16th Annual Larval Fish Conference

June 16-20, 1992
University of Rhode Island
Kingston, Rhode Island

Local Committee Members

Dave Bengtson
Larry Buckley
Barbara Dorf
Grace Klein-MacPhee
Chris Powell
Jennifer Specker

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PROGRAM

Wednesday, June 17, Morning

8:30 Welcome and Announcements
(Room 271, Chafee Social Science Center)

Theme Session—Problem Identification
Concurrent Session
(Room 277, Chafee Social Science Center)

Chair: Larry Buckley

8:55 THE IMPORTANCE OF HABITAT TO THE EARLY LIFE HISTORY OF ESTUARINE-DEPENDENT FISH
Donald E. Hoss
NOAA, NMFS, Beaufort Laboratory, Beaufort, NC 28516-9722

9:20 A REVIEW OF IN-SITU STRIPED BASS CONTAMINANT AND WATER QUALITY STUDIES IN THE CHESAPEAKE BAY WATERSHED
Lenwood W. Hall, Jr.,[1] Michael C. Ziegenfuss,[1] and Susan E. Finger[2]
[1]The University of Maryland System, Maryland Institute for Agriculture and Natural Resources, Agricultural Experiment Station, Wye Research and Education Center, P.O. Box 169, Queenstown, MD 21658
[2]U.S. Fish and Wildlife Service, National Fisheries Contaminants Research Center, Columbia, MO 65201

9:45 THE EFFECTS OF NAVIGATION-INDUCED SHEAR AND TURBULENCE ON THE EARLY LIFE HISTORY OF WALLEYE (*STIZOSTEDION VITREUM*), SAUGER (*STIZOSTEDION CANADENSE*), AND FATHEAD MINNOW (*PHIMEPHALES PROMELAS*) FROM THE UPPER MISSISSIPPI RIVER SYSTEM
R.E. Sigurdson
University of Minnesota-Duluth and Minnesota Cooperative Fish and Wildlife Research Unit, Duluth, MN

10:10 Break

10:30 TRANSPORT AND MORTALITY OF STRIPED BASS EGGS IN CONGAREE AND WATEREE RIVERS, SOUTH CAROLINA
James S. Bulak,[1] Noel Nurley,[2] and John S. Crane[3]
[1]S.C. Wildlife and Marine Resources Department, P.O. Box 170, Columbia, SC 29202
[2]U.S. Geological Survey, 720 Gracern Road, Columbia, SC 29210
[3]S.C. Wildlife and Marine Resources Department, 1921 Van Boklen Road, Eastover, SC 29044

10:55 USE OF ESTUARINE AND MARINE FISH LARVAE IN TOXICITY TESTING
David A. Bengtson and David J. Hansen
Department of Zoology, University of Rhode Island, Kingston, RI 02881
Environmental Research Laboratory, U.S. Environmental Protection Agency, 27 Tarzwell Drive, Narragansett, RI 02882

11:20 SUBLETHAL EFFECTS OF RICE PESTICIDES ON LARVAL STRIPED BASS
Alan G. Heath,[1] Joe Cech,[2] Joe Zinckle,[2] Brian Finlayson,[3] and Bob Fugimara[3]
[1]Virginia Polytech Institute and State University
[2]University of California, Davis
[3]California Department of Fish and Game, Pesticide Unit

11:45 IS WATER QUALITY A FACTOR IN STRIPED BASS STARVATION?
Robert B. Pond
Executive Director, Stripers Unlimited, P.O. Box 3045, South Attleboro, MA

12:10 Lunch

Contributed Paper Session—Predator-Prey
Concurrent Session
(Room 275, Chafee Social Science Center)

Chair: Scott Holt

8:55 GAMBLING ON PREDATION: ANTI-PREDATION STRATEGIES IN THE EARLY LIFE HISTORY OF FISHES
Matthew K. Litvak[1] and William C. Leggett[2]
[1]Huntsman Marine Science Centre, St. Andrews, NB EOG 2XO, Canada
[2]Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, PQ EOG 2XO, Canada

