia's recreational and commercial fisheries. Using trained anglers, the Virginia Game Fish Tagging Program (VGFTP) began tagging flounder in spring 2000. Through 2004 over 20,000 flounder (279-559 mm TL) have been tagged using Hallprint T-bar tags (65 mm streamer). Since 2002, recapture rates remained around 9 %; 1-1.5% of recaptures occurred the year following initial tagging. Within-year recaptures were largely concentrated at Chesapeake Bay structure sites (piers, bridges, tunnels, jetties), however, during cooler months, flounder consistently moved out of the bay and onto the continental shelf. During subsequent spring months, fish moved back inshore into the bay, but also to beaches, sounds, and inlets from New York to the NC/SC border. Single and multiple recaptures of fish demonstrated flounder seasonally remaining 2-15 weeks around structure sites and certain inlets where first tagged. Patterns were consistent year- to-year for fish tagged during both early and mid summer periods. Recaptures documented some instances of year-to-year site fidelity for certain Chesapeake Bay sites and Virginia coastal inlets. Results significantly expand upon, and provide stronger support for, inshore-offshore and coastal dispersal patterns observed by VIMS flounder tagging studies conducted during 1987-89 and 1995-96. Multiple recaptures of flounder over periods of weeks to months at certain structure sites in Chesapeake Bay, coupled with year-to-year returns, indicate the importance of such sites as annual foraging areas. Equally important, the tagging program provides hard evidence to anglers that their efforts to carefully release sub-legal flounder result in more catches, both short-term (later during the same season), and long-term (bigger fish 1-2 years later).

Resource Partitioning Between Four Species of Flounder in Narragansett Bay

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In this study, we investigated the diets of four species of flounder in Narragansett Bay: summer flounder (*Paralichthys dentatus*), winter flounder (*Pseudopleuronectes americanus)*, fourspot flounder (*Paralichthys oblongus*), and windowpane flounder (*Scophthalmus aquosus*). These four species are abundant in Narragansett Bay throughout the summer months and are therefore likely to be important components of the benthic food web. Living in the same region, these flounder share the same resources and may therefore directly compete. We investigated whether the four flounder species partition the resources by means of their diets and spatial area. Flounder were collected at weekly intervals at two stations in the bay from June to August of 2004. Stomach contents were sorted to the lowest taxonomic level, counted, and weighed. While there was some prey overlap, diet composition analysis by weight showed that each species of flounder had a different prey preference. The dominant prey categories in summer flounder were fish and mantis shrimp, winter flounder preferred worms and amphipods, fourspot flounder ate squid, and windowpane flounder ate mostly *Crangon*. The only significant prey overlap between summer, fourspot, and windowpane flounder was *Crangon*, however, the high abundance of this prey in the summer makes competition unlikely. The diet of summer flounder varied between stations, reflecting prey available at each location; in contrast, the winter flounder diet was the same at both stations. Fourspot and windowpane flounder were not collected at the mid bay site, therefore their diets were not analyzed by location.

Winter Flounder (*Pseudopleuronectes americanus*) Spawning and Early Life History in the New York and New Jersey Harbor Estuary

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Winter flounder (*Pseudopleuronectes americanus*) populations along the Atlantic coast of the United States have declined over the last decade. Overfishing, mortality from water withdrawals and degradation of essential spawning and nursery habitat are a few of the factors thought to have contributed to this decline. Coastal estuaries along the Eastern United States provide spawning and nursery habitat for winter flounder. To better understand how winter flounder use large coastal estuaries and local habitats, adult- and early-life stages of winter flounder were collected over two spawning seasons in the New York and New Jersey Harbor through trawl and epibenthic sled surveys.

Bottom habitat was characterized at each sampling location. Winter flounder were found throughout the Harbor; however adult abundance, sex ratios and egg and larval densities differed considerably among areas. Results suggest that spawning areas may be spatially separated within the estuary, likely resulting from local habitat conditions. Furthermore, spawning and nursery habitat were spatially separated suggesting that larvae migrate between spawning and nursery areas. These results parallel recent contributions to the literature that suggest that winter flounder spawn in the lower reaches of harbors and major coastal tributaries, while nursery areas occur well within the estuaries.

Acute and Chronic Stress in Juvenile Summer Flounder *Paralichthys dentatus*: Effects on Plasma Cortisol Concentrations and Growth

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The summer flounder (*Paralichthys dentatus*) is a marine flatfish in the early stages of commercial aquaculture. However, little is known about the physiological stress response to common culture practices such as handling and crowding during size grading--a technique that reduces cannibalism. To investigate the stress response, we first used an injection of porcine $ACTH_{1-24}$ to describe the magnitude and duration of the plasma cortisol (CORT) response in juvenile summer flounder. Injection of $ACTH_{1-24}$ significantly elevated CORT levels (28.1 ± 4.3 ng/ml versus 0.9 ± 0.4 ng/ml in uninjected controls) within 4 h and CORT levels returned to baseline by 24 h. This information was used to design short-term experiments that tested the hypothesis that handling and crowding would increase plasma CORT concentrations. Flounder resting CORT levels were normally low (<10 ng/ml, and typically ~1-3 ng/ml), and comparable to other sedentary species. Overall, the flounder CORT response to handling and crowding (for 1 or 4 h) was variable in both magnitude (range: 4-22 ng/ml) and duration, returning to baseline within 24 h in 1 of 3 instances. Finally, long-term experiments were designed that tested the hypothesis that chronic exposure to handling and/or crowding would dampen the stress response and/or reduce growth. Long-term (5-6 weeks) weekly or daily exposure to these stressors (15 min chasing or crowding) did not consistently affect growth (measured as weight (g) and total length (cm)), reducing it on one occasion and not affecting it on another. Additionally, in 1 of 2 instances our data suggested that long-term repeated exposure to handling/crowding stress could depress the CORT response to stress. These results demonstrate that, although plasma CORT levels are low in undisturbed juvenile summer flounder, they increase significantly due to crowding and can remain elevated for at least a day. Regardless, the growth of juvenile summer flounder was unaffected by long-term chasing and crowding. In addition, flounder showed some evidence of habituation to these stressors.

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Environmental Gene Expression in Winter Flounder, *Pseudopleuronectes americanus*

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Environmental regulation of gene expression underlying the processes of development, growth and reproduction may be a sensitive indicator of both condition and habitat quality. Measures of environmental gene expression may then be useful in predicting the limitations to growth and fecundity in specific environments. To begin to test these hypotheses, this project has been collecting sets of genes, starting with liver tissue, that appear to be markers of environmental response to diverse habitats. These genes or partial gene-transcripts have been isolated from winter flounder by subtractive hybridization, cloned, sequenced and identified by computer homology search. The gene sets represent genes that appear to be coordinately up-regulated or down-regulated in response to anthropogenic disturbance or specific challenges such as exposure to oil spills. Isolated genes were found to be related to detoxification, immune response, reproduction, transport, signaling and general metabolism. Some examples of detoxification genes are the cytochrome P450s 1A, 2D, 3 and 24; glutathone-s-transferase; and alcohol dehydrogenase. Immune responsive transcripts detected included the anti-microbial hepcidin, complement components C-3 and C-7 and differentially regulated trout protein-1. Signaling transcripts included tumor suppressor p33ING1, Bal-643-liver regeneration protein, and hepatocyte growth factor-1. Specific regulation of a subset of the isolated genes was confirmed by quantitative polymerase chain reaction (q-PCR).

Collection of this set of winter flounder genes, deposited as expressed sequence tags (EST) in the national database at Genbank (www.ncbi.nlm.nih.gov), is contributing to the delineation of the winter flounder genome and to the development of a winter flounder specific microarray for measurement of global gene expression.

Winter Flounder in Western Long Island Sound: Facts, Photos, Fallacies and Fate – It Ain't Rocket Science

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The Atlantic States Marine Fisheries Commission is responsible for formulating a winter flounder management plan. Commercially fished stocks can be gauged by trawl statistics and dealer reports. ASMC needs information on inshore recreational stocks, habitat and predation.

I have been documenting recreational fishing in Western Long Island Sound (WLIS) through writing and photography for more than forty years and have observed the population of winter flounder in WLIS to be less than 1% of the historical levels of the 1980's. What now remains are a few large fish, 14" plus, with a sparse scattering of 8 to 10" fish and no juveniles 1-2".

WLIS is a contained body of water because of its geography, geology and hydrology. The winter flounder are resident species along with blackfish and cunner. There is no commercial trawling in WLIS.

I, and my extensive network of fishermen, have observed that juvenile winter flounder are one of the major prey species for sea robin and fluke. We routinely examine stomach contents as we clean fish. We have also observed cormorants eating medium flounder. An over wintering population of seals in WLIS may prey on winter flounder as well.

Serious recreational anglers gladly partake in tagging and volunteer angler surveys. Six-pack charter men and head boats all want to restore the winter flounder fishery. To better monitor predation, I suggest we supply 4-6 of them with small digital cameras next summer. I propose we synchronize photography during one week in early season, mid-season and late season to document stomach contents as they clean fish. This would provide a snap shot of predation to confirm anecdotal observations. Anything is better than nothing.

Ecology and Biological Strategies of *Etropus crossoyus* and *Citharichthys spilopterus* (Pisces: Bothidae) Related to the Estuarine Plume, Gulf of Mexico

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Differences in the biological and ecological strategies of two dominant tropical flatfish *E. crossotus* (fringed flounder) and *C. spilopterus* (bay whiff) are discussed. The analysis is based on the relative seasonal abundance of the two species and the apparent coupling of both life history patterns with the organic matter concentration and food availability, coupled with the seasonality of estuarine plume. This contribution attempts to show that dominance (or ecological success) of coastal marine flatfish with similar biological and ecological patterns is based on the sequential use in time and space of habitats related to the estuarine plume of the Grijalva-Usumacinta mega delta onto the tropical inner shelf in the Southern Gulf of Mexico.

