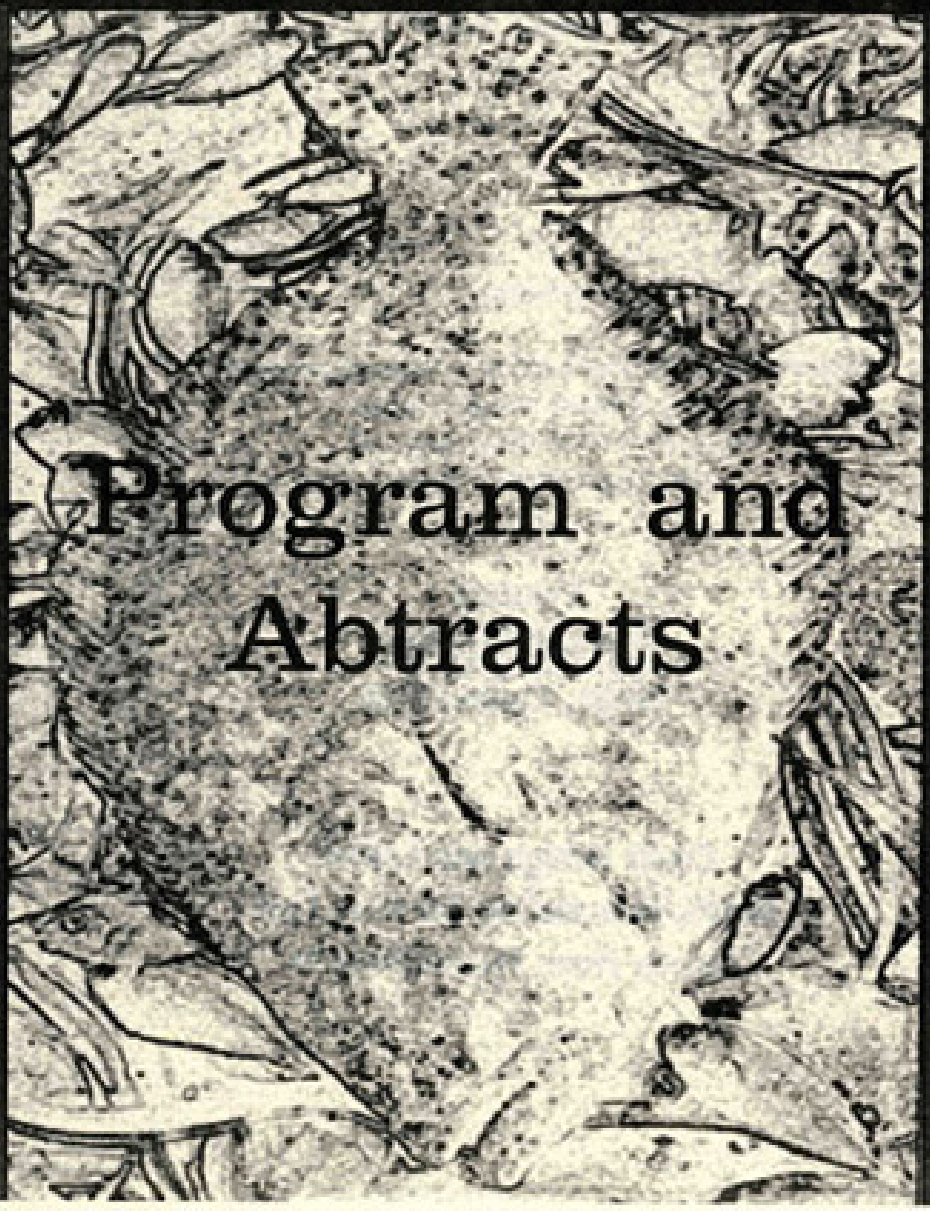
National Marine Fisheries Service
Northeast Utilities

Flatfish Biology Workshop

December 6 & 7, 1994
Mystic, CT



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Flatfish Biology Workshop
December 6-7, 1994, Mystic, Connecticut

by Conference Steering Committee: Anthony Calabrese (Chair)[1], Allan Beck[2], Jay Burnett[3], Donald Danila[4], Arnold Howe[5], Penelope Howell[6], Ambrose Jearld[3], and Anne Studholme[7]

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Fourth in a series of Flatfish Biology Conferences

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

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Flatfish Biology Workshop

December 6-7, 1994, Best Western Sovereign Hotel, Mystic, Connecticut

Oral Presentations

Tuesday, December 6th

7:45 a.m. **Registration/Coffee-Best Western**

8:45 a.m. Welcome and Introduction
Allen E. Peterson, Jr., Director
National Marine Fisheries Service
Northeast Fisheries Science Center
Woods Hole, MA

Anthony Calabrese, Conference Chair
National Marine Fisheries Service
Northeast Fisheries Science Center
Milford, CT

Session I

Allan Beck, Chair
Environmental Advantage Group
Prudence Island, RI

9:00 a.m. The Development and Use of an *In Vitro* Assay to Evaluate Antigen/Antibody Responses in Winter Flounder
J. Bodammer
National Marine Fisheries Service/University of Rhode Island
Kingston, RI

9:20 a.m. An Idiopathic Lesion with Large Vacuoles in Hepatocytes of Winter Flounder from Boston Harbor and Massachusetts Bay
R. E. Hillman[1] and M. J. Moore[2]
[1]Battelle Ocean Sciences, Duxbury, MA and [2]Woods Hole Oceanographic Institution, Woods Hole, MA

9:40 a.m. Neutronal Adaptation Accompanying Metamorphosis in the Flatfish Suggests that an Evolutionary Plan Underlies Vertebrate Oculomotor Behavior
R. Baker[1] and W. Graf[2]
[1]NYU Medical Center, New York, NY and [2]Labortoire de Physiologie de la Perception et de l'Action CNRS, Paris, France

10:00 a.m. A Two-year Field Study of Vitellogenesis in Winter Flounder (*Pleuronectes americanus*) Under PAH-contaminated Conditions
J. M. Nicolas[1], J. H. Vandermeulen[2], D. Mossman[2], and S. Kirby[1]
[1]Dalhousie University, Halifax, Nova Scotia, Canada and [2]Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

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

Session II

Don Danila, Chair
Northeast Utilities Environmental Laboratory
Waterford, CT

10:50 a.m. Predator-prey Interactions between Benthic Crustaceans and Recently Settled Winter Flounder: Field Observations
D. A. Witting and K. W. Able
Rutgers University, Tuckerton, NJ

11:10 a.m. Settlement Areas for Winter Flounder: Patterns in the Use of Coves Near Inlets
M. C. Curran and K. W. Able
Rutgers University, Tuckerton, NJ

11:30 a.m. Analysis of Life History Patterns in Flatfish with Emphasis on North Atlantic Species
C. Chambers
Huntsman Marine Science Centre, St. Andrews, New Brunswick, Canada

11:50 a.m. Distribution and Abundance of the Blackcheek Tonguefish, *Symphurus plaguisa* (Cynoglossidae: Pleuronectiformes), in Chesapeake Bay
M. R. Terwilliger
Virginia Institute of Marine Science, Gloucester Point, VA

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

Session III

Penny Howell, Chair
Connecticut Department of Environmental Protection
Old Lyme, CT

1:10 p.m. Comparisons of Growth and Mortality in Juvenile Winter Flounder from New Haven Harbor and the Connecticut River, 1993
C. Meise[1], J. Widman[2], P. Howell[3], P. Clark[2], R. Goldberg[2], J. Hughes[2], R. Mercaldo-Allen[2], J. Pereira[2], D. Perry[2], and D. Nelson[2]
[1]National Marine Fisheries Service, Narragansett, RI, [2]National Marine Fisheries Service, Milford, CT, and [3]Connecticut Department of Environmental Protection, Old Lyme, CT

1:30 p.m. Distribution, Growth Rate and Estuarine Recruitment of North Carolina Summer Flounder Larvae
D. S. Peters, and H. J. Walsh
National Marine Fisheries Service, Beaufort, NC

1:50 p.m. Monthly Trends in Growth and Feeding in Captive Immature Winter Flounder (*Pleuronectes americanus*)
D. Mossman and J. H. Vandermeulen
Bedford Institute of Oceanography, Dartmouth, Nova Scotia, Canada

2:10 p.m. Growth Estimates for Larval and Juvenile Winter Flounder in Cape Cod Estuaries
K. L. Lang and F. P. Almeida
National Marine Fisheries Service, Woods Hole, MA

2:30 p.m. The Anisotropic Structure of Fish-scale Patterns and its Consideration in the Quantification of Seasonal Growth
I. Smolyar[1], F. Almeida[2], and J. Burnett[2]
[1]SES, Inc., Greenbelt, MD, and [2]National Marine Fisheries Service, Woods Hole, MA

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

Session IV

Ambrose Jearld, Chair
National Marine Fisheries Service
Woods Hole, MA

3:20 p.m. Preliminary Results of the Utilization of the Newport River Estuary, North Carolina, by Juvenile Flatfish Species
D. P. Cyrus[1], D. E. Hoss[2], and D. S. Peters[2]
[1]University of Zululand, Natal, South Africa and [2]National Marine Fisheries Service, Beaufort, NC

3:40 p.m. Prediction of Optimum Spawning Location and Interannual Variation in Year-class Strengths of the Hecate Strait Fishes in Relation to Hydrodynamic Effects on Larvae
F. Juanes[1] and C. J. Walters[2]
[1]University of Massachusetts, Amherst, MA and [2]University of British Columbia, Vancouver, British Columbia, Canada

4:00 p.m. Effect of Somatolactin and Related Hormones on Winter Flounder Renal Functions
M. Lu[1], J. L. Renfro[1], and P. Swanson[2]
[1]University of Connecticut, Storrs, CT, and [2]National Marine Fisheries Service, Seattle, WA

4:20 p.m. Spatial and Temporal Patterns of Abundance of Larval and Juvenile Windowpane Flounder, *Scophthalamus aquosus*, in an Estuarine/Inner Continental Shelf System
M. J. Newman and K. W. Able
Rutgers University, Tuckerton, NJ

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

5:30 p.m. **Hosted Mixer and Poster Session**

Wednesday, December 7th

7:45 a.m. **Registration/Coffee**

Session V

Anne Studholme, Chair
National Marine Fisheries Service
Highlands, NJ

8:30 a.m. Fish Recruitment in the Northeastern United States: The Role of Estuarine Habitats
A. L. Studholme[1], A. Calabrese[2], K. W. Able[3], and S. C. Wainright[4]
[1]National Marine Fisheries Service, Highlands, NJ, [2]National Marine Fisheries Service, Milford, CT, [3]Rutgers University, Tuckerton, NJ, and [4]Rutgers University, New Brunswick, NJ