9:20 PREDATION ON JUVENILE WINTER FLOUNDER: EFFECTS OF PREY SIZE AND PREDATOR DENSITY
David A. Witting and Kenneth W. Able
Rutgers University Marine Field Station, Institute for Marine and Coastal Sciences, P.O. Box 278, Tuckerton, NJ 08087

9:45 SPATIAL AND TEMPORAL VARIATIONS IN AVAILABILITY OF ZOOPLANKTON PREY AND FEEDING SUCCESS OF STRIPED BASS LARVAE
Eileen M. Setzler-Hamilton[1] and James H. Cowan, Jr.[2]
[1]Chesapeake Biological Laboratory, University of Maryland System, Center for Environmental and Estuarine Studies, Solomons, MD
[2]Department of Marine Sciences, University of South Alabama, Mobile, AL

10:10 Break

10:30 THE INFLUENCE OF PREY SIZE, SPEED, AND DENSITY ON SELECTION BY LARVAL WEAKFISH (*CYNOSCION REGALIS*)
V.K. Pryor and C.E. Epifanio
University of Delaware, College of Marine Studies, Lewes, DE

10:55 PREY SELECTION BY JUVENILE WEAKFISH, *CYNOSCION REGALIS*: EFFECTS OF RELATIVE PREY ABUNDANCE, BEHAVIOR, AND PROFITABILITY ON FORAGING SUCCESS AND GROWTH
T.E. Lankford and T.E. Targett
University of Delaware, Graduate College of Marine Studies, Lewes, DE

11:20 SUSCEPTIBILITY OF ATLANTIC HERRING AND PLAICE LARVAE TO PREDATION BY JUVENILE COD AND HERRING AT TWO CONSTANT TEMPERATURES
Lee A. Fuiman[1] and Robert S. Batty[2]
[1]University of Texas at Austin, Marine Science Institute, Port Aransas, TX
[2]Dunstaffnage Marine Laboratory, Oban, Argyll, Scotland

11:45 Lunch

Wednesday, June 17, Afternoon

Theme Session—Problem Identification (continued)
Concurrent Session
(Room 277, Chafee Social Science Center)

Chair: Larry Buckley

1:30 REPRODUCTIVE SUCCESS OF WINTER FLOUNDER (*PLEURONECTES AMERICANUS*) IN LONG ISLAND SOUND WITH SPECIAL REFERENCE TO THE EFFECTS OF DREDGING
David A. Nelson, James C. Widman, and Jose J. Pereira
NOAA/NMFS, Northeast Fisheries Center, Milford Laboratory
212 Rodgers Avenue, Milford, CT 06460

1:55 EFFECTS OF CHEMICAL STRESSES ON BEHAVIOR OF LARVAL AND JUVENILE STAGES OF FISH AND AMPHIBIANS
W.J. Birge,[1] R.D. Hoyt,[2] J.A. Black,[3] and W.A. Robison[1]
[1]University of Kentucky, Lexington, KY
[2]Western Kentucky University, Bowling Green, KY
[3]EA Engineering Science and Technology, Inc., Sparks, MD

Theme Session—Research Approaches (Biochemical)
(Room 277, Chafee Social Science Center)

Chair: Jennifer Specker

2:20 CYTOCHROME P4501A INDUCTION IN DEVELOPMENTAL STAGES OF FISH: CAUSES AND BIOLOGICAL SIGNIFICANCE
John J. Stegman and Roxanna Smolowitz
Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA 02543

2:45 USE OF FLOW CYTOMETRY TO DETERMINE LARVAL FISH CONDITION
G.H. Theilacker[1] and W. Shen[2]
[1]NOAA, Alaska Fisheries Science Center, Seattle, WA 98115
[2]Department of Pathology, University of Washington, Seattle, WA 98195

3:10 Break

3:30 BIOCHEMICAL INDICATORS OF CHEMICAL CONTAMINATION: POTENTIAL USE IN ASSESSMENT OF POPULATION LEVEL CHANGES
Emily Monosson
North Carolina State University, Raleigh, NC 27604

3:55 BIOTRANSFORMATION OF HEXACHLOROBENZENE IN STEELHEAD LARVAE
Linda Frankovich,[1] M.A.Q. Kahn,[1] M.O. Allum,[2] G. Chapman,[2] and D. Stephens[2]
[1]Department of Biological Sciences, University of Illinois at Chicago, IL
[2]Western Fish Toxicology Station, USEPA, Corvallis, OR