Stage-specific Effects of Cortisol on Growth and Food Consumption by Larval Summer Flounder

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Previous research has shown that in larval summer flounder, *Paralichthys dentatus*, the variation in food consumption observed at 17-20 days post hatch (dph) is highly correlated with length variation noted at 26 dph. This size variation leads to post-settlement cannibalism that can result in high mortality in the hatchery. Since the endogenous levels of cortisol peak in the larvae around the time of food consumption variation, and all components of the hypothalamic-pituitary-interrenal axis are present at this time, we hypothesized that cortisol may be positively affecting the food intake of the larvae. We treated the rearing water of the larvae with cortisol, the cortisol receptor blocker RU486, and a combination of cortisol and RU486 and monitored consumption by the larvae during a week-long exposure period. Dry weights and total lengths were collected to compare any differences in growth among fish in the various treatments. Results varied depending on the developmental stage of the larvae (pre- and pro-metamorphic, late metamorphic climax). Cortisol had a negative effect on food consumption in both pre-metamorphic larvae and larvae in late metamorphic climax, while it did not affect consumption by pro-metamorphic fish. The only effect of cortisol on dry weight was noted in the pro-metamorphic group of fish. The length of the pre-metamorphic larvae was negatively affected by the addition of cortisol, while the fish in later developmental stages were unaffected. Contrary to our hypothesis, cortisol did not increase food consumption and growth, but reduced them during some developmental stages. [Supported by U.S.D.A./NRAC Project No. 2-6/4-4.]

Feeding in Larval Summer Flounder: Regulation by Hormones

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Variation in growth rates of summer flounder (*Paralichthys dentatus*) in culture conditions presents a major hurdle in the rearing of this commercially important species due to labor associated with reducing cannibalism. Variance in food consumption and growth during the 17-25 days post-hatch window occurs simultaneously with the activation of the hypothalamic-pituitary-interrenal (HPI) axis. In the present study we investigate the role of two potentially orexigenic endocrine signals in the feeding behavior of larval summer flounder. Glucocorticoids, secreted by the interrenal, in non-stress concentrations stimulate food intake and are vital to energy balance in mammals and may potentially serve a similar function in fishes. To correlate HPI axis maturation with feeding behavior radioimmunoassay was used to measure whole body cortisol (glucocorticoid) levels of fish grouped according to amount of *Artemia* nauplii consumption. Distribution of the glucocorticoid receptor and the amount of CRH and ACTH in the hypothalamus and pituitary was determined through immunocytochemistry. In addition, we report on the action of exogenous treatment with ghrelin, a peptide hormone, on the appetite of larval and juvenile summer flounder. Information regarding the hormonal regulation of feeding in larval summer flounder aims to increase knowledge regarding the growth and development of this important aquaculture species and other marine teleosts. [Supported by USDA/NRAC Project No. 2-6/4-4.]

Abundance and Distribution of Juvenile Flatfishes in a Near-Shore Shallow Water Habitat in New Haven Harbor

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Stock recruitment relationships continue to be one of the most difficult problems in fisheries research. The number of larvae or juveniles often varies greatly from year to year even though the number of breeding adults may change little. A better understanding of variation in habitat use by juvenile fish would be useful in the analysis of this problem. Beginning in 1998, we initiated a long-term study to examine habitat use by juvenile fishes at small spatial scales in the near shore zone. Using a beach seine, we sampled ten locations in Morris Cove in New Haven Harbor, CT once or twice a month from May through September from 1998 to 2004. Substrate in the study area varies from muddy sand (station 1), to sand in the middle of the sample area (2-6), to macroalgae-covered cobble (stations 7-10) at the other end of the beach. Water depths are generally around 1.5 meters or less.

Five species of juvenile flatfish are represented in this near shore fish assemblage. Winter flounder (*Pseudopleuronectes americanus*) far outnumbered other flatfish species with nearly 900 captured since the study began. We also captured 35 windowpane flounder (*Scophthalmus aquosus*), 11 summer flounder (*Paralichthys dentatus*), 3 hogchoker (*Trinectes maculatus*), and 1 smallmouth flounder (*Etropus microstomus*).

Annual winter flounder abundance varied greatly over the course of the study, with major peaks in 2000 and 2004. Flounder were more abundant at sites with softer sediments than at other sites. We have begun to examine the relationship between the annual abundance of juveniles caught in the beach seine and adult winter flounder population densities determined from trawl surveys conducted in Long Island Sound by the State of Connecticut.

Observing Larval Supply Processes on Coastal Ocean Seascapes: Adaptive Surveys in the New Jersey Shelf Observation System and a Preliminary Description of Pelagic Habitat Associations with Special Reference to Larval Flatfishes

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Examination of oceanographic and behavioral processes determining patterns of larval supply and connections between adult spawning and juvenile nursery grounds is necessary for the development of spatially explicit habitat models and effective fisheries habitat management. Traditional surveys stratified in geographic coordinate space cannot adequately describe stage-specific pelagic habitat associations and trajectories for larvae in the coastal ocean where meteorological, buoyancy, and tidal forcing produces spatially dynamic pelagic habitats and transport pathways that are frequently driven by episodic oceanographic phenomena rather than mean flows. Integrated ocean observation systems (IOOS) that network satellite, ground and autonomous underwater sensors provide real and near real time descriptions of coastal ocean climatology that permit surveys to be adaptively stratified in oceanographic feature space.

Here we describe a series of combined hydrographic, fishery hydroacoustic and Tucker trawl surveys performed within an IOOS in the New York Bight Apex. Broadband wireless communications were used to access near real time descriptions of coastal ocean structure. Pelagic habitat features under several coastal ocean states (upwelling, downwelling, high and low estuarine discharge) were adaptively sampled based on the near real time information.

Preliminary results suggest that specific ichthyoplankton assemblages that included several flatfishes (windowpane, yellowtail, witch flounder) show strong associations with Hudson River Plume, Cold Pool, or Shelf water, under particular ocean states. We also describe a strategy for hypothesis driven sampling within IOOS that is likely to improve our understanding of the mechanisms determining configurations of adult spawning/ juvenile nursery ground networks on coastal ocean seascapes.

Effects of Dredging on the Functional Role of Nursery Habitats for Juvenile Flatfishes. Part I: Distribution of Juvenile Summer and Winter Flounder in the Pre-dredged Assawoman Canal, Delaware, with Reference to Bottom Type

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Assawoman Canal is a man-made canal connecting Indian River Bay to Little Assawoman Bay, near Indian River Inlet, Delaware. Fish sampling occurred weekly from mid-May through October 2004 at four stations in the canal and biweekly at two stations in each of two adjacent creeks, for comparison with results from the canal. Fish were collected in standardized hauls using a 1-m beam trawl and a 7.6-m seine.

Sampling to-date (mid-May through August) has shown highest juvenile winter flounder (*Pseudopleuronectes americanus*) abundance at northern Assawoman Canal sites (sand bottom with sparse organic matter) where they were captured from May 12-July 8, had a 78% frequency of occurrence, and $\bar{x}$=0.3-3.6 per10m². Winter flounder abundance at the two sites in White Creek (mud bottom with macroalgae) was much lower, with fish captured only on May 12, 20% frequency of occurrence, and $\bar{x}$=0.2-0.3 per 10m². None were captured in southern Assawoman Canal (mud bottom with wood or leaf litter) or Miller Creek (mud bottom with no litter) south of the canal. Winter flounder densities in northern Assawoman Canal are comparable to those found in several previous studies in New Jersey and Connecticut estuaries. Juvenile summer flounder (*Paralichthys dentatus*) were more widespread than juvenile winter flounder but were not abundant at any site (captured May 12-August 26, 67% frequency of occurrence, and $\bar{x}$=0.1-0.2 per 10m²). These densities are lower than those found in several studies in North Carolina. Hogchokers (*Trinectes maculatus*) were the only other flatfish species to be captured (5 individuals).

Young winter flounder densities are higher in the northern Assawoman Canal than in the southern portion of the canal, in the natural creeks adjacent to the canal or in the natural creeks farther inland from Indian River Inlet (based on results from DNREC sampling). Juvenile summer flounder densities, on the other hand, are higher in the natural creeks farther inland. The proposed dredging of Assawoman Canal is therefore likely to have greatest immediate negative impact on juvenile winter flounder in the northern canal. Longer-term impacts (positive or negative) on juvenile flatfish habitat will depend, at least in part, upon post-dredging changes in current regimes and associated sediment characteristics.

Assessment of Power Plant Entrainment in Comparison to Long-Shore Ichthyoplankton Transport

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Winter flounder are commercially important in Cape Cod Bay and are a dominant species collected by the entrainment monitoring program at the Pilgrim Nuclear Power Station (PNPS). This study evaluated the impact of winter flounder larvae entrainment at PNPS through direct field measurements. Previous studies have indicated a general counterclockwise circulation in the Massachusetts/ Cape Cod Bay system, with net transport to the south along the Massachusetts shoreline from Newburyport into Cape Cod Bay. This net transport has a significant potential effect on transport of ichthyoplankton and may effect the life cycle of fish in the coastal ecosystem. This study applied an approach whereby field measurements were collected to determine the relative amount of net volumetric flow and winter flounder larvae entrained into the PNPS cooling water system compared to the net volumetric flow and amount of winter flounder larvae transported past PNPS in offshore Cape Cod Bay waters.