Habitat-specific Patterns for Distribution and Growth of Young-of-the-Year Winter Flounder in a Relatively Unimpacted Southern New Jersey Estuary
S. Hagan, R. Hoden, and K. W. Able
Rutgers University, Tuckerton, NJ

Habitat Use Patterns and Growth of Young-of-the-Year Winter Flounder in a Northern New Jersey Estuary
B. A. Phelan, J. T. Finn, A. J. Bejda, S. A. Fromm, D. Packer, and D. Jeffress
National Marine Fisheries Service, Highlands, NJ

Habitat Use Patterns and Growth of Young-of-the-Year Winter Flounder in a Central Long Island Sound Estuary in Connecticut
R. Goldberg, J. Pereira, P. Clark, F. P. Thurberg, and A. Calabrese
National Marine Fisheries Service, Milford, CT

Habitat Use and Growth of Young-of-the-Year Winter Flounder, *Pleuronectes americanus,* in the Lower Hudson River
J. M. Manderson[1, 2], A. L. Studholme[2], K. W. Able[1], and D. Packer[1]
[1]Rutgers University, New Brunswick, NJ, and [2]National Marine Fisheries Service, Highlands, NJ

Growth of Young-of-the-Year Winter Flounder in Three Estuarine Habitats as Measured by RNA/Protein Ratios
C. A. Kuropat, R. Mercaldo-Allen, and F. P. Thurberg
National Marine Fisheries Service, Milford, CT

Habitat Utilization by Juvenile Winter Flounder as Indicated by Stable Isotope Ratios
S. Y. Litvin and S. G. Wainright
Rutgers University, New Brunswick, NJ

10:00 a.m. **Coffee**

Session VI

Arnold Howe, Chair
Massachusetts Division of Marine Fisheries
Sandwich, MA

10:30 a.m. Influence of Hypoxia on the Foraging Ecology and Movement of Juvenile Winter Flounder, Windowpane and Fourspot Flounder
D. S. Lee and R. B. Whitlach
University of Connecticut, Groton, CT

10:50 a.m. Arsenic Induction of Metallothionein in Juvenile Winter Flounder
K. L. Jessen-Eller and J. Crivello
University of Connecticut, Storrs, CT

11:10 a.m. Utilization of New Haven Harbor as a Spawning and Nursery Area by Winter Flounder (*Pleuronectes americanus*)
J. J. Pereira, R. Goldberg, P. E. Clark, J. J. Ziskowski, R. A. Greig, J. B. Hughes, and D. M. Perry
National Marine Fisheries Service, Milford, CT

11:30 a.m. Habitat Models for Juvenile Pleuronectids Around Kodiak Island, Alaska
B. L. Norcross, F. -J. Muter, and B. A. Holladay
University of Alaska, Fairbanks, AK

11:50 a.m. A Multivariate Model of Winter Flounder Maturation:
What's Age Got to do with it Anyway?
J. Burnett
National Marine Fisheries Service, Woods Hole, MA

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

Session VII

Jay Burnett, Chair
National Marine Fisheries Service
Woods Hole, MA

1:10 p.m. Growth Rates at *ad libitum* Rations of Juvenile *Etropus crossotus* and *Citharichthys spilopterus* in North Carolina Coastal Waters
D. D. Davis[1], J. M. Miller[1], and J. S. Burke[2]
[1]North Carolina State University, Raleigh, NC, and [2]National Marine Fisheries Service, Beaufort, NC

1:30 p.m. Submersible Observations of Flatfish Nursery Habitats in the New York Bight
K. W. Able[1], R. K. Cowan[2], and M. P. Fahay[3]
[1]Rutgers University, Tuckerton, NJ, [2]State University of New York, Stony Brook, NY, and [3]National Marine Fisheries Service, Highlands, NJ

1:50 p.m. Biodiversity and Distributional Patterns of Symphurine Tonguefishes (*Symphurus*: Cynoglossidae: Pleuronectiformes) Occurring in the Western Atlantic Ocean
T. A. Monroe
National Marine Fisheries Service, National Systematics Laboratory, Washington, D.C.

2:10 p.m. Hudson/Raritan Estuary Winter Flounder
A. L. Pacheco, L. Stehlik, E. MacHaffie, and D. McMillan
National Marine Fisheries Service, Highlands, NJ

2:30 p.m. Salinity-related Changes in Resource Use by Two Sympatric Pleuronectid Flounders in Great Bay Estuary, New Hampshire
M. P. Armstrong
Massachusetts Division of Marine Fisheries, Sandwich, MA

2:50 p.m. Ontogeny of Functional Morphology of Feeding in Larval Fish: Winter Flounder *versus* Atlantic Cod
I. H. von Herbing and S. M. Gallager
Woods Hole Oceanographic Institution, Woods Hole, MA

3:10 p.m. **Adjourn**

Poster Session
Tuesday, December 6, 5:30 p.m.

Secretion of 2,4-Dichlorophenoxyacetic Acid (2,4-D) by Renal Proximal Tubule Primary Cultures is Inhibited by Phorbol Ester
P. A. Halpin and J. L. Renfro
University of Connecticut, Storrs, CT

Gonadotropin Induction of Testosterone and Estradiol-17β in Winter Flounder (*Pleuronectes americanus*) Ovarian Follicle Cultures
R. E. Gutjahr-Gobell[1], D. E. Black[2], and A. E. McElroy[3]
[1]SAIC, Narragansett, RI, [2]U. S. Environmental Protection Agency, Narragsentt, RI, and [3]State University of New York, Stony Brook, NY

Grossly Observed Lesions of Flatfishes from Various Northeast Embayments
S. A. MacLean[1] and J. J. Evans[2]
[1]National Marine Fisheries Service, Narragansett, RI, and [2]Maryland Department of Natural Resources, Oxford, MD

Heat Shock Stimulation of Daunomycin Secretion by Flounder Renal Proximal Tubule Cultures
C. Sussman-Turner and J. L. Renfro
University of Connecticut, Storrs, CT

Life History Aspects of Blackcheek Tonguefish, *Symphurus plaguisa* (Cynoglossidae: Pleuronectiformes), an Obscure, Abundant Flatfish in Chesapeake Bay and the Coastal Waters of Virginia
M. R. Terwilliger
Virginia Institute of Marine Science, Gloucester Point, VA

Validation of Daily Increment Formation in Juveniles of Four Flatfish Species: *Symphurus plagiusa*, *Scophthalmus aquosus*, *Paralichthys lethostigma*, and *Etropus crossotus*
M. J. Reichert, W. J. Jones, J. Seigle, and J. V. Campen
University of South Carolina, Columbia, SC

The Anisotropic Structure of Fish-scale Patterns and its Consideration in the Quantification of Seasonal Growth
I. Smolyar[1], F. Almeida[2], and J. Burnett[2]
[1]SES Inc., Greenbelt, MD, and [2]National Marine Fisheries Service, Woods Hole, MA

Analysis of Winter Flounder Population Structure Using Random Amplified Polymorphic DNA
T. L. Spinka, C. Callahan, K. Kallenbach, and K. Goddard
Ursinus College, Collegeville, PA

Distribution, Abundance and Habitat Preference of Juvenile Winter Flounder (*Pleuronectes americanus*) in the Shore-zone of Narragansett Bay, RI
C. Powell and R. Jones
Rhode Island Division of Fish, Wildlife and Estuarine Resources, West Kingston, RI

The Importance of Microzooplankton in the Diet of Winter Flounder Larvae
S. M. Gallager, L. Davis, and P. Alatalo
Woods Hole Oceanographic Institution, Woods Hole, MA

Marine Basins as Potential Winter Flounder Nursery Habitat
P. E. Pellegrino[1], M. E. Mroczka[2], and P. W. Dinwoodie[2]
[1]Southern Connecticut State University, New Haven, CT, and [2]Cedar Island Marina, Clinton, CT

Identification and Characterization of Cytochrome P-450s in Juvenile Winter Flounder
K. L. Wall and J. C. Crivello
University of Connecticut, Storrs, CT

A Novel Peptide Isolated from Flounder Skin has Antimicrobial Properties
G. Diamond and P. Weis
New Jersey Medical School, Newark, NJ

Maturation of Pleuronectiforms vs. Gadiforms: Size vs. Age
L. O'Brien
National Marine Fisheries Service, Woods Hole, CT

Abstracts
Oral Presentations

The Development and Use of an *In Vitro* Assay to Evaluate Antigen/Antibody Responses in Winter Flounder

J. E. Bodammer

URI/NOAA CMER Program
Fisheries, Aquaculture and Veterinary Science Department
University of Rhode Island
Kingston, RI 02881

During the past several years, we have been working on an *in vitro* assay method which would permit us to evaluate the antigen/antibody responses of winter flounder (*Pleuronectes americanus*) in both field and laboratory research. Using the well accepted passive hemolytic plaque assay (PHPA) as an analytical endpoint, we have aseptically isolated leukocytes from the flounder spleen, cultured the isolated cells in RPMI 1640 media, and antigenically stimulated them with the T-cell independent cell antigen TNP-LPS or the t-cell dependent antigen TNP-KLH before evaluating the number of plaque-forming (antibody producing) cells with TNP-labelled sheep red blood cells. This presentation will include technical information on the assay method and the results of applying it to the winter flounder immune system under laboratory conditions of stress (i.e., exogenous cortisol) or differing acclimation temperatures, as well as immunological data, obtained from fish collected in polluted (New Haven Harbor, New Haven, CT) and clean (Niantic River, Niantic, CT) sites in Long Island Sound.

An Idiopathic Lesion with Large Vacuoles in Hepatocytes of Winter Flounder from Boston Harbor and Massachusetts Bay*

R. E. Hillman[1] and M. J. Moore[2]

[1]Battelle Ocean Sciences
397 Washington Street
Duxbury, MA 02332

[2]Woods Hole Oceanographic Institution
Woods Hole, MA 02543

Winter flounder are collected annually in April from five sites in Boston Harbor and Massachusetts Bay as part of a monitoring study to assess the impact of the discharge of wastewater from the Deer Island Sewage Treatment Plant into Massachusetts Bay. The five sites include Deer Island flats, Broad Sound, off Nantasket Beach, the future outfall site, and a reference site in eastern Cape Cod Bay. Body burdens of selected organic and metal compounds in edible tissues and livers are determined, and histological observations of livers are made.