4:20 WHITE TRUNK MUSCLE CONCENTRATION OF RNA WAS FOUND TO TRACK GROWTH RATE IN LARVAL AND JUVENILE CHUB MACKEREL, *SCOMBER JAPONICUS*, NORTHERN ANCHOVY, *ENGRAULIS MORDAX*, AND CALIFORNIA HALIBUT, *PARALICHTHYS CALIFORNICUS*
Sandor E. Kaupp
Scripps Institution of Oceanography, University of California, San Diego, LaJolla, CA 92093-0202

4:45 THE ACTIVITY OF METABOLIC ENZYMES OF THE WHITE TRUNK MUSCLE OF LARVAL AND JUVENILE MARINE FISHES CORRELATES WITH WHOLE FISH METABOLIC RATES
Sandor E. Kaupp
Scripps Institution of Oceanography, University of California, San Diego, LaJolla, CA 92093-0202

5:10 THE INFLUENCE OF RATION LIMITATION ON THE GROWTH, SURVIVAL, AND BIOCHEMICAL CONDITION OF JUVENILE SUMMER FLOUNDER (*PARALICHTHYS DENTATUS*) AT EARLY SPRING TEMPERATURES: EVIDENCE FROM THE LABORATORY AND THE FIELD
K. D. Malloy and T. E. Targett
University of Delaware, Graduate College of Marine Studies, Lewes, DE

Contributed Paper Session—Distribution and Abundance
Concurrent Session
(Room 275, Chafee Social Science Center)

Chair: Nancy Auer

1:30 EARLY SPRING ABUNDANCE AND DISTRIBUTION OF ICHTHYOPLANKTON AND ZOOPLANKTON ALONG THE CENTRAL MAINE COAST
D.K. Stevenson, M.A. Lazzari, and D.A. Libby
Maine Department of Marine Resources, West Boothbay Harbor, ME 04575

1:55 EARLY LIFE HISTORY OF BLACK SEA BASS, *CENTROPRISTIS STRIATA*, IN THE MID-ATLANTIC BIGHT AND A NEW JERSEY ESTUARY
K.W. Able,[1] M.P. Fahay,[2] and G. Shepherd[3]
[1]Rutgers University Marine Field Station, Institute of Marine and Coastal Sciences, P.O. Box 278, Tuckerton, NJ 08087
[2]NOAA, National Marine Fisheries Service, Northeast Fisheries Science Center, Sandy Hook Laboratory, Highlands, NJ 07732
[3]NOAA, National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole Laboratory, Woods Hole, MA 02543

2:20 DISTRIBUTION PATTERNS OF ICHTHYOPLANKTON AT SOUTH GEORGIA, ANTARCTICA
Martin G. White
Marine Life Sciences Division, British Antarctic Survey, NERC, Madingley Road, High Cross, Cambridge CB3 OET, U.K.

2:45 LARVAL FISHES OF THE NORTH PACIFIC—ALASKA TO HAWAII
Brenda L. Norcross
Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, AK 99775-1080

3:10 Break

Contributed Paper Session—Ageing and Marking

Chair: Stan Warlen

3:30 SPECIES IDENTIFICATION AND TEMPORAL SPAWNING PATTERNS OF BUTTERFISH, *PEPRILUS* SPP., IN THE SOUTH AND MID-ATLANTIC BIGHTS
Teresa K. Rotunno and Robert K. Cowen
Marine Sciences Research Center
State University of New York at Stony Brook, Stony Brook, NY 11794

3:55 IMMERSION MARKING OF OTOLITHS OF STRIPED BASS, *MORONE SAXATILIS*, EGGS AND LARVAE USING TETRACYCLINE HYDROCHLORIDE AND ALIZARIN COMPLEXONE
Doreen M. Monteleone,[1] Edward D. Houde,[2] Linda G. Morin,[2] and David H. Secor[2]
[1]Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY 11794-5000
[2]Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, The University of Maryland System, Box 38, Solomons, MD 20688