The field program, conducted during May 2000 and May 2002, consisted of water velocity and tidal height measurements, and sampling of winter flounder larvae along offshore transects in Cape Cod Bay near PNPS. To continuously measure water velocity and tidal height, acoustic Doppler Current Profilers and tidal gages were deployed at locations along the transects for the two one-month study periods. During each of these May study periods, larval flounder were collected at locations along transects during four 24-hour field-sampling efforts. Larval samples were obtained four times, twice during the day, and twice during the night. Concurrent sampling was performed to quantify the amount of winter flounder larvae entrained into the PNPS cooling water flow. All winter flounder larvae were classified and enumerated according to four larval stages. The field larvae data were combined with the current measurements to determine the transport or flux of winter flounder larvae along the coast of Cape Cod Bay, for each of the daily measurement periods. These values were then compared to the amount of winter flounder larvae entrained into the PNPS cooling system, as determined from the entrainment study, during the same daily measurement periods. Similar results were obtained in the 2000 and 2002 studies. These results (1) confirmed that there is a southerly net flow and flux of winter flounder ichthyoplankton along the Massachusetts coast, and (2) indicated that PNPS entrains a relatively small percentage of the net larval transport—conservatively estimated at less than 1%.

Observations on the Systematics of *Etropus crossotus* Jordan & Gilbert 1882

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The fringed flounder, *Etropus crossotus* Jordan and Gilbert, 1882, was first described from eastern Pacific waters. Subsequently, populations identified as E. *crossotus* have also been recorded in the western Atlantic from Virginia to southern Brazil. Previous researchers have found only slight morphological differences between Atlantic and Pacific populations of *E. crossotus*. However, with the surfacing of the Isthmus of Panama some 3-5 million years ago possibilities ended for migration and genetic mixing of fish populations between eastern Pacific and western Atlantic waters, including those of E. *crossotus*. As a result of this interruption in gene flow, geminate species of fishes (and other organisms) evolved on either side of the Isthmus of Panama. It is hypothesized that such speciation has also occurred between Atlantic and Pacific populations of flatfishes currently referred to as E. *crossotus*. The goal of this project is to determine if any detectable morphological differences (including meristic and/or morphometric characteristics) exist among flatfishes presently referred to as E. *crossotus* that will reveal a western Atlantic and eastern Pacific geminate species pair. Results of this study will further clarify the taxonomic diversity of species of *Etropus*.

Developmental Changes in Gut, Skin, and Gill Epithelial Glycoconjugates in Summer Flounder (*Paralichthys dentatus* L): A Lectin Histochemical Study

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This study asked whether the glycoconjugates of gut, skin, and gills change during metamorphosis in summer flounder. Larvae and juveniles were assayed histochemically with a battery of 15 biotinylated lectins, and scored for differences in staining intensity and spatial pattern between the two developmental stages. All of the epithelia showed some developmental changes, but most were associated with the gut and skin epithelia and their mucous secretions. In the stomach, the mucus increased in staining with DBA, ECL, GSA II, PNA, and SBA lectins, while the epithelium changed little. A developmental decrease in the binding intensity of the intestinal brush border was noted for DSL, RCA $_{120}$, VVA, SNA, and UEA I lectins, while intestinal goblet cells underwent a large increase in binding for GSA II. The changes in the gut glycoconjugates correlate developmentally with shifts in bacterial flora composition found by other studies, and therefore might be relevant to the study of bacteria-host relationships in summer flounder. The skin mucous cells of the larvae were negative for DBA, DSL, ECL, PNA, RCA $_{120}$, and SNA, but became positive in the juveniles. The gills exhibited fewer developmental changes than the other tissues, increasing in labeling with SBA DBA, and PNA. In the juveniles, SBA labeled the gill-filament junction where chloride cells are usually found in summer flounder. In conclusion, this study showed that changes in glycoconjugate expression occur during metamorphosis in the gut, skin, and gills of summer flounder. Two lectins were identified as potentially useful cytological markers in this and possibly other species: UEA I for mucous cells, and SBA for chloride cells.

The Cortisol Antagonist, RU486, Inhibits Salinity Tolerance in Larval Summer Flounder

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Cortisol is the major corticosteroid secreted by the teleost interrenal. It stimulates seawater adaptation and is thought to be critical for maintaining water and electrolyte balance. However, a role for cortisol in salinity tolerance of marine larval fish is not clear. We report here, several experiments that were designed to test whether cortisol is necessary for larvae of the euryhaline summer flounder (*Paralichthys dentatus*) to tolerate their native seawater milieu. The actions of cortisol are largely accomplished through binding to its receptors in target tissues. We therefore used the synthetic cortisol-receptor blocker, RU486, to determine the effect of cortisol deficiency on survival rates. In the first experiment, larvae were exposed to 10 (near isoosmotic) or 30 (hyperosmotic) ppt seawater containing 0-3.6 μM concentrations of RU486. Survival rate over 5 days was near 100% at 0-0.12 μM RU486 in both 10 and 30 ppt, although at higher concentrations of RU486 (1.2 and 3.6 μM), larval survival was significantly lower at 30 ppt compared to 10 ppt. Next, larvae were exposed to salinities from 0-65 ppt with, or without, 1.2 μM RU486. RU486 inhibited survival rate at 30 ppt and above (within 2 days), but not at lower salinities. Finally, exposure of larvae to 10 or 100 μM cortisol with 1.2 μM RU486 (at 30 ppt) prevented a decrease in survival that occurred in larva exposed only to RU486. The results demonstrate that survival of larvae in seawater is dependent on cortisol. The time frame of action of RU486 is consistent with inhibition of metabolically demanding, ionoregulatory mechanisms.
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In Situ Effects of Suspended Particulate Loads Produced by Dredging on Eggs of Winter Flounder (*Pseudopleuronectes americanus*)

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In March of 2002, the U.S. Army Corps of Engineers began dredging in the Providence River to deepen shipping channels leading to the Port of Providence. We studied the impact of increased sediment loading on the early life stages of winter flounder, primarily on eggs and newly hatched larvae, by doing exposures in the field in areas adjacent to the dredging operations. In 2003 and 2004, we exposed newly spawned flounder eggs in weighted arrays holding 9 chambers with 100 winter flounder eggs per chamber. We placed one array adjacent to the dredging operation and one far away. Divers retrieved the arrays just at hatch time. Numbers of eggs and larvae, amount of sediment settled in the chambers, and size of larvae were compared. There was a significant difference in the amount of sediment deposited in the experimental vs. the control chambers (3.59 vs. 0.69g dry weight). There was no statistical difference in the numbers of live eggs and larvae between the treatment and the controls, although there was slightly greater survival in the controls (14.1% vs. 15.5 % eggs and larvae). Larvae were observed hatching and wriggling up through the sediment in both treatments. Survival of eggs exposed to different amounts of sediment at the EPA laboratory showed similar results- higher survival in controls but results not statistically significant.

Impacts of Hypoxia on Juvenile Fish Growth: Evidence From Laboratory and Field Studies

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For estuarine-dependent fishes, physicochemical factors such as temperature, salinity and dissolved oxygen (DO), which vary temporally and spatially, can have substantial effects on larval and juvenile growth rates and, consequently, on nursery habitat quality. The objectives of this study were to investigate the impacts of hypoxia (low DO) on growth rates of young-of-the-year (YOY) of two estuarine-dependent fishes: summer flounder (*Paralichthys dentatus*) and weakfish (*Cynoscion regalis*). We conducted controlled laboratory experiments over a range of chronic and diel-cycling DO conditions. From these results we made predictions of growth rates under a variety of conditions experienced in the field and tested these predictions using fishes collected in estuarine nursery grounds.

Our laboratory growth data show that moderate (<50% saturation) levels of chronic (<7 d) hypoxia and diel-cycling (30-160% saturation over 24 h) hypoxia significantly reduce growth of juvenile summer flounder but not weakfish. Summer flounder growth rate is reduced by 50-90% at 2 mg O_2 l^{-1}, compared with the rate at 7 mg O_2 l^{-1},with the greatest reduction being at higher temperatures. We are currently using RNA:DNA ratios to quantify growth rates of these fishes in the wild in response to short-term (2-4 d) changes in DO. RNA:DNA data from field-collected fishes will provide further insight into the impacts of low DO on growth of YOY summer flounder. The overall goal is a better understanding of the linkage between hypoxia, growth, and nursery habitat quality.

Predatory Impact of the Green Crab (*Carcinus maenas*) on Post-settlement Winter Flounder (*Pseudopleuronectes americanus*) as Revealed by Immunological Dietary Analysis

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Predation on flatfish during the early juvenile stage could be an important factor regulating year-class strength and recruitment. In this study, immunological dietary analysis was performed on green crabs (*Carcinus maenas*) collected from the Niantic River, Connecticut, in an effort to evaluate the predatory impact of this species on post-settlement winter flounder (*Pseudopleuronectes americanus*). Through the use of species-specific antiserum, winter flounder proteins were identified in 4.8% of the green crab stomachs analyzed (n = 313, size range = 14-74 mm carapace width; CW); revealing that crabs >29 mm CW are predators of post-settlement winter flounder in natural populations. The most significant factor underlying the predator-prey interaction was the relative size relationship between species, such that the incidence of winter flounder remains in the stomach contents of green crabs was positively correlated with predator-to-prey size ratios. Results from dietary analysis were incorporated into a deterministic model to estimate the average daily instantaneous mortality and cumulative mortality of winter flounder owing to green crab predation. Accordingly, green crabs accounted for 1.5 to 4.7% of the daily mortality of winter flounder, and consumed 10.7% of the flounder year-class. Relative to other macro-crustacean predators, however, predation by green crabs has a minimal effect on winter flounder survival, due in large part to the low densities of these crabs in temperate estuaries.

Study of Class-0 Benthic Fish Species in Norwalk Harbor, CT, Concentrating on Winter Flounder

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Class zero benthic fish species were studied in Norwalk Harbor, Norwalk, CT, concentrating on the population of winter flounder (*Pseudopleuronectes americanus*). The relative abundance and species diversity of these species captured were analyzed using trawling data gathered from the Norwalk Harbor. All organisms caught in the beam trawl were counted, identified, and released. In order to use comparable numbers of trawls in the harbor, data were analyzed from 1991 through 1994, and then compared to 2003. The data indicated that species abundance of juvenile benthic fish remained constant throughout the five years. However, overall species relative abundance decreased in juvenile benthic fish species examined, particularly winter flounder (*P. americanus)*, with the exception of an increase for northern sea robins (*Prionotus carolinus).* Further examination of the distribution of *P. americanus* within the Norwalk Harbor, indicated cyclical population trends from 1991 through 1994, and generally lower population densities in 2003. Possible causes for these trends may include the effects of reduced dissolved oxygen levels, increased bottom temperature, and increased predation. The variety and range of these possible variables prevent the selection of a single factor as the cause for the shift in relative abundance.