Livers of winter flounder collected in April 1993 contained a lesion previously unreported in fish from the northeast. The lesion was characterized by hepatocytes that had become swollen by a large vacuole that displaced the nucleus. The vacuole often contained a small round body with basophilic components. The presence of these cells in the liver was often accompanied by one or more pathological conditions including necrotic foci, loss of distinction of hepatocellular boundaries, cytomegaly, foci of basophilic or eosinophilic hepatocytes, and foci of cellular alteration. It is possible that the lesion is a manifestation of apoptosis, although other interpretations are possible at this time.

The lesion occurred in 59 percent of the fish collected on the Deer Island flats, the area of the present discharge from the sewage treatment plant; 62 percent of the fish from Broad Sound; 50 percent of the fish collected off Nantasket Beach; 52 percent of the fish collected at the future outfall site; and 23 percent of the fish from the reference site in eastern Cape Cod Bay. Although the Deer Island and Broad Sound sites receive the highest levels of anthropogenic input of contaminants, there was no correlation between any specific contaminant and the prevalence of the lesion.

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*This study is being conducted under a contract between Battelle and the Massachusetts Water Resources Authority.

Neutronal Adaptation Accompanying Metamorphosis in the Flatfish Suggests that an Evolutionary Conserved Plan Underlies Vertebrate Oculomotor Behavior

R. Baker[1] and W. Graf[2]

[1]*Department of Physiology and Biophysics, NYU Medical Center*
New York, NY 10016

[2]*Labortoire de Physiologie de la Perception et de l'Action*
CNRS, 15 rue de l'Ecole de Medecine
75270 Paris Cedex 06, France

Flatfish offer a natural paradigm to investigate adaptive changes in the CNS of vertebrates, since during metamorphosis the optic axis of each eye retains the same orientation in respect to the environment. Consequently, the vestibular reference frame is rotated 90º relative to the oculomotor coordinates. As a result, during swimming movements the same natural vestibular stimulation occurring before and after metamorphosis must produce different types of compensatory eye movements. This geometrical puzzle has been resolved by examining all of the anatomical and physiological changes that might occur extending from the sensory to motor periphery (i.e., from the labyrinths to the extraocular muscle apparatus). In summary, a unique synaptic connectivity was found in central vestibulo-oculomotor pathways of adult flatfishes wherein horizontal second-order vestibular neurons contacted vertical extraocular motoneurons. Extensive electrophysiological, immunohistochemical and ultrastructural observations revealed the new pathways to exhibit a reciprocal excitatory and inhibitory innervation of oculomotoneurons with characteristics common to that described in other vertebrates. From these data we conclude that the taxa-specific modifications of the adult flatfish vestibulo-oculomotor reflex are modeled after a representative vestibulo-oculomotor blueprint that appears to be highly conserved between vertebrates. Since the species studied to date are quite divergent on an evolutionary scale from a truly primitive vestibulo-ocular plan, we suggest that the development foundation for homologous canal-specific disynaptic excitatory-inhibitory pathways is the trait highly conserved through vertebrate phylogeny.

A Two-year Field Study of Vitellogenesis in Winter Flounder (*Pleuronectes americanus*) under PAH-contaminated Conditions

J. M. Nicolas[1], J. H. Vandermeulen[2], D. Mossman[1], and S. Kirby[1]

[1]Dalhousie University, Department of Biology
Halifax, Nova Scotia, Canada B3H 4J1

[2]Bedford Institute of Oceanography, Marine Chemistry Division
Department of Fisheries and Oceans, PO Box 1006
Dartmouth, Nova Scotia, Canada B2Y 4A2

The sediments of the Sydney Estuary are among the most contaminated along Canada's east coast. This is the result of almost 100 years of activity at a large coking facility located on the estuary's shoreline. Levels of up to 500 ppm of total sediment polycyclic aromatic hydrocarbon (PAH) have been reported (Vandermeulen, 1989). The chronic hydrocarbon contamination of Sydney Harbor has been an environmental concern for several years, but its effects on the reproductive biology of organisms exposed to the contaminants and the implications at the population level of organization had not been studied. Approximately 400 female winter flounder were collected in 1992 and 1993 over three sampling periods (June, September, November) from four stations in the estuary plus a control site. The stations were selected to reflect a gradient of sediment PAH concentrations ranging from 200 ppm (close to the point source) to less than detectable (control site). For each fish length, weight, age, egg and ovarian developmental stage, gonadosomatic index, hepatosomatic index, plasma estradiol and plasma vitellogenin were measured. Results show a significant effect of the sampling site on the reproductive parameters measured. The response of several of the parameters to contamination was non-linear, and suggests the existence of a threshold level of contaminant. The inconsistency of results over time and the implications for the flounder population of the Sydney Estuary are discussed.

Predator-prey Interactions Between Benthic Crustaceans and Recently Settled Winter Flounder: Field Observations

D. A. Witting and K. W. Able

Rutgers University
Institute of Marine and Coastal Sciences
800 Great Bay Boulevard, PO Box 278
Tuckerton, NJ 08087

The relationship between benthic invertebrate predators and small benthic winter flounder (*Pleuronectes americanus*) in a well-defined settlement area (Holgate Cove, Little Egg Harbor, New Jersey) was determined based on stomach content analysis of shrimp and crab predators. Benthic invertebrates and juvenile winter flounder were sampled during a winter flounder settlement period (April-June 1992) with a 1-m beam trawl (6-mm mesh). Benthic flounder densities peaked in the cove in May with catches exceeding 10 m^{-2} at sizes of 7-32 mm SL, then decreased rapidly to <1 m^{-2} by the end of June when they ranged from 26-52 mm SL. The stomach contents of potential predators including *Calinectes sapidus* (8.3-123.7 mm, n=977), *Cancer irroratus* (10.0-47.3 mm, n=22), *Carcinus maenus* (18.3-70.7 mm, n=30), *Ovalipes occelatus* (9.1-36.8 mm, n=18), and *Crangon septemspinosa* (11.4-67.5 mm, n=2242) were examined for evidence of winter flounder predation (i.e., otoliths and vertebrae). Overall, 36 individual predators of three species: *C. sapidus* (n=30), *C. maenus* (n=2) and *C. septemspinosa* (n=4) had preyed upon winter flounder. *Calinectes sapidus* was the most common predator with an average of 4.3% (range 0-33%) of the individuals containing otoliths or vertebrae. Another crab *C. maenas* averaged 2.6% (0-33%), while *C. septemspinosa* had fewer otoliths (average 0.3%, range 0-5%). Back calculating the size of flounder prey based on an otolith-body length regression determined that most fish consumed by these benthic crabs and shrimps were between 8 and 41 mm SL. These data support the hypothesis that benthic crustacean predators, especially crabs, may impose significant levels of mortality upon settling and immediately post-settled winter flounder because although predation rates were low, the abundance of these predators was very high in the settlement area.

Settlement Areas For Winter Flounder: Patterns in the Use of Coves Near Inlets

M. C. Curran and K. W. Able

Rutgers University
Institute of Marine and Coastal Sciences
800 Great Bay Boulevard, PO Box 278
Tuckerton, NJ 08087

Coves near ocean inlets have been suggested to be important settlement areas for winter flounder (*Pleuronectes americanus*). The formation of a new cove in the Great Bay/Little Egg Harbor Estuary system in southern New Jersey during 1993-1994 gave us the opportunity to address this issue in more detail. Sampling in the same geographic location before it became a cove yielded no winter flounder. Upon cove formation, winter flounder density increased dramatically. To quantify winter flounder population size, a 1-m beam trawl with 3-mm mesh was used on 24 occasions during a 100-day period, with sampling intensity increasing during the period of maximum winter flounder density. The first individual (7.2 mm SL) was found in the cove on 7 May. Density peaked on 9 June (5 m^{-2}), with individuals ranging from 12.4-54.8 mm TL, and declined to a value of 0.2 m^{-2} on 19 August (size range 44.6-72.5 mm TL). Using regression analysis on the mean size of winter flounder per sampling date, the fish grew 0.6 mm day^{-1}. This result falls within the range of growth rates obtained in a complimentary study in which growth rates were calculated on caged flounder in other natural habitats in the same estuarine system. Approximately 1500 juvenile winter flounder from 13-72 mm TL were tagged in the cove to determine retention in and emigration from the cove. Fifteen fish were recaptured; the maximum duration of a marked fish in the cove was 20 days. This evidence, as well as the decrease in population size, and the small number of individuals over 45 mm TL, indicates that the cove is probably utilized for only 2-3 months immediately following settlement. Winter flounder strongly selected this site, even more so than a cove situated slightly farther from the inlet that had been an important settlement site in previous years. The new cove was the only site at which we found recently settled winter flounder in 1994. Further investigation into the temporal stability of coves and their function in winter flounder recruitment is warranted in light of the present study.

Analysis of Life History Patterns in Flatfish with Emphasis on North Atlantic Species

C. Chambers

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We used data from literature sources to construct a quantitative description of flatfish life histories. Data were compiled from over 120 species of flatfish and were used to represent the range of across-species variability in a suite of important life history features, e.g., sizes and durations of pre-adult life stages, growth rate, maturation schedule, fecundity, and life span. The set of species resident in the North Atlantic were isolated and evaluated with respect to their coverage of "flatfish life history space". Where data were lacking for North Atlantic species, congeners or other species with the most similar life histories were identified. These similar species may be used as surrogates to provide first approximations of the life history and vital rates that we might expect for species where data are scarce and/or anticipated to be difficult to collect. The utility and limitations of the comparative approach are described.

Distribution and Abundance of the Blackcheek Tonguefish, *Symphurus plagiusa* (Cynoglossidae: Pleuronectiformes), in Chesapeake Bay

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Monthly trawl survey cruises were conducted in the lower Chesapeake Bay during 1955-1993 to produce indices of juvenile abundance of important marine and estuarine finfish and crustaceans. Data from 1986-1993 cruises can be used to determine distribution and abundance of blackcheek tonguefish in Chesapeake Bay and its tributaries: the York, James, and Rappahannock Rivers. Blackcheek tonguefish are the second most abundant pleuronectiform occurring throughout Chesapeake Bay and its tributaries, second only to hogchokers in abundance. It was found that blackcheek tonguefish are an extremely euryhaline species, as individuals were collected in waters ranging in salinity from 0.00 ppt to 36.2 ppt. Individuals were collected in depths ranging from 3.0 meters in the James River to 40.5 meters in the lower Chesapeake Bay. Abundance of blackcheek tonguefish was at a maximum in 1989 when 7156 specimens were collected. Abundance was at a minimum in 1993, with 1982 specimens reported.