4:20 A LARVAL MARK-RECAPTURE EXPERIMENT TO STUDY EARLY LIFE POPULATION DYNAMICS AND RECRUITMENT IN STRIPED BASS
D.H. Secor,[1] D.M. Monteleone,[2] and L.G. Morin[1]
[1]Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, The University of Maryland System, Solomons, MD 20688-0038
[2]Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY 11794-5000

4:45 PROBLEMS IN AGEING LONGNOSE DACE, *RHINICHTHYS CATARACTAE* (VALENCIENNES)
P.M. Powles and S. Scholten
Department of Biology, Trent University, Peterborough,
Ontario K9J 7B8, Canada

5:10 DIFFERENCES IN THE SAGITTA, LAPILLUS, AND ASTERISCUS IN ESTIMATING AGE AND GROWTH OF JUVENILE RED DRUM (*SCIAENOPS OCELLATUS*)
Andrew W. David, J. Jeffery Isely, and Churchill B. Grimes
NOAA/NMFS, Southeast Fisheries Science Center, Panama City, FL 32408

7:30 AFS - ELHS Business Meeting

Thursday, June 18, Morning

Theme Session—Research Approaches (Biochemical to Organismal)
Concurrent Session
(Room 277, Chafee Social Science Center)

Chair: Gail Theilacker

8:30 GENOTYPIC VARIATION, SPAWNING TIME, AND RECRUITMENT OF REDFISH (*SEBASTES* SP.) IN THE GULF OF ST. LAWRENCE
Y. de Lafontaine and J-M. Sevigny
Fisheries & Oceans Canada, Institut Maurice Lamontagne, P.O. Box 1000, Mont-Joli, Quebec G5H 3Z4, Canada

8:55 MATERNAL CONTRIBUTION TO EGG AND LARVAL NUCLEIC ACIDS, PROTEIN, AND TOTAL WEIGHTS IN CAPELIN, *MALLOTUS VILLOSUS*
A. Ferron, R.C. Chambers, and W.C. Leggett
Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, Quebec H3A 1B1, Canada

9:20 A MOLECULAR METHOD FOR THE SPECIES IDENTIFICATION OF FISH LARVAE WITH A RESULTING DESCRIPTION OF *XYRICHTYS NOVACULA* (PISCES: LABRIDAE) LARVAE
Jonathan Hare, John Zehr, and Francis Juanes
Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY

9:45 THE TERATOLOGICAL AND PATHOLOGICAL EFFECTS OF CONTAMINANTS ON FISH LARVAE EXPOSED AS EMBRYOS: A BRIEF REVIEW
Joel E. Bodammer
Fisheries, Aquaculture, and Veterinary Science Department, University of Rhode Island, Kingston, RI 02881

10:10 Break

10:30 EVALUATION OF CONTAMINANT EFFECTS ON THE OSTEOLOGICAL DEVELOPMENT OF LARVAL FISH
Mark T. Steingraeber
U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, P.O. Box 936, LaCrosse, WI 54602-0936

10:55 GROSS AND MICROSCOPIC OBSERVATIONS ON NARRAGANSETT BAY YOUNG-OF-THE-YEAR WINTER FLOUNDER
Sharon A. MacLean
NOAA, NMFS, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI 02882-1199

11:20 BEHAVIORAL IMPAIRMENTS IN CONTAMINATED ENVIRONMENTS: IMPLICATIONS FOR THE SURVIVAL OF EARLY LIFE STAGE FISH
Edward E. Little and Aaron J. DeLonay
U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, 4200 New Haven Road, Columbia, MO 65201

11:45 Lunch

Contributed Paper Session—Transport, Settlement, Recruitment
Concurrent Session
(Room 275, Chafee Social Science Center)

Chair: Perce Powles

8:30 RECRUITMENT OF LARVAL FISHES TO A NORTH CAROLINA ESTUARY DURING A RED TIDE, *GYMNODIUM BREVE*, BLOOM
Stanley M. Warlen and Patricia A. Tester
NOAA, NMFS, Southeast Fisheries Science Center, Beaufort Laboratory, Beaufort, NC 28516-9722