Investigations into the Growth of Yellowtail Flounder In and Around a Closed Area

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There is some indication that yellowtail flounder, *Limanda ferruginea*, are growing to larger sizes and older ages in areas closed to commercial fishing on Georges Bank. Recent assessments for the Georges Bank transboundary stock of yellowtail flounder have demonstrated retrospective patterns that could be due to these differences in age structure inside and outside of Closed Area II. These observations could be due to the effect of Closed Area II and the U.S.-Canada boundary on sampling associated with data collection programs or due to biological responses to reduced fishing mortality.

To test the latter, we examined data from 1986-2004 collected by the Northeast Fisheries Science Center's bottom trawl survey, commercial sampling, and fishery observer programs as well as comparable data from Canada's Department of Fisheries and Oceans. These data were divided into two time periods: 1986-1994 represents the period prior to the establishment of Closed Area II in December 1994, and 1996-2004 that afterwards (1995 was considered a transitional year).

The Winter Flounder Gender Bender: What Are We Culturing?

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Studies have shown that sexual differentiation, and therefore male:female sex ratio in some flatfish species, can be influenced by juvenile incubation temperature. This also may be true for winter flounder, whose juveniles are quite eurythermal, but sexual differentiation and the sex ratio of cultured winter flounder have never been investigated. This is significant for both aquaculture and stock enhancement programs. In aquaculture, it may be desirable to culture female genotypes for production of larger fish. In stock enhancement, the sex ratio of fish used for releases can affect the wild population by altering the sex ratio and population dynamics of the wild population.

Because the sex ratio of cultured winter flounder, and the factors that may influence it, are completely unknown, we studied the sexual differentiation and cultured fish sex ratio as part of a larger study evaluating the effectiveness of a winter flounder stock enhancement program. To accomplish this, we sampled 385 fish from the general culture population at approximately 10 mm total length (TL) intervals, starting shortly after metamorphosis and continuing through the first year. On each sampling occasion, we randomly collected 30 fish. Tissues were fixed and stored in modified Davidson's solution for at least 48 hrs. Prior to histological processing, the samples were washed in freshwater and stored in 70% alcohol. Histological processing involved embedding the tissues, sectioning (6 microns), and staining with hematoxylin and eosin. Slides were examined to view structures and cells associated with gonadal tissue. By examining the size series of fish collected, we were able to determine the size and age when sexual differentiation is visible histologically, as well as the sex ratio of the cultured population. Results of these studies will be discussed.

Analysis of this study continues, and initial findings suggest that the sex of winter flounder as small as 40 mm TL can be determined histologically.

Spatially Explicit Modeling of the Effects of a Thermal Discharge and Ambient Temperatures on Winter Flounder, *Pseudopleuronectes americanus*

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Trawl finfish surveys conducted in the Narragansett Bay Estuary over the past three decades reveal steep declines in the abundance of several groundfish species since the late 1970s. Of particular concern is the decline in winter flounder, a species important to the local commercial and recreational fisheries. To determine whether heat introduced to the system from Brayton Point Station's thermal discharge could be contributing to the decline of Mount Hope Bay winter flounder, a biothermal modeling assessment was performed by LMS. The model was based on predictions of the temporal and spatial location of the BPS thermal plume, as provided by Applied Science Associates, Inc. The biothermal assessment was performed for a range of biological functions, including critical growth, reproduction, avoidance, migratory blockage, and thermal mortality. The analysis evaluated the thermal effects of a variety of BPS operating conditions including ambient temperatures (no plant), historical plant operation, and proposed future operational alternatives. A temperature tolerance polygon was developed to depict how winter flounders' performance envelope varied with acclimation temperature. This figure, in conjunction with the results of the plume model, permitted a quantitative evaluation of the effects of the plant's thermal discharge, including: (1) refined spatial resolution making it possible to pinpoint the location of any predicted thermal effects, (2) delineation of the species-specific habitats by life stage, and (3) the inclusion of a unique assessment of chronic thermal mortality. The analysis concluded that the BPS thermal discharge is not causing appreciable harm to the winter flounder population within Mount Hope Bay.

Flatfishes of Chesapeake Bay: An Overview of Species Diversity, Abundance and Occurrence

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Chesapeake Bay is uniquely positioned among western North Atlantic estuaries in being situated close to a major biogeographic boundary between a northern, cold temperate province and a warm temperate province to the south. Since 1968, the Virginia Institute of Marine Science has conducted juvenile fish surveys in lower Chesapeake Bay and major tributaries (James, York and Rappahannock rivers). Thirteen flatfish species have been reported from Chesapeake Bay. Of these, 12 are valid species. *Neoetropus macrops*, known from a single specimen purportedly captured in Chesapeake Bay, is not a valid species; rather it is a reversed specimen of Gulf Stream flounder with questionable locality data. Among 12 species constituting the flatfish assemblage, 6 are common, 2 uncommon, and 4 species are rare in the Bay. Common, abundant species include summer flounder, smallmouth flounder, hogchoker and blackcheek tonguefish; common, less abundant species are windowpane and fourspot flounders. Uncommon species occurring in low abundance are winter and fringed flounders. Rarely occurring species are halibut, yellowtail and southern flounders, and bay whiff. The Chesapeake Bay flatfish assemblage is a unique mix of species with some at or near southern (winter flounder; yellowtail flounder, halibut) or northern limits of their distributions (blackcheek tonguefish, southern flounder, bay whiff). Summer flounder, hogchoker, blackcheek tonguefish and smallmouth flounder are abundant, estuarine-dependent species; winter flounder is an estuarine-dependent species occurring in low abundance (more abundant in northern estuaries). Southern flounder and bay whiff are estuarine-dependent species that occur in greater abundance in more southern estuaries. Coastal species commonly utilizing lower Chesapeake Bay are windowpane, fourspot flounder and fringed flounder.

Scale Formation in Selected Western North Atlantic Flatfishes

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We examined the patterns of scale formation (onset, completion, spatial pattern) for five species in four families of flatfishes (Bothidae: *Etropus microstomus, Paralichthys dentatus*; Scopthalmidae: *Scophthalmus aquosus*; Pleuronectidae: *Pseudopleuronectes americanus*; Soleidae: *Trinectes maculatus*) to determine if the patterns are a useful indicator for the transition from the larval to the juvenile stage. In all species the ontogenetic pattern was very similar, with onset of scale formation occurring on the lateral surface of the caudal peduncle, then spreading anteriorly along the lateral line, then laterally over the body, on to the head, and eventually on to the medial fins, a characteristic of Pleuronectiform fishes. The timing of scale formation, relative to fish size, was late relative to other morphological characters (i.e., fin ray formation, eye migration, settlement). Onset of scale formation, across all species, occurred at 9.0 - 13.5 mm TL, at the same approximate size as eye migration and settlement. Completion of scale formation on the body occurred at 22 - 54 mm TL, but completion of scale formation on the fins did not occur until 44 - 88 mm TL. Thus, completion of scale formation in these flatfishes is apparently the last morphological change to occur during the larval to juvenile transition and, as a result, is not completed until approximately one third (*Scophthalmus aquosus*, *Paralichthys dentatus*) to one fourth (*Pseudopleuronectes americanus*) or at the same time (*Etropus microstomus, Trinectes maculatus*) as the size at first reproduction. We continue to examine these patterns, especially with regard to ecological correlates (e.g., general habitat use, burial, etc.).

The Importance of Freshwater Riverine Habitat, Particularly as a Nursery for *Paralichthys lethostigma*, in the Atchafalaya River Delta, Louisiana

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The southern flounder, *Paralichthys lethostigma*, is a common flatfish, ranging on the Atlantic coast of the U.S. from northern North Carolina to southern Florida, and in the Gulf of Mexico from south Florida to north-central Mexico. Although it spawns in coastal waters, it spends much of its life cycle in nearshore and coastal estuarine habitats. In Louisiana it is the only *Paralichthys* found in estuaries and often resides in lower salinity and freshwater habitats. It is our most sought-after flatfish.

We have been examining fish assemblages in low salinity [< 3 ppt] and freshwater areas of the Atchafalaya River delta and have taken all life stages of this species from small YOY [<15 mm] to adults [360mm+, 4-5 yrs]. These riverine habitats are particularly important nursery areas. We have collected hundreds of YOY [35-90 mm] during late winter and early spring, found in soft- mud bottom, protected vegetated habitats. Nearly all of these are found in freshwater, associated with highly turbid waters from the Atchafalaya River. It is interesting to note that much of this southern flounder habitat has been constructed with dredge materials as part of the reconstruction program presently attempting to offset coastal erosion in coastal Louisiana.

Previously we suggested that male southern flounder spend much of their mature life cycle offshore (Fischer and Thompson, In Press), but our present findings suggest that life history movements are more complicated with perhaps multiple movements across a wide range of salinity regimes. Some of these seem to be independent of spawning migrations since they involve immature fish. The hypothesis of these movements is supported by some preliminary studies examining Sr:Ca ratios in southern flounder otoliths. Additional work examining Sr:Ca ratios and tracking tagged flounder are planned to provide additional details of their life history in Louisiana.