Comparisons of Growth and Mortality in Juvenile Winter Flounder from New Haven Harbor and the Connecticut River, 1993

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Field estimates of growth and mortality for juvenile winter flounder from New Haven Harbor and the Connecticut River were made in 1993. Growth of juveniles was compared using the Gompertz growth equation. New Haven Harbor had higher growth constants than the Connecticut River. Mortality rates were also higher in New Haven Harbor (approximately 10%). How these increases in mortality affect fishable population numbers was explored.

Distribution, Growth Rate and Estuarine Recruitment of North Carolina Summer Flounder Larvae

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Larval density, spatial and temporal distribution, and otolith increment counts were determined from samples collected on transects across the continental shelf in Onslow Bay, and in areas immediately inside and outside of Beaufort Inlet. We found little evidence supporting a strong vertical stratification of larvae. The least developed larvae (about 3 mm SL with 3 to 5 otolith increments) were found on the middle shelf at 40 to 74 m depth. The larval size and increment count increased, to 6-10 mm SL with 15-20 increments, at the more shoreward stations. The highest densities (2-3/100 m^3) were found at intermediate depths of 20 to 30 meters. Fish immediately outside the inlet were more variable in size and increment number than those which were collected inside. Outside they ranged from 4.5-14 mm with 8-56 increments with a mode of about 12 mm and 34 increments. Inside the inlet, fish ranged from 10-18 mm with a mode of 14 mm, and increment counts ranged from 28-54 with a mode of 56. Based on the temporal occurrence of small larvae in shelf waters and the number of increments on larvae entering Beaufort Inlet, spawning season appears to extend from late November or early December into March. Length (mm) of all larvae captured = 2.8 + 0.26 number of increments, which is faster growth than observed in laboratory measurements.

Monthly Trends in Growth and Feeding in Captive Immature Winter Flounder (*Pleuronectes americanus*)

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Immature winter flounder (*P. americanus*) were obtained by otter trawl from a local coastal population. Each fish was tattooed on the blind side with an identification code. Three groups were held captive in 6-foot diameter circular tanks under ambient light and water temperature for a period of eleven months. Initial densities of 2.69, 1.20, and 0.766 kg/m^2 were established in each tank, respectively. Fish were fed a diet of chopped squid *ad libitum* every two days. Growth patterns in each of the tanks were monitored relative to water temperature, hours of daylight, and effects of density. Monthly length and weight measurements of individuals were recorded. Amount of food consumed (per week, per fish/day) was calculated for each tank. Fish condition index, simple growth rates and gross conversion efficiencies were determined. Food consumption and growth rates showed strong correlation with water temperature and daylight length. Final loadings in the three tanks were measured to be 4.24, 2.46, and 1.87 kg/m^2, accounting for total weight increases of 57, 105 and 144%, respectively. Effects of density and competition are investigated and statistical differences are discussed. Both positive (length and weight gain) and negative (weight and length loss) growth periods were observed in each tank. The latter occurred during the winter months (January to March). Caudal fin erosion and measurement error can only account for a small portion of the recorded "shrinkage" in length associated with periods of negative growth.

Growth Estimates for Larval and Juvenile Winter Flounder in Cape Cod Estuaries

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There have been numerous investigations into age and growth rates of winter flounder, *Pleuronectes americanus*, particularly in the juvenile stage. Our studies were conducted to provide estimates of growth of larval and juvenile winter flounder from a relatively "clean" environment for use in modeling the early life history and for comparative studies of habitat use by this species.

Separate field studies were conducted on the two life stages. In the first, approximately 2,000 larvae were exposed to oxytetracycline (OTC) at 500 mg/L for 24 hours and transferred to two floating 505-µ mesh cylindrical enclosures (1,000 larvae/enclosure). The enclosures, which measured 1 m in diameter and 2.5 m in length, were deployed in Waquoit Bay, MA for approximately one month. Larvae were sacrificed weekly to examine growth and validate daily growth increments.

For the study of juveniles, 12 fish were exposed to OTC (500 mg/L for 72 hours), and placed in four 1-m^2 subtidal enclosures (3 juveniles/enclosure) located adjacent to Ram Island within Great Harbor, Woods Hole, MA. These fish were marked with acrylic paint injections to identify individuals; one fish of each color was placed in an enclosure. Monitoring was done *via* videotape at ten-day intervals.

We found that larval winter flounder deposit increments on their sagittal otoliths daily (or nightly); a daily growth rate was calculated. We also found that otolith growth was decoupled from somatic growth in juvenile winter flounder and calculated both individual and population growth rates for these fish. The growth rates of both life stages will be combined for use in a life history model for this species.

The Anisotropic Structure of Fish-scale Patterns and its Consideration in the Quantification of Seasonal Growth

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Fish scale patterns are divided into seasonal growth zones with each zone providing information about variability of the fish's growth rate. The data derived from these scales are used in life history studies of fish. In our approach, the information about seasonal growth zones is derived from a plot describing relative widths of the spaces between circuli from the center of the scale to its margin. The shape of this plot is highly dependent on the direction of the measurement chosen due to numerous breaks and confluences of the circuli. Thus, scale patterns are anisotropic objects. Presently, there is no formal procedure for quantifying seasonal growth zones that takes into account the anisotropic nature of the scale pattern.

The objective of this study is to develop a formal procedure to quantify seasonal growth zones, which incorporates the anisotropic nature of scale patterns. The tool for solving this problem is a N-dimensional model of the scale pattern. This model is based on a table that describes the width of the circuli spacing in the N directions and a plot that represents the structure of the circuli such that all breaks and confluences are taken into account.

Plots of the relative widths of the spaces between circuli were plotted for N directions. The plot was used to combine patterns for different directions into a common chart. The resultant chart described the variability of the circuli for an entire scale. A Boolean function was used to define the notion of the "stability of circuli widths" in a context of the variability of the scale structure. The notion was introduced in order to investigate the impact of the anisotropic structure of scale patterns on the accuracy of the quantification of the seasonal growth zones and to help in the selection of the version of the circuli structure.

Scales of yellowtail flounder, *Pleuronectes ferrugineus*, of different ages were analyzed. The results showed that the method reduced uncertainty in the recognition of the seasonal growth zones as well as the quantification of the age of these fish. Further studies to quantify variability in growth patterns between fish collected from different areas, representing potentially different stocks, are underway.

Preliminary Results on the Utilization of Newport River Estuary, North Carolina, by Juvenile Flatfish Species

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The role of the Newport River Estuary in the juvenile phase of the life cycle of flatfish species occurring along coastal North Carolina was determined using a microhabitat approach. The system was divided into six zones according to two dominant physical characteristics. These were salinity and turbidity, both of which exhibit strong gradients extending up the length of the system as well as showing seasonal variations. The microhabitats within each zone were identified and monthly sampling of each was undertaken. This took place from April, just after settlement, through to November, when the bulk of juveniles of marine species emigrate to the coastal waters. Although the target species of study were the Paralichthid flounders, whose adults are of importance in North Carolinas offshore fishery, data were collected on a total of nine flatfish species recorded. In addition, a series of physical measurements were taken each sampling.

Preliminary results show that the three Paralichthid species present are largely separated by microhabitat utilization, but that this was also influenced by other physical aspects, in particular salinity and turbidity. Their distribution changed during midsummer when salinities increased to >35 ppt, at which point the bulk of individuals left the system. At the same time, a dramatic increase in numbers of Etropus crossotus, particularly in the sand and compacted mud habitats, took place. Two other species, Symphurus plagiusa and Trinectes maculatus, were common and occurred throughout the system. These two are essentially estuarine species that are able to complete their entire life cycle within the system; however, distinct microhabitat utilization took place based on size.

Prediction of Optimum Spawning Location and Interannual Variation in Year-class Strengths of Hecate Strait Fishes in Relation to Hydrodynamic Effects on Larvae

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An individual-based model of larval drift and growth in relation to wind- and tide-driven advection and stratification in the Hecate Strait (British Columbia) was used to predict spatial and interannual variation in larval fitness. The model correctly predicted the main spawning location for English sole and Pacific cod, and indicated that this location represents a balance between access to better feeding conditions in the northern part of the strait versus export from this area due to wind-driven currents. However, the model was unable to predict observed patterns of interannual variation in year-class strength; it predicted more variable recruitment than has been observed. This failure could be due to incorrect estimates of spawn timing in relation to hydrodynamic conditions, omission of some key factor limiting larval survival, or strong control of survival by factors operating after larval settlement.

Effect of Somatolactin and Related Hormones on Winter Flounder Renal Functions*

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Prior studies by others have shown that somatolactin is produced in the pars intermedia of the pituitary gland by teleosts, including flounder, cod, and salmon. The target and function of the hormone have been uncertain. Winter flounder renal proximal tubule primary monolayer cultures mounted in Ussing chambers were used to determine the effect of salmon somatolactin (sSL) on transepithelial inorganic phosphate (Pi) and Ca^{2+} transport. sSL stimulated P^i reabsorption in a dose-dependent manner at physiological levels of the hormone (12.5 ng/ml). Net P^i transport was significantly altered by sSL (200 ng/ml) within 2 h after the initial exposure. Ca^{2+} fluxes were unchanged by the addition of 200 ng/ml sSL. The sSL-induced P^i reabsorption was abolished by 10 µM H-89, a highly specific protein kinase A inhibitor. Moreover, the production and release of a cAMP were significantly increased following 1 h and 2 h exposure to sSL. The data indicate that sSL directly stimulates net renal P^i reabsorption by a cAMP-dependent pathway. In addition to sSL, flounder SL and rat prolactin greatly, and salmon growth horomone (2.3 µg/ml) slightly, increased net P^i reabsorptive flux, whereas salmon prolactin had no effect. These data provide the first evidence for a physiological action of somatolactin, and together with evidence from other studies may implicate the hormone in renal nutrient conservation during gonadogenesis.

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Spatial and Temporal Patterns of Abundance of Larval and Juvenile Windowpane Flounder, *Scophthalmus aquosus*, in an Estuarine/Inner Continental Shelf System

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The windowpane flounder, *Scophthalmus aquosus*, ranges from the Gulf of Saint Lawrence to Florida, but the species is most abundant from Georges Bank to Chesapeake Bay. Spawning is bi-model off of New Jersey and occurs from April to May, and again in September to October; however; the spatial and temporal distribution of planktonic larvae and newly settled and older juveniles has not been examined in detail.