8:55 DIFFERENCES IN GROWTH AND SURVIVAL OF METAMORPHOSED AGE-0 WINTER FLOUNDER (*PLEURONECTES AMERICANUS*) BETWEEN NIANTIC RIVER AND NIANTIC BAY, CT
Donald J. Danila
Northeast Utilities Environmental Laboratory, P.O. Box 128, Waterford, CT

9:20 TIDAL SAMPLING TO DETERMINE THE SOURCE OF WINTER FLOUNDER LARVAE IN NIANTIC BAY, CT
J. Dale Miller
Northeast Utilities Environmental Laboratory, Millstone Nuclear Power Station, P.O. Box 128, Waterford, CT 06385

9:45 TRACKING SCIAENID EGGS AND LARVAE FROM ISOLATED ESTUARINE SPAWNING SITES RELATIVE TO ENVIRONMENTAL PARAMETERS
Sabine Alshuth and R. Grant Gilmore, Jr.
Harbor Branch Oceanographic Institution, 5600 Old Dixie Highway, Fort Pierce, FL 34946

10:10 Break

10:30 RECRUITMENT OF ATLANTIC CROAKER TO CHESAPEAKE BAY
Stephen W. Nixon and Cynthia M. Jones
Applied Marine Research Laboratory, Old Dominion University, Norfolk, VA 23529-0456

10:55 FORMATION OF DEMERSAL FISH COMMUNITIES IN THE NORTHWESTERN GULF OF MEXICO
Mark E. Chittenden, Jr.
College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, VA 23062

11:20 ONSHORE TRANSPORT OF SETTLEMENT-STAGE FISHES IN THE BAHAMAS: A SEASONAL COMPARISON
J. Shenker,[1,2] E. Maddox,[2] R. Mojica,[2] E. Wishinski,[2] and N. Smith[3]
[1]Department of Biological Sciences, Florida Institute of Technology
[2]Caribbean Marine Research Center
[3]Harbor Branch Oceanographic Institute

11:45 Lunch

Thursday, June 18, Afternoon

Theme Session—Research Approaches (Populations)
Concurrent Session
(Room 277, Chafee Social Science Center)

Chair: Cynthia Jones

1:30 INDIVIDUAL-BASED MODELING OF THE EFFECTS OF ENVIRONMENTAL QUALITY ON EARLY LIFE STAGES OF FISH
Kenneth A. Rose,[1] James H. Cowan,[2] Charles C. Coutant,[3] and Edward D. Houde[4]
[1]Environmental Sciences Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831
[2]Department of Marine Sciences, University of South Alabama, Mobile, AL 36688
[3]Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN
[4]Chesapeake Biological Laboratory, University of Maryland, Solomons, MD

1:55 MARINE POLLUTION AND FISH POPULATION PARAMETERS: ENGLISH SOLE IN PUGET SOUND, WA
J.T. Landahl and L.L. Johnson
Environmental Conservation Division, Northwest Fisheries Science Center, NMFS, NOAA, Seattle, WA 98112

2:20 MODELING CONTAMINANT EFFECTS ON MARINE POPULATIONS
Michael J. Fogarty, Andrew A. Rosenberg, and F. P. Almeida
NOAA/NMFS Northeast Fisheries Science Center, Woods Hole, MA 02543

2:45 POPULATION-LEVEL EFFECTS OF CHANGES IN AGE 0 SURVIVAL OF WINTER FLOUNDER IN THE GULF OF MAINE
John Boreman,[1] Steven Correia,[2] and David B. Witherell[2]
[1]UMass/NOAA CMER Program, Blaisdell House, University of Massachusetts, Amherst, MA
[2]Massachusetts Division of Marine Fisheries, 18 Route 6A, Sandwich, MA

3:10 Break

3:30 NATURAL HISTORY DISCOVERIES IN ENVIRONMENTAL SCIENCE
Jeffrey B. Marliave
Vancouver Aquarium, P.O. Box 3232, Vancouver, B.C. V6B 3X8, Canada

3:55 NOAA'S NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM AND STUDIES RELATED TO PROTECTING THE EARLY LIFE STAGES OF FISH
Allan D. Beck[1] and Michael P. Crosby[2]
[1]Manager, Narragansett Bay National Estuarine Research Reserve, Prudence Island, RI 02872
[2]Chief Scientist and National Coordinator, NOAA Sanctuaries and Reserves Division, NOS/OCRM, 1825 Connecticut Ave., N.W., Washington, DC