Temporal Trends in Distribution and Abundance of Flatfishes in Lower Chesapeake Bay and its Major Tributaries

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From 1979 to 2003, eight species of flatfishes and 150 other species of demersal fishes have been identified from the 21,508 trawls conducted by the Virginia Institute of Marine Science juvenile finfish bottom trawl survey of Chesapeake Bay and its three major Virginia tributaries. Hogchoker, blackcheek tonguefish, and summer flounder occur widely over the lower Bay and throughout the major rivers during spring through fall, moving to deeper waters in winter. Smallmouth flounder are abundant in the Bay mouth and lower rivers in summer and fall. Windowpane have a more scattered distribution near the Bay mouth and lower rivers in winter and spring, become more abundant in summer, and move toward higher salinity waters along the eastern shore of the Bay in fall. Winter flounder occur infrequently in the Bay and lower rivers, and disappear from catches in the fall. Fringed flounder and fourspot flounder are rare catches in the lower Bay. Of demersal fishes captured, 38.4 % were flatfishes. Hogchokers were most abundant at 35.9 % of the demersal total. Blackcheek tonguefish ranked second in abundance among flatfishes, but constituted only 1.3 % of the total demersal fish catch. Other flatfishes (summer flounder, smallmouth flounder, windowpane, winter flounder, fringed flounder, and fourspot flounder) together accounted for only 1.2 % of the demersal fish total. Overall catch per unit effort (CPUE) per 5-minute tow were: 79.14 for hogchoker, 2.87 for blackcheek tonguefish, 1.45 for summer flounder, 1.09 for smallmouth flounder, and 0.122 to 0.003 fish per tow for other flatfishes.

Metabolic Acidosis Stimulates Renal Tubular Sulfate Secretion in Winter Flounder, *Pseudopleuronectes americanus*

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Active SO_42- secretion by the renal proximal tubule of marine teleosts eliminates the plasma SO_42- burden that would otherwise occur from the continuous ingestion of SO_42- -rich (~25 mM) seawater. The model of tubular SO_42- secretion includes pH-dependent uptake of SO_42- across the basolateral membrane of proximal tubule cells (SO_42-/2OH^-) and the exchange of intracellular SO_42- for either luminal HCO_3- or Cl^- (SO_42-/2HCO_3- or SO_42-/2Cl^-). The requirement of HCO_3- and OH^- ions as substrates for SO_42- transport has led to the hypothesis that changes in interstitial pH would alter the rate of tubular SO_42- secretion. Flounder renal proximal tubule epithelium in primary culture (fPTCs) mounted in Ussing chambers actively secreted SO_42- at a net rate of 80 ± 7.7 nmoles x cm^{-2} x h^{-1} when flounder saline of normal pH (7.7, control) bathed the interstitium. Reduction of interstital pH to 6.8 (metabolic acidosis) significantly increased net secretion 41%, and elevation of interstitial pH to 8.8 (metabolic alkalosis) decreased net secretion 32%. For whole animal studies (*in vivo*), reduction of environmental pH from 7.5 to 4.3 was used to induce metabolic acidosis. Metabolic acidosis caused a decrease in serum pH (7.7 ± 0.01 to 7.3 ± 0.05), and significant increases in serum osmolality (338 ± 4.3 to 358 ± 8.6 mOsmol x kgH_2O^{-1}) and tubular SO_42- secretion rate (3.2 ± 0.76 to 5.5 ± 0.84 µmol x kg body wt^{-1} x h^{-1}). Furthermore, there was a significant linear relationship between serum pH and tubular SO_42- secretion rate (R^2 = 0.57). Supported by NSF.

Behavioral Responses of Summer Flounder and Weakfish to Declining Dissolved Oxygen: Inter- and Intraspecific Comparisons

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Understanding how fish respond behaviorally to environmental stress is vital to predicting consequences of exposure, and ultimately, the impact of stressors on distribution. Flatfishes are particularly susceptible to hypoxia because dissolved oxygen (DO) tends to decrease with depth and flatfishes are generally less mobile than pelagic fishes. The objectives of this study were to characterize and compare the swimming behaviors of juvenile summer flounder and weakfish during exposure to and recovery from severely low DO, such as is commonly experienced in estuarine nursery habitats.

Swimming activity (body lengths s^{-1}) was recorded in a 2-m diameter mesocosm tank and quantified every second over 6.5 h trials. Dissolved oxygen was decreased from 7 mg $O_2\ l^{-1}$ (normoxia) to 1.4 mg $O_2\ l^{-1}$ (20% sat.) at 1.4 mg $O_2\ l^{-1}$ increments, then further reduced to 0.8 mg $O_2\ l^{-1}$ (15% sat.) and finally to 0.4 mg $O_2\ l^{-1}$ (10% sat.). DO was then increased at the same rate during a 'recovery' period to determine latent effects of hypoxia on swimming activity. Fish remained at each DO level for 30 minutes.

Both species exhibited an initial active response (increase in activity) until DO dropped to ~2.8 mg $O_2\ l^{-1}$, beyond which both species exhibited a passive response (decrease in activity). During subsequent exposure to increasing DO, summer flounder did not recover normal swimming speed over the 3 h 'recovery' period. Furthermore, individual fish maintained rank-order of swimming speeds throughout trials, suggesting that intraspecific variability plays a role in population-level responses to hypoxia. In conclusion, subtle increases in activity at DO levels above those that impair growth or cause mortality may result in fish avoiding some detrimental hypoxia conditions. However, when summer flounder are exposed to very low DO, long recovery times may have significant consequences in terms of predation risk and decreased foraging.

Abundance and Distribution of *Etropus microstomus* and *Etropus crossotus* in Virginia's Portion of Chesapeake Bay and its Major Tributaries

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The Virginia Institute of Marine Science (VIMS) has conducted a bottom trawl survey in Virginia's portion of Chesapeake Bay and its major tributaries (James, Rappahannock and York rivers) since 1955, with gear configuration standardized in 1979 (30' semi-balloon otter trawl with ¼" mesh cod-end liner and a tickler chain). Of 12 flatfish species known from Chesapeake Bay and its tributaries, eight have been captured by the VIMS juvenile finfish trawl survey, including two members of *Etropus*: *E. microstomus* (smallmouth flounder) and *E. crossotus* (fringed flounder). From 1979 to 2003, both *E. microstomus* and *E. crossotus* were regularly encountered during sampling, though at very different frequencies and abundances. Among members of the flatfish assemblage, *E. microstomus* ranks 4th and *E. crossotus*is 7th in numerical abundance. Smallmouth flounder is a common and abundant species in lower Chesapeake Bay present in some abundance during all four seasons, with highest abundances occurring in late summer and fall. Though found throughout most of Virginia's portion of the Bay and its tributaries, most trawl survey records for this species are from southern and eastern regions of the Bay in close proximity to the bay mouth or near downstream ends of the tributaries. In contrast, fringed flounder is uncommon in Virginia's portion of the Bay and occurs in considerably lower abundances than its congener. Though fringed flounder are captured throughout the year, most occurrences are found during fall, usually in deeper portions of the survey area.

An Evaluation of Summer Flounder, *Paralichthys dentatus*, Estuarine Habitat Use Using Acoustic Telemetry

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Summer flounder, *Paralichthys dentatus*, an economically important fish, is seasonally abundant in estuaries along the East Coast of the United States but a comprehensive understanding of habitat use is lacking. The Mid-Atlantic Bight population of summer flounder migrates between continental shelf spawning habitat in fall/winter and estuarine spring/summer habitat. Because the species is transient, measurements of habitat quality to determine essential fish habitat (EFH) is confounded by local population overturn. Tracking individual fish throughout summers provided insight into habitat use patterns beneficial in delineating their EFH. This research focuses on patterns of juvenile and adult summer flounder (268-535 mm) habitat utilization during 2003 and 2004 in the Jacques Cousteau National Estuarine Research Reserve (JCNERR) encompassing the Mullica River/Great Bay estuary. Habitat use was determined by tracking summer flounder throughout polyhaline-obligohaline parts of the estuary using acoustic telemetry. Individually coded acoustic transmitters were externally attached, allowing individuals (2003 n=30; 2004 n=40) to be tracked passively with stationary hydrophones and actively with a mobile hydrophone. Mobile tracking included two methods of tracking. Weekly locations of all fish in the system, from June through November in 2003 (300 hours tracking) and April through November in 2004 (250 hours tracking), addressed the distribution of tagged fish throughout summer residence. Mobile tracks of individual fish over time provided data on tidal and diel patterns of movement (150 hours of tracking in 2003 and 2004).

Stationary hydrophones detected all tagged fish within the system and reported 176,099 hits since the first tagged fish was released in June of 2003. 700 hours of active tracking (both methods) provided data on 51 out of 70 tagged fish. Dynamic and static variables - temperature, salinity, dissolved oxygen, pH, depth, and substrate - were correlated with fish movements to examine the effects these variables have on habitat use. The fish were found to remain within narrower ranges of temperature, salinity, and dissolved oxygen during nighttime hours.

Ulcerative Dermatitis in Massachusetts Bay Winter Flounder, *Pseudopleuronectes americanus*

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Prior to 2002, ulcerative dermatitis in winter flounder has been very rare in the Gulf of Maine, including the urban harbors of Massachusetts Bay. Since 2002, blind side ulcers have been recorded in up to 42% of the winter flounder sampled at any one station. Prevalence has been highest in spring surveys in western Massachusetts Bay, and rare to absent in Cape Cod Bay and the rest of the Gulf of Maine. Ulcers in the spring appear to be acute and those in June show evidence of healing, with a lower overall prevalence. Ulcers have been observed less consistently in fall surveys. Histology of sub-acute to chronic ulcers showed hemorrhagic, macrophagic, lymphocytic and fibrosing superficial and deep dermatitis. There was focal loss of epithelium, scales, superficial dermal connective tissues and muscle and necrosis of remaining exposed deeper dermal muscle. Areas of healing that were undergoing re-epithelization showed the development of fat cells in upper dermis in place of scales and superficial dermal muscle. Gram-negative bacterial findings showed similar bacteria on ulcerated vs. un-ulcerated skin. However, some of the bacteria identified are potentially important opportunistic disease producing bacteria. This might indicate that there is some other primary cause for the occurrence of the ulcers that might be associated with higher levels of opportunistic bacteria in the environment resulting in the occurrence of multi-focal irregularly occurring ulcers of various sizes in the skin. Of possible significance is that the Boston Outfall was extended into Massachusetts Bay in 2000.