Within the Great Bay/Little Egg Harbor estuarine system, annual variability in abundance existed between the spring-spawned cohorts such that in 1989 and 1993 windowpane abundances were much greater than they were in 1990, 1991, and 1992. These spring-spawned larvae ranged from 2.5-18.4 mm SL (n=280). Over these same years, the fall-spawned larvae were rarely collected inside the estuary and these larvae ranged from 7.4-13.5 mm SL (n=5). Differences in abundance between spring- and fall-spawned larvae from 1991 to 1992 were not apparent at an adjacent inner continental shelf site (LEO-15). These spring- and fall-spawned larvae ranged from 2.1-8.8 mm SL (n=90) and 2.3-9.2 mm SL (n=83), respectively, thus the maximum size of larvae at LEO-15 was much smaller than those collected in the estuary. This pattern may suggest that larger larvae from the spring cohort are moving into the estuary; however the fate of larger larvae from the fall-spawned cohort is unclear.

Newly settled spring-spawned individuals appear to use higher salinity, sandy portions of the estuary as nursery habitats throughout the summer where they reach a maximum size of approximately 63 mm SL by August. Evidence suggests that fall-spawned individuals are using similar estuarine habitats in the spring. Both cohorts also occur at LEO-15. These preliminary observations suggest that windowpane use the inner continental shelf and lower portions of estuaries as spawning and nursery areas in New Jersey.

Fish Recruitment in the Northeastern United States: the Role of Estuarine Habitats

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A comparative approach to assess the functional value of selected habitat types as nursery areas for juvenile fishes has been adopted in three southern New England-mid-Atlantic coast estuaries. Habitat use patterns are identified by comparing distribution, abundance and growth of newly-settled fishes in Great Bay-Little Egg Harbor and the Hudson-Raritan estuary in New Jersey, and Clinton Harbor along the Connecticut coast of Long Island. While each of these systems serves as a nursery area for a variety of juveniles, particularly winter flounder, *Pleuronectes americanus*, and tautog, *Tautoga onitis*, the availability of specific habitat types varies within and between systems, as does the degree of anthropogenic disturbance. The study has several objectives. The first, based on the premise that variation in growth may be an important indicator of habitat quality, is to determine habitat-specific growth rates, using several measures of growth, including somatic growth, change in otolith increments and RNA/protein ratios. A second objective is to determine spatial and temporal changes in habitat use patterns both qualitatively and quantitatively. A third objective is to examine trophic linkages of YOY fishes within specific habitats using stable isotope ratios of carbon and nitrogen. The first year of the study has been completed and results will be presented particularly as they relate to YOY winter flounder distribution, growth and trophic associations.

Habitat-specific Patterns for Distribution and Growth of Young-of-the-Year Winter Flounder in a Relatively Unimpacted Southern New Jersey Estuary

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In an attempt to define the relative quality of estuarine habitats for young-of-the-year winter flounder (*Pleuronectes americanus*), we determined the habitat-specific patterns of 1) distribution and abundance with traps and beam trawls and 2) growth with caging experiments. These observations and experiments were conducted in the Great Bay-Little Egg Harbor estuary, a relatively unimpacted, polyhaline, shallow (average depth < 2 m) system in southern New Jersey. During spring and early summer of 1994, early benthic-phase juveniles (< 30 mm TL) were found in settlement areas as described in our earlier presentation. After dispersing from these sites, winter flounder (20-103 mm TL) were subsequently collected in a variety of shallow vegetated and unvegetated habitats based on trapping and beam-trawl catches.

Survival and growth varied with habitat type. In salt marsh creeks, where dissolved oxygen levels were very low, survival was poor. In all other habitats, growth of caged individuals (14-73 mm TL) ranged from 11.1 to < 0 mm TL per day. The greatest growth rates occurred for the smallest individuals in early June and these rates declined significantly thereafter. Comparisons among habitats indicate that growth rates were similar except for marsh creeks, which were much lower. Together these data suggest that both vegetated and unvegetated habitats are important as nurseries for young-of-the-year winter flounder and these data agree generally with the results of an earlier study in the same estuary. Interpretation and extrapolation of these data should be made cautiously because we have 1) an inadequate understanding of movements and 2) movements between habitats.

Habitat Use Patterns for Growth of Young-of-the-Year Winter Flounder in a Northern New Jersey Estuary

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The Navesink River, located in the Hudson-Raritan estuary, has a variety of habitat types utilized by young-of-the-year fishes. Of these, three were selected for study: (1) unattached macroalgae (usually *Ulva lactuca*), which is a dominant habitat; (2) eelgrass (*Zostera marina*), which is scarce and patchy and (3) marsh creeks, which are usually anthropogenically altered. Habitat use patterns were determined both quantitatively (1-meter beam trawl) and qualitatively (fish traps). Habitat specific growth was measured in caging experiments. Data will be presented on habitat specific abundance, distribution and growth of young-of-the-year winter flounder (*Pleuronectes americanus*) in vegetated (macroalgae, eelgrass), adjacent unvegetated and in marsh creek habitats.

Habitat Use Patterns and Growth of Young-of-the-Year (YOY) Winter Flounder in a Central Long Island Sound Estuary in Connecticut

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The study area, in Clinton, Connecticut, has several habitat-types including: sea lettuce (*Ulva*) in Clinton Harbor, eelgrass (*Zostera*) in the Hammonassett River, and marsh creeks leading into Hammonasset State Park. Monthly trawling and mapping surveys and cage experiments were conducted to determine site-specific habitat use by and growth of winter flounder during their first year of life.

Preliminary trawling results indicate that young-of-the-year flounder (YOY) appeared in June with dispersal limited to primary settlement areas. By July, most YOY flounder were associated with eelgrass and adjacent unvegetated sites. In August, significant numbers of YOY were found in both eelgrass and sea lettuce sites. In August, several YOY flounder were sampled for the first time in one of the two marsh creeks. Trapping results were not always consistent with trawl samples at similar times or sites. Winter flounder were sampled in traps, but usually in low numbers.

Three ten-day cage experiments using YOY winter flounder were conducted between late June and early August. Recovery of flounder used in the first cage experiments (initial size about 35 mm total length) was poor and showed minimal growth, a result perhaps of stress from the initial capture, holding, and deployment into the experimental cages. Recovery of fish from the second flounder run (initial total length, about 45 mm) improved to about 50% and growth of up to 3.5 mm over 10 days was recorded for several individuals. Fastest growth was recorded among fish in cages in and near eelgrass beds. Initial total length of YOY flounder in the third run was about 55 mm. Recovery from this experiment exceeded 50%; however, growth was minimal, indicating either a seasonal drop in growth rate or inadequate nutritional conditions. In all three cage experiments, few fish were recovered from one of the marsh creek sites and none were recovered from a second. Data collected in August, using a continuous data logger, indicated diurnally low dissolved oxygen concentrations (< 2.0 ppm) and high water temperatures (> 27ºC) associated with low tides, conditions most likely detrimental to young fish.

Habitat Use and Growth of Young-of-the-Year Winter Flounder, *Pleuronectes americanus*, in the Lower Hudson River

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Trapping and growth experiments were performed in the lower Hudson River to evaluate the effects of artificial structures, particularly pile-supported platforms (piers), on the growth and distribution of recently-settled fishes. Study sites were established at subtidal depths (≤5m) in pile field, interpier, and underpier habitats on the eastern and western sides of the river in Manhattan, NY and Hoboken, NJ.

In June-October 1993 and May-September 1994, bimonthly trapping experiments were performed to determine the relative abundance of juvenile fishes in the three habitat types. Based on collections of 1474 individuals representing 25 species, the relative abundance and species richness of juvenile fishes was low in underpier habitats when compared with interpier and pile field habitats. Young-of-the-year winter flounder (12-141 mm TL) accounted for 2.2% of the total catch (N=15) in 1993, and for 10.5% (N=80) in 1994. In 1994, the abundance of winter flounder was relatively high in both interpier and pile field habitats (x cpue 0.116-0.166 fish d^{-1}) while fish collected in 1993 were caught exclusively in pile field habitats (x cpue 0.04-0.05 fish d^{-1}). Only one winter flounder was caught in an underpier habitat during the study.

Caging experiments (N=6) were performed on recently-settled winter flounder (N=522; 17.1-89.9 mm TL) in July-August 1993 and June-July 1994 to determine their relative growth rates in the three habitat types. During the study, 70% (N=365) of the fish caged were recovered live after the 10-day experiments. The mean instantaneous growth in weight of winter flounder caged in underpier habitats was negative in all six experiments. Instantaneous growth rates in length of fish caged in underpier habitats were negative or slightly positive. Mean growth rates in length or weight were positive for winter flounder caged in pile field habitats in three experiments and for fish caged in interpier habitats in four experiments. Mean growth rates as high as 5.0% and 1.5% d^{-1} in weight and length, respectively, were observed in the pile field and interpier habitats. The results of the trapping and growth experiments suggest that pile-supported platforms provide relatively poor habitat for recently-settled winter flounder when compared with interpier and pile field habitats.

Growth of Young-of-the-Year Winter Flounder in Three Estuarine Habitats as Measured by RNA/Protein Ratios

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A comparative study to assess the functional value of selected types of nursery areas for juvenile fish has been initiated in two estuaries in New Jersey and one in Connecticut. One method of measuring comparative fish growth between these estuaries is determination of RNA/protein ratios in fish muscle tissue.

Deoxyribonucleic acid (DNA) is found in constant quantities in normal somatic tissue within a given species, while ribonucleic acid (RNA) is present in variable quantities in the nucleus and cytoplasm. Quantities of RNA vary directly with the activity of protein synthesis: it is expected to be more concentrated in tissues undergoing faster growth or protein synthesis. Protein content of muscle tissue is an index of nutritional condition. Protein plays a major role in energy storage, metabolism, and is an important structural component of tissue.

Trial runs of the RNA/DNA procedure at Milford with juvenile winter flounder showed protein contamination of the DNA fraction. This is known to occur in juvenile fish and is not a result of the methodology. The relationship between cell number and size breaks down in juveniles, which contain fats and carbohydrates that contribute to body weight without adding cells. We therefore limited our analysis to the RNA fraction and expressed this information as a concentration of mg wet weight and/or mg protein. This is a more accurate and appropriate means of expressing growth in juvenile fish than the RNA/DNA ratio.

The results obtained from young-of-the-year winter flounder held in cages at sites in coastal areas of Connecticut and New Jersey will be presented.