Contributed Paper Session—Growth and Development
Concurrent Session
(Room 275, Chafee Social Science Center)

Chair: Ken Able

1:30 LATITUDINAL VARIATION IN GROWTH OF JUVENILE *TAUTOGA ONITIS* (LABRIDAE): PRELIMINARY LABORATORY AND FIELD OBSERVATIONS
D.L. Martin and T.E. Targett
University of Delaware, Graduate College of Marine Studies, Lewes, DE 19958

1:55 SOMATIC AND OTOLITH GROWTH OF REARED AND WILD ATLANTIC HERRING LARVAE (*CLUPEA HARENGUS* L.)
D.A. Libby
Maine Department of Marine Resources, West Boothbay Harbor, ME 04575

2:20 MAGNITUDE AND CORRELATES OF MATERNAL INFLUENCE ON EARLY LIFE HISTORY TRAITS IN CAPELIN, *MALLOTUS VILLOSUS*
R.C. Chambers, A. Ferron, and W.C. Leggett
Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, Quebec H3A 1B1, Canada

2:45 CORRELATIONS BETWEEN LARVAL AND JUVENILE GROWTH RATES: AN ANALYSIS USING WINTER FLOUNDER
D.F. Bertram, R.C. Chambers, and W.C. Leggett
Department of Biology, McGill University, 1205 Ave., Dr. Penfield, Montreal, Quebec, H3A 1B1, Canada

3:10 Break

3:30 THE WEIGHT-TO-LENGTH RELATIONSHIP OF JUVENILE TAUTOG (*TAUTOGA ONITIS*) IN NARRAGANSETT BAY, 1990–1991
Barbara A. Dorf
Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882

3:55 LIGHT INTENSITY AND SCHOOLING BEHAVIOR OF LARVAL GULF MENHADEN (*BREVOORTIA PATRONUS*)
Dennis M. Higgs and Lee A. Fuiman
University of Texas at Austin, Marine Science Institute, Port Aransas, TX 78373

4:20 DEVELOPMENT OF LIGHT SENSITIVITY IN RED DRUM LARVAE (SCIAENIDAE: *SCIAENOPS OCELLATUS*)
D.E. Stearns,[1] G. Joan Holt,[2] R.B. Forward, Jr.,[3] and P.L. Pickering[2]
[1]Department of Biology, Rutgers University, Camden, NJ 08102, and Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08901
[2]University of Texas
[3]Duke University Marine Laboratory, Pivers Island, Beaufort, NC 28516-9721

4:45 EVALUATION OF OMEGA-3 FATTY ACID ENRICHMENT TECHNIQUES FOR *ARTEMIA* USED AS FOOD SOURCE FOR STRIPED BASS (*MORONE SAXATILIS*) LARVAE
Sureyya Ozkizilcik and Fu-Lin E. Chu
Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary, Gloucester Point, VA 23062

Thursday, June 19, Evening

Theme Session—Posters
(University Club)

7:00–9:00

VERTICAL DISTRIBUTION OF LARVAL FISH AT A TIME-SERIES STATION IN GERLACHE STRAIT, ANTARCTICA, NOVEMBER 1989
Valerie J. Loeb[1] and Anthony F. Amos[2]
[1]Moss Landing Laboratories, Moss Landing, CA
[2]Marine Science Institute University of Texas at Austin, Austin, TX

DEVELOPMENT OF EMBRYOS AND LARVAE DURING GESTATION IN VIVIPAROUS YELLOWTAIL ROCKFISH, *SEBASTES FLAVIDUS*
Maxwell B. Eldridge
NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Tiburon Laboratory, 3150 Paradise Dr., Tiburon, CA 94920

PHYSICAL FACTORS ASSOCIATED WITH THE RECRUITMENT OF LARVAL SPRINGER (*ELOPS MACHNATA*) INTO LAKE ST. LUCIA ON THE SOUTH EAST COAST OF AFRICA
Digby Cyrus and Stefanie Kriel
Coastal Research Unit of Zululand, Zoology Department, University of Zululand, Private Bag X1001, KwaDlangezwa, 3886, Natal, South Africa