Reduction in Organic Contaminant Exposure and Resultant Hepatic Hydropic Vacuolation in Winter Flounder (*Pseudopleuronectes americanus*) Following Improved Effluent Quality and Relocation of the Boston Sewage Outfall into Massachusetts Bay, USA: 1987-2003

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Effluent upgrades for Metropolitan Boston have included toxicant reduction, primary and secondary treatment and outfall extension. Between 1992 and 2003, winter flounder at five stations were surveyed annually for liver and muscle burden and chronic hepatic sub-lethal impacts of polynuclear and halogenated aromatic hydrocarbons, and metals. Trends in flounder availability and fin condition were also examined. In 1988, 12% of the adult winter flounder in Boston Harbor exhibited hepatic neoplasms and up to 80% had hepatic hydropic vacuolation (HV). Tumor prevalence fell to 0 to 2% and HV to <50% by 1996. Since then tumors have been absent, while a steady prevalence of HV has persisted, consistent with lower hydrocarbon loading and tissue levels. Contaminants and HV also fell with distance from the Boston outfall. After the outfall extension was activated in 2000, there has been no significant change in flounder liver health at the new outfall site.

Abstracts
Poster Presentations

Winter Flounder, *Pseudopleuronectes americanus,* Hatching Success as a Function of Burial Depth in the Laboratory

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Previous experiments have shown that viable hatch of winter flounder eggs is reduced when the eggs are buried by as little as one half of one egg diameter (approximately 0.5 mm of sediment). This sensitivity to burial has resulted in seasonal banning of dredging in several northeastern U.S. estuaries. In this study, a series of experiments was performed to better determine burial effects on hatching success of winter flounder. In the first experiment, eggs were exposed to clean, fine-grained sediment with burial depths including a no-sediment control, dusting (< 0.5 mm), and up to 2 egg diameters (2 mm) of sediment. A trend of decreased hatch success and delayed hatch date with increasing depth of burial relative to controls was observed: however, differences were not statistically significant ($p>0.05$). In a second experiment, treatments included a no-sediment control, 4 egg diameters (4 mm) of clean, fine grained sediment, and between 0.5 to 6 diameters (0.5 - 6 mm) of highly contaminated, fine-grained sediment. Eggs buried in 4 diameters of clean sediment did not hatch. Hatch from eggs dusted with contaminated sediment was similar to controls, while eggs buried by 3 diameters of contaminated sediment had little or no hatching success. There was no evidence of delayed hatch. The results of the second experiment must be interpreted with caution, however, due to the low control survival (21%). Overall, the results of our initial trials indicate that winter flounder eggs may be more resistant to burial than previously thought.

Effect of Contaminated Sediments on Mortality and Predation Avoidance in Winter Flounder

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Young-of-the-year (YOY) winter flounder (*Pseudopleuronectes americanus*) held on sediment from the south branch of the Elizabeth River, VA, sustained significantly higher rates of *in situ* mortality and higher predation by bay shrimp (*Crangon septemspinosa*) than did fish held on less contaminated York River, VA sediment. The mortality pattern paralleled previous toxicity results for winter flounder on Newark Bay, NJ sediment. We speculate that observed effects on these juvenile demersal fish were the result of transdermally absorbed sediment components, most likely PAHs, which are well documented in the Elizabeth River. Preliminary measurements show that respiration was lower in fish held on Elizabeth River sediment, which suggests a mechanism for the observed reduction in escape capability.

A Comparison of the Use of Estuarine Habitats by Flatfishes in South Carolina and Georgia

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As part of a class project in fall 2004, we began a monitoring program to assess the abundance of flatfishes in a small tidal creek in South Carolina and one in Georgia. The purpose of the exercise was to familiarize a student with various fishing gear in two marsh creeks - one accessible by boat and the other by foot. In Country Club Creek, GA we conducted three replicate hauls with a 1-meter beam trawl (3-mm mesh). In Chowan Creek, SC we conducted 3 replicate hauls with a 3-meter seine net. The Georgia site was dominated by the blackcheek tonguefish *Symphurus plagiusa*, although we also obtained the summer flounder, *Paralichthys dentatus*. We caught fewer flatfishes in South Carolina, possibly due to the gear type, but *S. plagiusa* and *P. dentatus* were present. From historical summer data collected from 1998 –2001, fringed flounder, *Etropus crossotus,* and bay whiff, *Citharichthys spilopterus,* were also found at this site. Future research will include comparing the efficiency of the seine and beam trawl in Chowan Creek.

Bay Whiff Distribution and Abundance in Galveston Bay, Texas

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Bay whiff (*Citharichtys spilopterus*) are the numerically dominant flatfish in the Galveston Bay estuary, yet little is know about the ecological significance of the species. Our objective was to characterize the distribution and abundance of bay whiff in Galveston Bay. We used a one-meter beam trawl to sample three types of habitat (marsh edge, 1m depth water, and 2-to-5m water depth) in three main regions of the bay. Total length ranged between 20 to 30mm in the February, increasing to 40 to50mm in May. The highest density ($0.618/m^2$) was measured in deep water habitat during March, and overall equal densities ($0.579/m^2$) were measured in both east and west bay regions with lower densities ($0.3/m^2$) in the central portion of Galveston Bay. Based on preliminary results, the large numbers of bay whiff in Galveston Bay could represent competition for resources with other flatfish of the same size range.

The Abundance of Flatfishes in Country Club Creek, GA

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The purpose of this study was to provide a quantitative comparison of the relative abundance and sizes of the flatfish species occupying a small estuarine tributary over the course of two seasons (Jan-Apr 2004) as part of an undergraduate research project. Using three replicate hauls with a 1-meter beam trawl (3-mm mesh), we noted that the catch was dominated by the blackcheek tonguefish *Symphurus plagiusa* and, towards late spring, summer flounder *Paralichthys dentatus*. *S. plagiusa* ranged from 5-20 individuals per date and lengths varied from 1.7-7.8 cm TL. *P. dentatus* ranged from 0-23 individuals per date and lengths varied from 2.0-7.9 cm TL. The southern flounder, *Paralichthys lethostigma,* and oscellated flounder, *Ancylopsetta quadrocellata*, were also collected. This project will provide some preliminary data that may be used as part of a future long-term monitoring study.

Differential Effects of Preservative Methods on American Plaice and Atlantic Cod Ovarian Tissue

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Addition of relative fecundity estimates to stock-recruit models can significantly strengthen recruitment predictions, but confusion in the literature about the effects of common preservatives on ovarian tissue hinders the standardization of fecundity methods and comparison of fecundity data across studies. In this research subsamples (~1.5g) of ovarian tissue of developing American plaice (*Hippoglossoides platessoides*) and Atlantic cod (*Gadus morhua*) were subjected to four preservative treatments (10% phosphate buffered formalin, non-toxic Gilsons solution, 70% ETOH, and freezing) to quantify effect on sample weight, and assess whether the preserved samples were suitable for measurement using digital image analysis. All treatments preserved eggs well enough to measure digitally, though only eggs in formalin could be analyzed without first removing debris. Mean weight of American plaice samples in the ethanol treatment increased by 25%, samples in 10% formalin increased by 20%, and samples in non-toxic Gilson's solution decreased by 21% on average. Samples that were frozen in distilled water increased by an average of 8%, but this change was not significantly different from zero. Percent change in weight due to treatment differed significantly between the two species for all treatments except formalin. In both species, coefficient of variation for the change in weight was highest for the frozen samples. Ethanol altered the weight of the cod samples the least, while freezing altered the weight of plaice samples least, and formalin was the most stable treatment overall. This information is useful in planning fecundity lab methods and comparing data across studies using different preservatives.

Use of Shallow Habitats by Juvenile Winter Flounder, *Pseudopleuronectes americanus,* along the Maine Coast

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Historically, the fisheries in Maine's shallow waters (< 10 m) provided resources of recreational and commercial importance, but no comprehensive studies of the fishes occupying these habitats along the entire coast ever occurred. Recent legislation has emphasized the importance of "essential fish habitat" including "those waters necessary for spawning, breeding, feeding, or growth" to healthy fisheries.

We divided the entire Maine coast into three zones for sampling over five consecutive years. In 2000, we sampled the midcoast from Casco to Penobscot Bay, during 2001 - 2002 along the southern Maine coast to New Hampshire and along the eastern Maine coast to Canada in 2003 - 2004. Sampling with a 2.0-meter beam trawl (5 minute tows) provides estimates of the importance of various shallow water habitats (eelgrass, kelp, drift algae, sand/mud) to the early life history of fishes.

Winter flounder were a major component of midcoast estuaries (> 2 fish tow $^{-1}$), but much less common to the east and south (< 0.2 tow $^{-1}$). All shallow habitats function as nurseries. CPUE was consistent (0.73 – 1.0 tow $^{-1}$) in the three major habitats sampled in eelgrass, *Zostera marina*, kelp, *Laminaria longicruris*, and over sand, but much lower in drift algae, *Gracilaria* sp. (0.10 tow $^{-1}$). CPUE increases from 0.01 tow $^{-1}$ in April to average about 1 tow $^{-1}$ during June to September before dropping by half in October. Winter flounder ranged from one – 42 cm TL with most between 2 – 10 cm (73%) and few adults greater than 20 cm.