Habitat Utilization by Juvenile Winter Flounder as Indicated by Stable Isotope Ratios

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The measurement of stable isotopes in tissues of marine consumers can allow a time-integrated estimation of assimilated diet. The nitrogen isotopic composition of a consumer is used as an indication of trophic level while values of ä^{12}C are employed to identify sources of organic carbon to consumers. Taken together, ä^{13}C and ä^{15}N data provide a two-dimensional view of the trophic position of juvenile winter flounder within an environment. In order to quantify the relationship between diet and consumer isotopic composition juvenile winter flounder were confined to cages for ten days in four different environments (marsh creek, sand bottom, benthic macroalgae, and *Zostera*). The juvenile fish and environmental samples consisting of sediment, *Ulva*, and *Zostera* were analyzed for C and N stable isotopes. These results yield information on the effects of confinement to a single habitat (and diet) on stable isotope composition and growth rate (RNA/DNA). In the future comparison of stable isotopes and RNA/DNA data from wild-caught fish with those raised under confined conditions (the present study) will allow us to determine habitat utilization by juvenile winter flounder in the field.

Influence of Hypoxia on the Foraging Ecology and Movement of Juvenile Winter, Windowpane, and Fourspot Flounder*

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A two-year study to examine the relationships between benthic community structure and secondary production, seasonal hypoxia, and the foraging ecology of demersal fishes was conducted in 1992 and 1993 near Branford, CT and Hempstead, NY. The Hempstead site was consistently exposed to hypoxic events while the Branford site remained normoxic throughout the summer. Periodic sampling of the benthic community, hypolimnetic oxygen, and fish stomach contents every 14 to 17 days was conducted in concert with the CT DEP's summer survey trawls. The diet composition of winter flounder reflected both benthic community structure and the effect of hypoxia on the distribution of benthic infauna at the Hempstead site. At both sites, diet composition changed predictably with fish size. During hypoxia, winter flounder larger than 100 mm TL were absent from the Hempstead site but remained abundant at the Branford site. However, juvenile winter flounder (50 to 99 mm) were still encountered at the Hempstead site during hypoxia. Foraging opportunistically on *Nepthys* and other polychaetes forced to the surface of the sediment by high sulfide and low oxygen concentrations, juvenile winter flounder moved in and out of the site in response to differential oxygen concentrations above and below the thermocline. Juvenile windowpane flounder foraged predominantly on copepods, *Crangon septemsinosus* and *Neomysis americanus*, crabs (*Pinnixia, Rithropanopeus, and Cancer*) and fish. All size classes of windowpane and fourspot flounder were absent from the experimental site during hypoxic events.

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Arsenic Induction of Metallothionein in Juvenile Winter Flounder

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Tissue background levels of arsenic were unusually high in winter flounder (Pleuronectes americanus) collected in Long Island Sound. Juvenile flounder (length 100-150 mm) from the relatively clean Niantic River/Bay region had liver arsenic concentrations between 2.0-273.0 µg/g liver. Although arsenic induction of the metal-binding protein metallothionein (MT) has been demonstrated in mammals, this is the first study to show such a relationship in fish. An arsenic liver uptake curve was generated by exposing juvenile winter flounder to sodium arsenite (2.0, 4.0, 8.0 and 20.0 µM/g fish) via subcutaneous implants. The liver arsenic levels of all treatments differed significantly ($p < 0.01$) from the control after 24 hours. The treatments also exhibited a pattern of arsenic accumulation with increasing dosage. No fish died at the lowest dose, however 10%, 20%, and 40% mortality was observed at the respective higher levels. Subsequent determination of MT in surviving fish showed that it was significantly ($p < 0.01$) elevated above the control for each arsenic treatment. However, no increasing pattern of MT protein was evident beyond the first treatment. These results suggest that arsenic does induce fish MT but more research is necessary to determine an MT/arsenic dose-response curve. Future work will include evaluation of MT protein at lower levels of exposure. The time course of MT protein and message induction in fish by sodium arsenite will also be examined.

Utilization of New Haven Harbor as a Spawning and Nursery Area by Winter Flounder (*Pleuronectes americanus*)*

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The presence of winter flounder larvae, juveniles, and gravid adults in New Haven Harbor and the Quinnipiac River has been noted by various investigators without linking them into a cohesive life history. This study investigates three important links in the chain from spawning adults to the next generation: 1. Where do adult fish spawn? 2. Where do the juveniles spend their first year of life? and, 3. What is their health and condition?

To find spawning areas, ultrasonic transmitters were attached to gravid females during spawning season. The areas where fish were most often detected were sampled with an epibenthic sled to collect fertilized eggs as evidence of spawning activity. Results indicated that spawning most likely occurs in the Lighthouse Point-Morris Cove area, and perhaps at the southern end of Long Wharf. Recaptures of tagged fish after the spawning season came from as far away as the Charlestown Breachway in Rhode Island and the area south of Fisher's Island (NY), demonstrating that fish spawning in New Haven Harbor contribute to fisheries as far away as Block Island Sound.

The second and third questions were addressed by conducting periodic beam-trawls to compare the relative numbers and health of juveniles in four different locations in the harbor-river system. These included Morris Cove, a shallow, sandy embayment on the eastern side of the harbor; the Long Wharf area, a mud flat west of the main channel and north of the Morris Cove site; the Reach site, located in the Grand Avenue Bridge Reach section of the Quinnipiac River; and the Hemingway Creek site, located further upstream where Hemingway Creek empties into the Quinnipiac River.

In the spring, more young-of-the-year fish were caught at Long Wharf than at Morris Cove, where one-year-old fish were more common. The fish at Hemingway Creek in the Quinnipiac River were smaller, less abundant, and had a higher incidence of fin rot than fish caught in other locations. The overall prevalence of axial skeletal anomalies in the young fish is similar to the prevalence in adult fish. The prevalence of axial skeletal anomalies in the abdominal region of young fish is higher than in the adults suggesting that this type of anomaly may be fatal to young fish.

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Habitat Models for Juvenile Pleuronectids Around Kodiak Island, USA

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Juveniles of four species of Pleuronectid flatfishes were abundant in bays and nearshore areas around Kodiak Island, Alaska during August 1991 and August 1992. Linear discriminant analyses were used to identify physical characteristics important in determining presence or absence of juveniles for each species in 1991 and resulting discriminant functions were tested on 1992 data. Discriminant functions predicted presence more accurately than absence in 1991 for rock sole (*Pleuronectes bilineatus*), yellowfin sole (*Pleuronectes asper*), and Pacific halibut (*Hippoglossus stenolepis*). In 1992, absence was predicted more accurately than presence for these three species. The result was opposite for flathead sole (*Hippoglossoides elassodon*) in 1991 with absence being more accurately predicted, while in 1992 presence and absence were predicted equally well.

The distribution of flatfishes captured in 1991 were examined with respect to the following conceptual habitat models which had been produced from the mathematical models based on 1991 data.

MODEL #1: Age-0 rock sole are found predominantly in water depths less than 70 m on sand or mixed sand substrate within 10 km of bay mouths.

MODEL #2: Age-0 flathead sole are found predominantly in water depths greater than 70 m on mud or mixed mud substrate throughout bays.

MODEL #3: Age-0 Pacific halibut are found predominantly in water depths less than 70 m on mixed sand substrate near or outside mouths of bays.

MODEL #4: Age-1 yellowfin sole are found predominantly in water depths less than 40 m on mixed substrate at upper reaches of bays.

A Multivariate Model of Winter Flounder Maturation: What's Age got to do with it Anyway?

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Traditional models of fish maturation invoke fish length or age as explanatory variables for the onset of maturation, since these variables are "useful" data with respect to stock assessments and management plans. However, if onset examines the variability in body weight for fish of a given size, particularly over the range of sizes encompassing the critical "window" of first maturation, it is apparent that body weight or perhaps condition factor may explain the maturation process better than length or age.

To test this hypothesis, data for slower-growing, later-maturing Gulf of Maine winter flounder and faster-growing earlier-maturing Georges Bank winter flounder are analyzed. Univariate and multivariate models are constructed to evaluate the relative contribution of length, age, and body weight/condition factor to the one of maturation. Finally, the practicality and applicability of a weight-based maturation model is considered within the framework of assessment and management requirements.

Growth Rates at *Ad Libitum* Rations of Juvenile *Etropus crossotus* and *Citharichthys spilopterus* in North Carolina Coastal Waters

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Preliminary laboratory experiments were conducted at the National Marine Fisheries Service Laboratory in Beaufort, North Carolina to determine temperature-controlled maximum growth rates in two flatfish species. These growth rates will be compared to field rates in different parts of the fish's ranges to test whether food limits growth. From May-August 1994, three 14-day trials were conducted at 15, 23, and 30ºC. Mean absolute growth rates at *ad libitum* rations for *Etropus crossotus* at sizes of 30-40 mm were 0.2 mm/d at 15ºC, 0.30 mm/d at 23ºC, and 0.23 mm/d at 30ºC. Fish with initial lengths of 70-80 mm had growth rates of –0.03 mm/d, 0.28 mm/d, and 0.10 mm/d, respectively. Growth rates of *Citharichthys spilopterus* (65-80 mm) were 0.05 mm/d, 0.11mm/d, and 0.09 mm/d, at the same temperatures, respectively. The patterns of mean and maximum growth showed the expected relation to temperature with a peak at the intermediate temperature (23ºC). However, differences among means were not significant in *Citharichthys spilopterus* and the smaller size class of *Etropus crossotus*, owing to high variability. Upper quartile rates may be better estimates of maximum growth rates. The comparison of laboratory-derived maximum growth rates with field growth rates is discussed as a test implication for the hypothesis that recruitment variability is not controlled by food.

Submersible Observations of Flatfish Nursery Habitats in the New York Bight

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In order to determine the distribution of fish nursery areas in the New York Bight, we conducted visual transects with a 4.7-m submersible at eleven stations along two benthic transects over depths from 15-85 mm during August 2-12, 1994. Based on our preliminary analysis to date, there is a very strong cross-shelf zonation for recently settled flatfishes. The Gulf Steam flounder (*Citharichthys arctifrons*) was most abundant at our deepest stations (65-85 m), while yellowtail flounder (*Pleuronectes ferrugineus*) was most abundant at depths of 35-50 m. The fourspot flounder (*Paralichthys oblongus*) was restricted to our shallowest sites (15-20 m). There was little overlap of these species at any dive site. The size frequency of fish observed varied with the species, but most individuals were 40 mm TL or less, while *Citharichthys* were smaller (<25 mm). The smaller sizes observed corresponded with the maximum reported sizes of the late larval stages of these species, indicating that we were observing recently-settled fishes. These *in situ* observations suggest that a submersible is much more efficient at detecting these recently-settled fishes than are surface-operated beam trawls, because density estimates for the latter ranged from 1-8% of the total observed from the submersible. In summary, we believe these are the first data to document the distribution of nursery areas for these species, and this technique, with some modifications, offers some distinct opportunities for defining nursery areas and providing insights into recruitment processes on the continental shelf.