EFFECTS OF FOOD AVAILABILITY ON SURVIVAL AND GROWTH OF POND-REARED LARVAL RAZORBACK SUCKERS

Diana Papoulias[1] and W. L. Minckley[2]
[1]U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, 4200 New Haven Rd., Columbia, MO 65201
[2]Department of Zoology, Arizona State University, Tempe, AZ 85287- 1501

DEVELOPMENT RATE AND INSTREAM SURVIVALS OF EARLY AND LATE-RUN PINK SALMON (*ONCHORYNCHUS GOBUSCHA*)

K.P. Hebert , W.W. Smoker, J.E. Joyce and A.J. Gharrett.
Juneau Center for Fisheries and Ocean Sciences, School of Fisheries Sciences, University of Alaska Fairbanks, 11120 Glacier Highway, Juneau, Alaska 99801

Friday, June 19, Morning

Theme Session—Research Approaches (Mesocosms)
Concurrent Session
(Room 277, Chafee Social Science Center)

Chair: Chris Chambers

8:30 USE OF MESOCOSM STUDIES IN PESTICIDE REGISTRATION: DIRECT AND INDIRECT IMPACTS OF INSECTICIDES ON EARLY LIFE STAGES OF FISH
James F. Fairchild
National Fisheries Contaminant Research Center, U.S. Fish and Wildlife Service, 4200 New Haven Rd., Columbia, MO 65201

8:55 USING MESOCOSMS TO ASSESS THE INFLUENCE OF FOOD RESOURCES, PREDATION, AND TOXIC MATERIALS ON LARVAL FISH SURVIVAL
Barbara K. Sullivan and Grace Klein-MacPhee
Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882-1197

9:20 OPEN MESH IN SITU ENCLOSURES FOR MARINE LARVAL FISH STUDIES
Thomas A. Halavik, Lawrence J. Buckley, Geoffrey C. Laurence, Peter Long, and Bruice R. Burns
NOAA/NMFS Northeast Fisheries Science Center
Narragansett Laboratory, Narragansett, RI 02882

9:45 ENCLOSURE EXPERIMENTS ON SURVIVAL AND GROWTH OF BLACK DRUM EGGS AND LARVAE IN LOWER CHESAPEAKE BAY
James H. Cowan, Jr.
Department of Marine Sciences, University of South Alabama, Mobile, AL 36688

10:10 Break

Theme Session—Mitigation and Management
(Room 277, Chafee Social Science Center)

Chair: John Boreman

10:30 CAN LARVICULTURE PLAY A ROLE IN ALLEVIATING POPULATION AND HABITAT LOSSES?
G. Joan Holt
The University of Texas at Austin Marine Science Institute, Port Aransas, TX 78373-1267

10:55 THE USE OF LARVAL FISH CULTURE IN FISHERIES MANAGEMENT: THE CALIFORNIA HALIBUT *PARALICHTHYS CALIFORNICUS* AS AN EXAMPLE
Dena M. Gadomski
VANTUNA Research Group, Occidental College, Los Angeles, CA 90041
Present address: U.S. Fish and Wildlife Service, National Fishery Research Center, Columbia River Field Station, Cook, WA 98605

11:20 CAN THE EFFECT OF POLLUTION STRESS AND FISHING BE EQUATED?
Michael Sissenwine and P. M. Mace
NOAA/NMFS, 1335 East West Highway, Room 9322, Silver Spring, MD 20910

11:45 CERTAIN DECISIONS WITH UNCERTAIN DATA
Penny Howell
Connecticut Department of Environmental Protection, Marine Fisheries Division, P.O. Box 248, Waterford, CT 06385

12:10 Lunch

Contributed Paper Session—Fisheries Oceanography
Concurrent Session
(Room 275, Chafee Social Science Center)

Chair: Brenda Norcross

8:30 THE RELEVANCE OF THE FEEDING ENVIRONMENT OF HERRING (*CLUPEA HARENGUS*) LARVAE TO THEIR RETENTION OFF S.W. NOVA SCOTIA, CANADA
Jose H. Muelbert
Department of Oceanography, Dalhousie University, Halifax, NS B3H 4J1, Canada