Impacts of Size on Growth and Early Maturity in Female Yellowtail Flounder, *Limanda ferruginea* (Storer)

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Yellowtail flounder is a small, early-maturing flatfish that has been considered as a candidate species for cold-water aquaculture in Newfoundland. The experiment examined three size classes of one-year-old, cultured female fish over a 14-month period. Small, medium and large females were separated as 0+ and young 1+ year fish. Pubertal development in 1+ fish was lowest, intermediate and highest for the small, large and medium size classes, respectively. Growth rates were highest for the small size class and lowest for the medium size class. Large fish still grew well but mature individuals of this group grew more slowly than immature individuals. These results reinforce the negative relationship between maturity and growth rate in flatfish. However, pubertal onset at one year of age was not always connected with a larger size in these cultured females.

Real-time PCR Analysis of Steroid Enzyme Gene Expression During Atlantic Halibut (*Hippoglossus hippoglossus*) Development

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Atlantic halibut aquaculture would benefit from the development of all female lines, since females grow faster and reach a larger size than males. Determining the period when gonad development occurs would define the critical time when hormonal or environmental treatments should be applied to influence sex ratios. We investigated the transcription levels of the steroid hormone biosynthetic enzyme genes, aromatase (both brain- and ovary-type) and 11-beta hydroxylase, which catalyze key steps in the synthesis of 17 beta-estradiol and 11-ketotestosterone, respectively, in juveniles (16 - 67 mm in standard length) using real-time PCR. The results suggest that treatments to manipulate sex ratios should be started by the time fish reach as small as 16 mm when both of the aromatase genes showed elevated levels in the brain. For all three genes, elevations in expression levels were observed in both brain and gonad regions in fish prior to histological sex differentiation (approximately 32 mm). The elevations in brain occurred slightly earlier than in gonad, supporting the idea that steroid hormone expression in the brain is a key determinant of phenotypic sex in fish. However, we were unable to detect consistent differences in the expression patterns of these genes that would be diagnostic of sex.

PLEUROGENE: Genomics for the Enhancement of Commercial Production of Atlantic Halibut and Senegal Sole

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Atlantic halibut (*Hippoglossus hippoglossus*) and Senegal sole (*Solea senegalensis*) are two flatfishes yielding high value market products with good potential for aquaculture in eastern North America and Mediterranean Europe, respectively. Production–related problems in these two evolutionary–related species may be addressed with improved knowledge of important basic biological processes such as reproduction, development, nutrition, genetics and immunity. The use of genomic approaches to thoroughly characterize these processes will translate into knowledge that can be used to overcome the production obstacles and create (for Senegal sole) or expand (for Atlantic halibut) solid aquaculture industries for these fish.

PLEUROGENE is a new initiative funded through Genome Canada-Genome Spain for three years (2004-2007). There are two main goals: (i) the construction of genetic linkage maps for Atlantic halibut and Senegal sole for use in the selection of improved broodstock based on molecular markers, and (ii) the design, construction and use of a flatfish microarray for studies of gene expression in these two species. High-throughput genome- and proteome-based technologies will be used for the identification, characterization and mapping of genes important for reproduction, larval development, immunity and nutrition. All the genetic and molecular information obtained in this project will be integrated into an interactive bioinformatic platform specifically developed for the project. The knowledge generated by the PLEUROGENE project will ultimately lead to the establishment of new technologies for the control of reproduction and optimization of larval health and nutrition in the Senegal sole, Atlantic halibut, and other related flatfish species under intensive culture conditions.

Effects of Contaminants on Winter Flounder Living in a Sewage-Impacted Estuary-Jamaica Bay, NY

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Jamaica Bay, NY is an urban estuary that receives millions of gallons of sewage effluent daily making sewage effluent its primary source of freshwater. Extremely high levels environmental estrogen mimics (e.g., nonylphenol, estradiol, estrone) observed in sediments led us to postulate that benthic fish residing in Jamaica Bay, NY are likely targets for endocrine disruption and, potentially, reproductive impairment. We collected adult, juvenile and young-of-the-year winter flounder, *Pseudopleuronectes americanus*, from multiple sites in Jamaica Bay and a reference site off the east coast of Long Island, Shinnecock Bay, in the spring of 2002 and 2003. Very few male fish were found at the site with the highest levels of endocrine disruptors. Levels of circulating 17 beta-estradiol (E2), vitellogenin (VTG) and 11-Ketotestosterone (11-KT) showed unusual patterns of endocrine disruption in this species. Females from the most contaminated site showed significantly higher levels of VTG and males only showed decreased levels of E2 and 11-KT as compared to reference fish. Histological analysis of liver and gonad tissue are also ongoing.

Habitat for Flatfish: The Relative Importance of Depth, Temperature and Substrate

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Understanding how flatfish abundance, distribution, and production are related to habitat factors and how these relationships change across ontogeny at large spatial scales are key components to the development of spatial tools for fisheries management. A geographic information system (GIS) was used to bin USGS substrate grain size data and a 34-year NEFSC time series of environmental and biological data into 10-minute squares. Data were averaged over 2 seasons (fall and spring) for each of 3 time blocks (1968-79, 1980-89 and 1990-02). Multivariate statistical analyses were then used to examine the relative importance of bottom temperature, depth, substrate grain size, season, and time block for individual size classes for four flatfish species: American plaice (*Hippoglossoides platessoides*), fourspot flounder (*Paralichthys oblongus*), winter flounder (*Pseudopleuronectes americanus*), and yellowtail flounder (*Limanda ferruginea*). Depth explained the largest proportion of variance in the distribution of size classes for American plaice, winter flounder, and fourspot flounder with larger individuals more abundant in deeper waters. This pattern reflects the characteristic onshore-offshore spawning migration undertaken by adults of these species. For yellowtail flounder, which inhabits deeper waters, time block was the strongest explanatory factor, with larger individuals relatively more abundant later in the time series. This is likely a response to the combined effects of changing exploitation and subsequent recruitment patterns. In contrast, larger individuals declined over the time series for the other three species most likely in response to the preferential exploitation of bigger fish. Substrate grain size explained 2-13% of the explainable variance in species size-class distributions. Larger substrates were associated with shallower depths and smaller individuals for all four species. Although more refined estimates of essential fish habitat for marine fishes will continue to be challenging, novel geostatistical approaches offer strong potential in meeting these challenges.

Development of Digestive Capacity in Larval Atlantic Halibut: A Preliminary Survey

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The objectives of the present study were to identify the location and timing of gene expression of specific digestive enzymes in first-feeding Atlantic halibut larvae and juveniles. Prior to the start of first feeding, the gastrointestinal tract (GIT) is divided into anterior, mid and hindgut regions. The liver is present at this time, as is the pancreas. During larval development the pancreas changes from a compact organ to a diffuse tissue interspersed though much of the mesentery surrounding the GIT. Functional gastric glands are not present until approximately 66 days post-hatch (dph). Using primers based on winter flounder digestive enzyme gene sequences for bile salt-activated lipase (BAL), trypsinogen (Trp), and pepsinogen (Pep), we were able to amplify products from RNA extracted from whole larvae and juveniles using RT-PCR. These products were sequenced and the sequences used to design halibut gene-specific primers for the above enzymes. RT-PCR analysis using halibut-specific primers revealed that Trp and BAL gene expression was evident at least from the time of first feeding. Pep gene expression was not detectable until 80 dph. *In situ* hybridization with DIG-labeled antisense RNA probes localized expression of BAL and Trp to the exocrine pancreas. Pep expression was localized only to the glandular regions of the stomach. These data provide a first step toward understanding the molecular biology underlying the ontogeny of digestive capacity in Atlantic halibut.

Fish Community Structure of Intertidal Habitats of the Mount Hope Bay Estuary with Emphasis on Juvenile Winter Flounder, *Pseudopluronectes americanus*

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Fish respond to a variety of factors in the selection of habitat, including prey availability, predator avoidance, and competition. Fish are able to respond to these cues and alter their distribution to minimize metabolic cost. Identifying which habitats may be preferred for juvenile winter flounder is critical in conservation efforts and the definition of essential fish habitat for this species. My masters research focuses on the juvenile winter flounder population of Mount Hope Bay, where there is large areas of intertidal rocky/cobble habitat, with patches of *Spartina patens*. Intertidal habitat use of juvenile winter flounder was assessed using a three-pronged effort of field study, habitat mapping and laboratory study. Collections of winter flounder on site were attempted using a 50ft beach seine and a blocking tidal trap with mixed results. Intertidal habitats were quantified using random transects and .5m x .5m quadrats. Ongoing laboratory study will address in depth the substrate and vegetation preferences of juvenile winter flounder using habitat types present in the field. These laboratory studies will mimic the dominant rocky/cobble substrate and emergent *Spartina patens* grass present in Mount Hope Bay to determine use by juvenile winter flounder. These habitats are not sampled effectively with beach seines commonly used in monitoring programs, therefore juvenile winter flounder may be under sampled in Mount Hope Bay. It is generally understood in the literature that coarse/ sandy substrates or organic coves are the preferred habitat for juvenile winter flounder, but it is yet unclear if juvenile winter flounder utilize rocky/cobble substrates to any great extent.

Regulation of Carbonic Anhydrase-Dependent Renal Sulfate Secretion by Cortisol in Winter Flounder, *Pseudopleuronectes americanus*

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Sulfate secretion by the marine teleost renal proximal tubule is stimulated by cortisol and dependent on carbonic anhydrase (CA). Thus, cortisol modulation of sulfate secretion may be through stimulation of CA. To study this relationship primary cultures of flounder renal proximal tubule epithelium (fPTCs) were exposed to elevated hydrocortisone (HC) or reduced HC for 5 days prior to determination of CA activity, CAII protein abundance (immunoblotting), and transepithelial transport of sulfate in Ussing chambers. Degenerate primers and RT-PCR were used to obtain a partial cDNA clone (327 bp) of fPTC CAII that exhibited high sequence similarity to CAII from numerous species. CAII was localized to the cytosol and plasma membranes of intact flounder renal tubules with immunohistochemistry. Treatment of fPTCs with reduced HC caused reductions in CA activity (28%), CAII protein abundance (65%), and active sulfate secretion (28%), without affecting cell differentiation. Treatment of fPTCs with methazolamide (MTHZ, 0.1 mM), a CA inhibitor, reduced active sulfate secretion 55%. Treatment with reduced HC and MTHZ together had the same effect as MTHZ alone. These data demonstrate that the marine teleost proximal tubule contains both cytosolic and membrane-associated CAII and that cortisol directly stimulates CA activity, CAII abundance, and a fraction of sulfate secretion that is CA-dependent. Supported by NSF.