Biodiversity and Distributional Patterns of Symphurine Tonguefishes (*Symphurus*: Cynoglossidae: Pleuronectiformes) Occurring in the Western Atlantic Ocean

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Including two new species, 24 of 72 species now recognized in *Symphurus* occur in the western Atlantic Ocean. *Symphurus* is the most diverse flatfish taxon occurring in this region. Diversity of species recorded in this area is comparable with that in the Indo-Pacific (n=24), and is greater than that (n=17) occurring in eastern Pacific or eastern Atlantic (n=6) regions. High diversity of *Symphurus* species in the western Atlantic reflects the presence there of species groups that are highly successful in exploiting shallow-water environments, which are more diverse in the western Atlantic than in other regions of the Atlantic and eastern Pacific Oceans. Although *Symphurus* species occur from Nova Scotia (ca. 45ºN) to Argentina (ca. 38ºS), this genus is primarily a tropical and warm-temperate taxon. All 24 western Atlantic *Symphurus* occur between 34ºN and 25ºS latitudes, with the most diverse assemblage of species (12 species) found in tropical regions. Geographical distributions of individual species are influenced by evolutionary relationships and by major oceanographic features. Faunal boundaries traditionally recognized for other groups of marine organisms also separate different components of this taxon geographically. Few species transcend these boundaries successfully. Ecological distributions are strongly influenced by depth and substrate distributions within the geographic range.

Hudson/Raritan Estuary Winter Flounder Studies

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All fishery surveys of the lower Hudson and Raritan Bays and tributaries that included information on winter flounder are reviewed. Early data on distribution and abundance are compared with results of recent benthic finfish surveys with respect to habitat utilization. Depth zones and bottom type are related to the seasonal abundance of various size groups of winter flounder.

Salinity-related Changes in Resource Use by Two Sympatric Pleuronectid Flounders in Great Bay Estuary, New Hampshire

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Smooth, *Pleuronectes putnami*, and winter, *P. americanus*, flounder are morphologically similar and sympatric from Newfoundland to Massachusetts. Little is known about the interaction between these two species. The purpose of this study was to compare the use of estuarine resources by these two flounder species in Great Bay Estuary, New Hampshire. The species partially segregated along a salinity gradient, with smooth flounder occurring more abundantly at lower salinity stations than winter flounder. However, the species distributions were very dynamic and the amount of habitat use overlapped, and therefore the potential for interactions between the species, varied seasonally in response to varying salinity. Growth experiments indicated that physiological constraints played a major role in determining species distributions. Both species preyed on a variety of benthic invertebrates and exhibited a high overlap in prey usage. Cluster analysis produced groupings based on habitat type and body size rather than species. Changes in food habitats were associated with changes in abundance of prey items. Little evidence of prey switching or changes in niche breadth were associated with increasing overlap in habitat use, suggesting that direct competition for food was not important between these species.

Ontogeny of Functional Morphology of Feeding in Larval Fish: Winter Flounder *versus* Atlantic Cod

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Abstract not available

Abstracts
Poster Presentations

Secretion of 2, 4-Dichlorophenoyyacetic Acid (2, 4-D) by Renal Proximal Tubule Primary Cultures is Inhibited by Phorbol Ester*

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The fate of winter flounder in polluted waters depends in part on their ability to secret toxic organic anionic pollutants. Factors that influence this system can therefore influence survival. To date, regulators of this transporter are uncertain. Because organic anion secretion is strongly expressed in primary monolayer cultures of winter flounder proximal tubule, this tissue was used to characterize the renal transport of herbicide. Tissues were mounted in Ussing chambers and short-circuited. The herbicide 2, 4-dichlorophenoxy acetic acid (2, 4-D) is normally actively secreted by the flounder kidney. Transepithelial transport of ^{14}C-2, 4-D (10μM) by control tissues revealed net secretion of 0.55 ± 0.11 nmoles/cm^2/h (secretory flux: 0.67 ± 0.05; reabsorptive flux: 0.12 ± 0.03). Probenecid (1mM) significantly ($P < 0.05$) inhibited secretory flux (0.51 ± 0.09) but not reabsorptive (0.19 ± 0.06), yielding reduced net secretion of 0.32 ± 0.14. HPLC analysis demonstrated that 2, 4-D was secreted intact by this system. To determine if there was regulation through intracellular Ca^{2+} was raised by the ionophore A23187 (2μM) and the Ca-ATPase inhibitor, thapsigargin (0.2 μM). Neither had any effect on 2, 4-D transport. The adenylate cyclase stimulator, forskolin (10μM) had no effect; however, 1 μM phorbol 12-myristate 13-acetate (PMA) significantly ($P<0.05$) inhibited net 2, 4-D secretion (control: 0.96 ± 0.13; PMA: 0.55 ± 0.04). Because PMA also inhibited phloridzin-sensitive Na-dependent glucose transport, phorbol-12, 13-didecanoate (PE) was tested. With 1 h preincubation, PE significantly ($P<0.05$) inhibited net 2, 4-D secretion (control: 0.75 ± 0.06; PE: 0.53 ± 0.07) and had no effect on glucose transport. Thus, a protein kinase C, insensitive to elevated calcium, may have a role in the regulation of this process. Determining the regulation of organic anion transport will further the understanding of how this animal adapts to pollution.

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Gonadotrophin Induction of Testostrone and Estradiol-17 in Winter Flounder *(Pleuronectes americanus)* Ovarian Follicle Cultures

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Studies on winter flounder reproduction were designed to elucidate causal connections between PCB contamination, endocrine function and fecundity. In support of this effort, development of *in vitro* techniques to assess gonadotropin and steriod hormone production were required. Winter flounder were collected from uncontaminated areas in Narragansett Bay and Long Island Sound by otter trawl. Pituitary extract prepared from winter flounder and two mammalian gonadotropins, ovine-LH and human chorionic gonadotropin, were used to induce testosterone and estradiol-17β production in follicle cultures. Testosterone and estradiol-17β levels were determined in the follicle cultures by radioimmunoassay. In addition to measuring *in vitro* hormone production, the follicle size frequency and the gonadosomatic index were also measured on individual fish. All three gonadotropins significantly induced testosterone production in a dose-dependent fashion. Estradiol production, however, was stimulated only by human chorionic gonadotropin. Stage of ovarian development appeared to contribute to variability observed in testosterone and estradiol-17β levels between individual winter flounder. Further research will incorporate these findings to study whether PCBs affect flounder reproduction.

Grossly Observed Lesions of Flatfish from Various Northeast Embayments

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Winter flounder (N=919), windowpane flounder (N=404), and fluke (N=30) collected at various estuarine/coastal sites in the northeastern United States were examined grossly for lesion occurrence. Lesion types included ulceration, finrot, nodules/cysts, pigmentation anomalies, hemorrhages, cataracts, and those caused by a variety of parasites. Pigmented cysts caused by metacercariae were by far the most commonly occurring lesions. Fin rot, ulcerations and gill erosion were found predominantly in winter flounder, to a lesser extent in windowpane flounder, and in fish from relatively clean as well as contaminated sites. Fluke collected from Delaware Bay did not have these lesions. Individual fish collected from Boston Harbor tended to have multiple lesions of several types as compared to fish from other sites, which had one or two types of lesions. Results of the study will be discussed relative to the level of site contamination, and age and habits of the fish examined.

Heat Shock Stimulation of Daunomycin Secretion by Flounder Renal Proximal Tubule Cultures

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Cells may respond to stressful conditions so that their tolerance of the same or different stressful conditions is increased. This tolerance is manifest as increased cellular survival and (or) tissue function. For example, in cultured renal proximal tubule cells, mild heat or chemical stress stimulates transepithelial sulfate secretion, thereby protecting them from damage by subsequent, more severe heat or chemical stress. If the renal secretion (and therefore excretion) of a toxin were similarly affected by stress, an organism's ability to tolerate it would also be influenced by prior exposure of that organism to stress. To determine whether toxin secretion is responsive to stress, we examined the effect of heat shock on the transepithelial transport of daunomycin (DAU), a P-glycoprotein substrate, by primary monolayer cultures of winter flounder renal proximal tubule epithelium mounted in Ussing chambers under short-circuited conditions. Cultures performed active net secretion of DAU (0.064 ± 0.027 nmol/cm^2/h). Mild heat shock (5ºC elevation for 6-8 h followed by return to normal temperature) almost doubled DAU secretion (0.114 ± 0.026 nmol/cm^2/h). The protein synthesis inhibitor, cycloheximide, inhibited DAU secretion by heat shocked-cultures approximately 40%, indicating that protein synthesis is involved in the stimulation of DAU secretion by heat shock. To elucidate the mechanism of DAU secretion in heat-shocked tissues, we examined the effects of several compounds on DAU secretion. The P-glycoprotein substrates, verapamil, vinblastine, and cyclosporin A, effectively inhibited DAU secretion. The organic cation, tetra-ethylammonium, also inhibited DAU secretion, although its effect was smaller, and tetraethylammonium secretion was inhibited by vinblastine. Finally, DAU secretion was not inhibited by the organic ion, para-aminohippurate, and para-aminohippurate secretion was not inhibited by vinoblastine. None of the treatments affected the transepithelial reabsorptive flux of DAU. There was no nonspecific toxic effect of any inhibitor on the tissues; the transepithelial and the electrical characteristics of the tissues, including rheogenic glucose transport, were unaffected by any of the treatments. Reaction of tissues with a monoclonal antibody to P-glycoprotein (C219) revealed this transporter on only apical microvilli. The data indicate that flounder possess an active mechanism for renal excretion of DAU that is stimulated by mild heat shock. This mechanism is distinct from organic anion, but not organic cation, transport and has characteristics consistent with transport by an apical P-glycoprotein.

Life History Aspects of Blackcheek Tonguefish, *Symphurus plagiusa* (Cynoglossidae: Pleuronectioformes), an Obscure Abundant Flatfish in Chesapeake Bay and the Coastal Waters of Virginia

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The blackcheek tonguefish, *Symphurus plagiusa*, is a species of shallow water flatfish that ranges from Connecticut southward through the Florida Keys and Bahamas. From Chesapeake Bay and southward it is an abundant estuarine species. This species is the second most abundant pleuronectiform occurring throughout Chesapeake Bay and its tributaries, second only to hogchokers in abundance. Information on life history parameters of this species is limited. Blackcheek tonguefish will be collected primarily via the Virginia Institute of Marine Science's juvenile finfish and blue crab stock assessment monthly trawl surveys of the lower Chesapeake Bay and fixed station mid-channel transects in each of the three major Virginia tributaries: the York, James, and Rappahannock rivers. Each specimen will be measured and weighed; gonads will be excised, examined macroscopically to determine sex and state of maturity, and weighed. Gonads selected for histological examination will be fixed in Davidson's fixative to examine seasonal patterns of development and maturity, while gonads selected for fecundity measurements will be stored in 10% buffered formalin. Sagittal otoliths will be removed from all fish and will be examined for yearly growth rings to determine growth rates, age structure, age at maturity, and number of year classes present within Chesapeake Bay.

Validation of Daily Increment Formation in Juveniles of Four Flatfish Species: *Symphurus plagiusa*, *Scophthalmus aquosus*, *Paralichthys lethostigma* and *Etropus crossotus*

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Juvenile *Symphurus plagiusa*, *Scophthalmus aquosus*, *Paralichthys lethostigma* and *Etropus crossotus* were collected in the North Inlet area of South Carolina using a 1-m beam trawl. Live specimens were transported to the lab and the otoliths were marked by submerging the fish in alizarin complexone solution (75 ppm for 24 hours). The fish were kept in individual containers and given food *ad lib* for a period between 7 and 21 days. After this period the fish were sacrificed and the otoliths were removed. The sagital otolith of the ocular side of the fish was prepared for increment analysis.

Examination with a UV-microscope and a scanning electron microscope validated daily increment formation in all four species. Daily increment width was variable and is related to diet.

The Anisotropic Structure of Fish Scale Patterns and its Consideration in the Quantification of Seasonal Growth

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Fish scale patterns are divided into seasonal growth zones, with each zone providing information about variability of the fish's growth rate. The data derived from these scales are broadly used in life history studies of fish. In our approach, the information about seasonal growth zones is derived from a plot describing relative widths of the spaces between circuli from the center of the scale to its margin. The shape of this plot is highly dependent on the direction of the measurement chosen due to numerous breaks and confluences of the circuli. Thus, scale patterns are anisotropic objects. Presently, there is no formal procedure for the quantification of seasonal growth zones that takes into account the anisotropic nature of the scale pattern.

The objective of this study is to develop a formal procedure to quantify seasonal growth zones, which incorporates the anisotropic nature of scale patterns. The tool for solving this problem is a N-dimensional model of the scale pattern. This model is based on a table that describes the width of the circuli spacing in N directions and a plot that represents the structure of the circuli such that all breaks and confluences are taken into account.

Plots of the relative widths of the spaces between circuli were plotted for N directions. The plot was used to combine patterns for different directions into a common chart. The resultant chart described the variability of the circuli for an entire scale. A Boolean function was used to define the notion of the "stability of circuli widths" in a context of the variability of the scale structure. This notion was introduced in order to investigate the impact of the antisotropic structure of scale patterns on the accuracy of the quantification of seasonal growth zones and to help in the selection of the version of circuli structure.

Scales of the yellowtail flounder, *Pleuronectes ferrugineus*, of different ages were analyzed. The results showed that the method reduced incertainty in the recognition of seasonal growth zones as well as the quantification of the age of these fish. Further studies to quantify variability in growth patterns between fish collected from different areas, representing potentially different stocks, are underway.

Analysis of Winter Flounder Population Structure Using Random Amplified Polymorphic DNA*

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Winter flounder, a valuable fish to both sport and commercial fishermen, return to natal estuaries along the northeastern seaboard to spawn. If fish returned strictly to their natal waters, slight genetic distinctions between populations would be expected. This characteristic would be expected to be prominent in the offshore population at Georges Bank, where these fish are morphologically different, sporting a darker color and larger size. Using random amplified polymorphic DNA (RAPDs), we examined eleven onshore populations and the offshore population at Georges Bank for genetic variation, particularly looking at those from the greatest geographical distance. Each RAPD banding pattern type was assigned a genotype, and each individual was described by a compiled genotype determined from the pattern of all primers examined. There was as much variation found within populations as between populations; the statistical analysis supports the previous mitochondrial DNA studies that indicate there is no genetic distinctness among any population.

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Distribution, Abundance, and Habitat Preference of Juvenile Winter Flounder (*Pleuronectes americanus*) in the Shore Zone of Narragansett Bay, Rhode Island

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Data on juvenile winter flounder have been collected monthly from June through October since 1986 as part of an ongoing juvenile finfish survey of Narragansett Bay. Length frequency, distribution, and abundance data were collected from sixteen stations sampled with a 200-foot beach seine. Trends in abundance and distribution throughout the bay are discussed. Overall, upper bay and Sakonnet River stations had the highest density of juveniles. Mean abundances were higher during the month of July followed by June and August, respectively. Our data indicate that shore-zone juveniles prefer sandy-mud substrate regularly interspersed with macroalgae dominated by *Ulva lactuca*.

The Importance of Microzooplankton in the Diet of Winter Flounder Larvae

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Abstract not available

Marine Basins as Potential Winter Flounder Habitat

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Marina basins are man-made, dredged habitats that are conspicuous features of coastal ecosystems like Long Island Sound. Despite the large volume of information on the importance of finfish nursery grounds, there has been little attention given to the potential importance of marina basins as juvenile habitat. The major purpose of this study was to document the usage of Cedar Island Marina Basin (Clinton, CT) by juvenile winter flounder. Specific objectives were to: (1) evaluate general diversity of juvenile species utilizing the Cedar Island Marina Basin, (2) evaluate seasonal abundance patterns of juvenile winter flounder, and (3) describe feeding habits of juvenile winter flounder in the marina basin.

A one-meter beam trawl survey was conducted at three stations and monitored on a weekly basis (1989-1991) within the Cedar Island Marina Basin. A total of 28 juvenile sized finfish species were collected during the study period. Large numbers of juvenile winter flounder were found to inhabit the marina basin with daily population estimates in some months exceeding 9,000 fish. Lowest numbers of winter flounder were found during the spring and highest numbers during the summer and fall. Density estimates were highest in 1990 and declined at all stations in 1991.

A total of 31 prey species were identified from 92 flounder stomachs examined. The diets of 01-49 mm sized flounder were dominated by the spionid polychaete *Streblospio benedicti* and crab zoea. The diets of 50-99 mm flounder were found to be extremely diverse with over 26 prey species reported. The dominant food source was again *Streblospio benedicti.* A major change occurred in the diets of 100-149 mm flounder with crustaceans increasing in importance and polychaetes decreasing. The dominant prey species was the commensal crab *Pinnixia spp*. Amphipods also increased in importance as a prey group. The trend of increasing importance of crustaceans and declining importance of polychaetes continued into the 150-199 mm size class. The dominant prey species were the hermit crab *Paguras longicarpus* and *Pinnixia spp.*

Identification and Characterization of CytochromeP-450s in Juvenile Winter Flounder

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Due to their role in detoxification and their high degree of substrate specificity, cytochrome P-450s have great potential for use as biomarkers. Although previous field studies have demonstrated a relationship between pollutant levels and P450E activity in many fish species, there is still a serious gap in our understanding of P-450 systems in fish. The primary goals of this study were to use biochemical and molecular tools to begin to further characterize the one previously identified fish P-450 and to attempt to uncover other isoforms. Juvenile winter flounder were ideal for this study due to their limited range, lack of sex hormones (known to affect P-450 activity), their potential for exposure to benthic contaminants, and their prevalence in local marine waters. Enzyme activities were determined in liver microsomes using substrates specific to P-450IA1 (Ethoxyresorufin) and 2E1 (Chlorzoxazone). Enzyme activities for both isoforms were above background (both in the range of nmole/mg/min). Assays carried out at different temperatures revealed that the optimum for both 2E1 and IA1 were closely correlated to the environmental temperature. By acclimating fish to warmer temperatures in the laboratory a variation in this pattern was observed and may be indicative of a shift in temperature optimum to correspond with shifting environmental temperatures. Molecular analysis was carried out using a winter flounder genomic library constructed using the cosmid vector pwe-15 with inserts of genomic DNA between 35-40 kb. Primary screen with P^{32} labeled oligonucleotide (49 bases) homologous to a region of rat 2E1 revealed several positive clones. Upon secondary screen three positives were isolated and amplified. DNA from these clones was isolated, digested with restriction enzyme (EcoRI) and analyzed using gel electrophoresis. Banding patterns revealed many high molecular weight fragments. Slot blot and subsequent hybridization to chemiluminescent probe confirmed that these clones contain regions with homology to rat 2E1. In addition PCR of DNA from positive clones using generic P-450 primers resulted in five products ranging in size from 370 bp to 1.8 kb. PCR of genomic DNA using P-450IA1 primers also resulted in five products ranging in size from 300 bp to 1.7 kb. These PCR fragments have subsequently been subcloned and are presently being sequenced.

This study reveals for the first time both molecular and biochemical evidence that a 2E1-like isoform of P-450 exists in fish. Temperature effects observed also emphasize the importance of taking into account environmental and laboratory conditions when utilizing enzyme activities as indicators of exposure to pollutants. Overall it is hoped that by continuing to integrate classical biochemical methods with new genomic analysis tools scientists can acquire a better understanding of how these marker systems are regulated.

A Novel Peptide Isolated from Flounder Skin Has Antimicrobial Properties

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Abstract not available

Maturation of Pleuronectiforms vs. Gadiforms: Size vs. Age

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Observations on maturation stages of several species of pleuronectiformes and gadiforms off the Northeast coast of the USA were analyzed to examine the relationships between fish size or age, and maturity. Maturation schedules and median lengths (L_{50}) and ages (A_{50}) at maturation were derived by fitting the logistic model to the observed proportions. Analyses were generally restricted to observations from 1985-1990 obtained during stratified random bottom trawl surveys conducted in spring and autumn by the Northeast Fisheries Science Center and the commonwealth of Massachusetts Division of Marine Fisheries in waters of the continental shelf from Nova Scotia to Cape Hatteras, north Carolina. Estimates of L_{50} and A_{50} for pleuronectiforms extend over a wide range of ages (1.3 to 4.4 year) within a narrow length span (19.1 to 30.4 cm). Gadiforms exhibit an opposite pattern with estimates of L_{50} extending over a wide range of lengths (22.2 to 41.8 cm) within a relatively narrow age span (1.3 to 2.3). This suggests that maturation is size-dependent for the pleuronectiforms and age-dependent for the gadiforms.