A Flatfish Perspective on Asymmetry: What Genes Mediate Southern Flounder Metamorphosis?

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Metamorphosis in frogs and flatfish is mediated by thyroid hormone (TH). The craniofacial morphology for both tadpoles and larvae is initially bilaterally symmetric, but during metamorphosis the skull and jaw undergo abrupt and extensive remodeling. In contrast to the newly remodeled froglet head that retains bilateral symmetry, the juvenile flatfish has metamorphosed into the world's most asymmetric vertebrate: translocation of one eye to the opposite side of the head is accompanied by asymmetric skull and jaw development. What TH-responsive genes mediate flatfish metamorphosis in general, and craniofacial remodeling in particular? Does asymmetric gene expression correspond with left and right sidedness within and among flatfish species? How evolutionarily conserved is metamorphosis among vertebrates? The first step in addressing these questions is to identify genes that are differentially expressed during metamorphosis. Premetamorphic 13-day old southern flounder were treated for 3 days with either TH or an inhibitor of TH production (methimazole). Messenger RNA from each group was purified, and differentially-expressed genes were enriched using a PCR-based subtractive hybridization procedure. Though we will sequence 3,000 differentially-expressed clones, here we describe the first 300 TH-upregulated and 160 downregulated clones of our screen based upon sequence homology with known vertebrate genes. Upregulated genes include several implicated in bone remodeling (periostin, PTH-responsive osteosarcoma protein, Sox, and alpha-2-HS-glycoprotein), as well as development of skin, gut, muscle, central nervous system, and cell proliferation. Downregulated genes were homologous to proteins expressed in skin (keratins), gut (trypsin, lipid binding protein), blood proteins (parvalbumin) and many metabolic proteins.

Benthic Food Webs on Georges Bank: Where Do Flatfish Fit into the Picture?

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Flatfish are an important component of benthic food webs. These species provide major links between the benthos and upper trophic level predators in the northeast US continental shelf ecosystem. We examined more than 30 years of food habits data for seven species of flatfish and their major predators from Georges Bank to evaluate the temporal variation in flatfish predator-prey relationships. The morphology of flatfish (gape width) suggests that most species have a strong preference for certain prey, adopting either a benthivorous or piscivorous diet after reaching adulthood. Summer flounder (*Paralichthys dentatus*) and fourspot flounder (*Paralichthys oblongus*) were generally piscivorous, consuming herring, sand lance, hakes, mackerel, and similar forage fish. American plaice (*Hippoglossoides platessoides*) specialized on ophiuroids and sand dollars (*Echinarachniusparma*). Yellowtail flounder (*Limanda ferruginea*), winter flounder (*Pseudopleuronectes americanus*), windowpane (*Scophthalmus aquosus*), and witch flounder (*Glyptocephalus cynoglossus*)ate primarily polychaetes, gammarids and similar benthic invertebrates. Significant shifts in diet were observed for summer and fourspot flounder across the time series. In contrast, changes in diet composition were not apparent for the benthivorous flatfish. The major predators of flatfish on Georges Bank include spiny dogfish, Atlantic cod, red hake, white hake, sea raven, goosefish, longhorn sculpin, winter skate, little skate, and piscivorous flatfish. Our results suggest that the major predator-prey relationships in the Georges Bank benthic food web have not fundamentally changed over time, despite changing energy flows and abundance over the past three decades.

Elemental Fingerprints of Juvenile Winter Flounder Otoliths from Narragansett Bay, RI and Surrounding Coastal Ponds

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Elemental fingerprinting has become a powerful tool in fisheries science for identifying fish migration patterns, seasonal changes in habitat use, and for delineating the nursery origins of adult fish populations. In this study we investigated whether elemental signatures in juvenile winter flounder *(Pseudopleuronectes americanus*) otoliths, collected from different habitat types and locations, could be used as natal fingerprints.

Juvenile flounder were collected from different nearshore habitats (unvegetated, macroalgae, and eelgrass) and locations (upper, mid, lower) within Narragansett Bay, RI (USA) and surrounding coastal ponds. Sagittal otoliths were removed, cleaned under a laminar flow hood and digested with high purity nitric acid. Elemental analysis was then conducted using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) and or Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).

The concentrations of nine elements (Ca, Sr, K, Na, Ba, Rb, Li, Mg and Mn) were measured and statistically analyzed using multivariate techniques. Both canonical discriminant analysis (CDA) and linear discriminate function analysis (LDFA) showed that otolith chemical fingerprints differed between fish collected from Narragansett Bay and the coastal ponds. In addition, significant differences were observed in the otolith chemistry of fish collected from the three habitat types (unvegetated, macroalgae, and eelgrass). These differences were more pronounced for comparisons either within the Bay or the coastal ponds and less pronounced for the combined data including all stations. In order to enhance our ability to differentiate among juvenile nursery areas, additional measurements including stable carbon and oxygen isotopes and rare earth elements will be investigated in the future.

Fin Rot in Winter Flounder from New Haven Harbor, CT: The Clinical Profile of a Wasting Disease

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Fin rot is a wasting disease characterized by fin loss and muscular emaciation often found in winter flounder sampled from urban estuaries. This condition was observed in nearly 50% of flounder present in trawl catches from New Haven Harbor, Connecticut during the 1980's. From 1988 to 1990, 106 fish were processed for blood serum analyses to gain an understanding of the underlying physiological effects of this disease condition. Initially, blood was removed from affected fish and controls at sea, soon after capture. About half-way through the study, it was decided to take advantage of the wet lab capabilities of the Milford Laboratory and return specimens to shore, holding them overnight for blood removal and processing the next day. Fish were identified by sex, measured, fin loss was quantified, hematocrits determined and blood serum chemistry values measured for: hemoglobin, calcium, bilirubin, osmolality, phosphate, and total protein. A categorical database was created using fin rot (1/0) as the outcome variable and all other clinical parameters as predictor variables. Stepwise Logistic Regression was used to model the contribution of blood values resulting in the final fin rot outcome. Statistical analyses were done separately for each sex and for each mode of sampling. For flounder that were sampled after an overnight rest period, hematocrit and calcium values were the primary predictors of fin rot in female fish only. Hematocrits were depressed and calcium values were elevated in these female fin-rotted fish. Hemoglobin levels were the only predictors of fin rot on female flounder sampled at sea; calcium levels were not identified as a contributing variable in the final Stepwise Regression model. Only 6 male flounder were available for sampling at sea; an insufficient number for statistical analysis. Blood parameter values varied for diseased fish, depending on the magnitude of fin loss. The etiology of fin rot is not known but could result from toxic chemicals or microbes adversely impacting resident flounder through the food chain, resulting in anemia and hypercalcemia in affected individuals.

Axial Skeletal Anomalies in Commercially Important Fish from the North Atlantic

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Deformities of the axial skeleton are usually observed in fish in the form of dwarfism, spinal curvature, and cranial compression. When radiographs are displayed in fish with these conditions; the following underlying structural deformities can be seen: fusion of vertebral centra, complexed vertebrae resulting from incomplete fission during embryonic development, accessory spinal processes, reduced spinal processes, deformed spinal processes, reduced centra, and deformed centra. Species displayed include: winter flounder, American plaice, yellowtail flounder, witch flounder, Dover sole from the North Sea, Acadian redfish, and alewife. Specimens were obtained from NMFS research vessels operating in the Gulf of Maine and Georges Bank, from Boston Harbor during New England Aquarium's Fish Days, and from trawling activities conducted by the NMFS Milford Laboratory in New Haven Harbor, Connecticut. The Dover sole was purchased at a fish market. Associated with this poster presentation, radiographs of fish will be displayed.

Procedures for Issuing Manuscripts in the *Northeast Fisheries Science Center Reference Document* (CRD) Series

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Preparation: Type a clean/neat, single-spaced version of the document. The document must be paginated continuously from beginning to end and must have a "Table of Contents." Begin the preliminary pages of the document — always the "Table of Contents" — with page "iii." Begin the body of the document — normally the "Introduction" — with page "1," and continuously paginate all pages including tables, figures, appendices, and indices. You can insert blank pages as appropriate throughout the document, but account for them in your pagination (*e.g.*, if your last figure ends on an odd-numbered/right-hand page such as "75," and if your next page is the first page of an appendix, then you would normally insert a blank page after the last figure, and paginate the first page of the appendix as "77" to make it begin on an odd-numbered/right-hand page also). Forward the final version to the Editorial Office as both a paper copy and electronically (*i.e.*, e-mail attachment, 3.5-inch floppy disk, high-density zip disk, or CD). For purposes of publishing the CRD series only, the use of Microsoft Word is preferable to the use of Corel WordPerfect.

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Publications and Reports of the Northeast Fisheries Science Center

The mission of NOAA's National Marine Fisheries Service (NMFS) is "stewardship of living marine resources for the benefit of the nation through their science-based conservation and management and promotion of the health of their environment." As the research arm of the NMFS's Northeast Region, the Northeast Fisheries Science Center (NEFSC) supports the NMFS mission by "conducting ecosystem-based research and assessments of living marine resources, with a focus on the Northeast Shelf, to promote the recovery and long-term sustainability of these resources and to generate social and economic opportunities and benefits from their use." Results of NEFSC research are largely reported in primary scientific media (*e.g.*, anonymously-peer-reviewed scientific journals). However, to assist itself in providing data, information, and advice to its constituents, the NEFSC occasionally releases its results in its own media. Currently, there are three such media:

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