8:55 DYNAMIC ESTUARINE FRONTS: IMPORTANCE TO SMALL FISH
Mike Kingsford and Iain Suthers
University of Sydney, NSW 2006, Australia

9:20 DISTRIBUTION AND CHARACTERISTICS OF INDIVIDUAL COD (*GADUS MORHUA*) LARVAE ON THE SCOTIAN SHELF
T.J. Miller, T. Herra, and W.C. Leggett
Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, Quebec PQ H3A, Canada

9:45 SPATIAL VARIATION IN GROWTH AND MORTALITY OF KING MACKEREL AND SPANISH MACKEREL LARVAE IN THE VICINITY OF THE MISSISSIPPI RIVER PLUME
Churchill B. Grimes and Douglas A. Devries
NOAA, NMFS, Southeast Fisheries Science Center, Panama City, FL 32408

10:10 Break

10:30 FACTORS INFLUENCING THE DEPTH OF WALLEYE POLLOCK EGGS AND LARVAE IN SHELIKOF STRAIT, GULF OF ALASKA
A.W. Kendall, Jr.,[1] L.S. Inzce,[2] P.B. Ortner,[3] S.R. Cummings,[3] and P.K. Brown[1]
[1]NOAA, Alaska Fisheries Science Center, 7600 Sandpoint Way N.E., Seattle, WA 98115
[2]Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME 04575
[3]NOAA, Atlantic Oceanographic and Meteorological Laboratory, 4301 Rickenbacker Causeway, Miami, FL 33149

10:55 DISTRIBUTION OF SCIAENID LARVAE ACROSS AN ESTUARINE TIDAL FRONT
Scott A. Holt
University of Texas at Austin, Marine Institute, Port Aransas, TX

11:20 End of Contributed Paper Sessions

Friday, June 19, Afternoon

Theme Session—Mitigation and Management (continued) (Room 277, Chafee Social Science Center)

Chair: John Boreman

1:00 WALLEYE RECRUITMENT IN MINNESOTA'S LARGE LAKES: A SYNTHESIS OF CONTEMPORARY AND HISTORICAL ASSESSMENT
D.L. Pereira, R. Bruesewitz, T. Heinrich, and D. Williams
Minnesota Department of Natural Resources, Section of Fisheries, 1200 Warner Road, St. Paul, MN 55106

1:25 USE OF EARLY LIFE-STAGE DATA: U.S. EPA REGION IX PERSPECTIVE (NO ABSTRACT)
Brian Melzian
U.S. Environmental Protection Agency, 27 Tarzwell Drive, Narragansett, RI 02882

1:50 THE APPLICATION OF LARVAL FISH IN TOXICITY TESTS AND REGULATORY PROCESSES (NO ABSTRACT)
Albert Iacobucci, Rose Gatter-Evarts, and Lee Dunbar
Connecticut Department of Environmental Protection, Water Toxics Section, 122 Washington Street, Hartford, CT 06106

3:00 Buses Depart for Bay Campus Tours

6:00 Buses Depart for Evening Banquet

Able, K.W.[1], M.P. Fahay[2], and G. Shepherd[3]. [1]Rutgers University, Marine Field Station, Institute of Marine and Coastal Sciences, P.O. Box 278, Tuckerton, N.J. 08087. [2]National Marine Fisheries Service, Sandy Hook Laboratory, Highlands, N.J. 07732. [3]National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole, MA 02543. EARLY LIFE HISTORY OF BLACK SEA BASS, *CENTROPRISTIS STRIATA*, IN THE MID-ATLANTIC BIGHT AND A NEW JERSEY ESTUARY. The black sea bass, *Centropristis striata*, is an important component of commercial and recreational fisheries throughout its range yet we know relatively little concerning the early life history. We have attempted to fill this void by focusing on composite field collections, *in situ* observations, etc., in order to elucidate aspects of the first year. Spawning in the Mid-Atlantic Bight occurs over a prolonged period (April - November) based on extensive MARMAP collections of larvae during 1977-1987. Planktonic larvae have been collected between Cape Hatteras and Long Island but probably occur further north in more inshore areas. Age-0 individuals occurred August - October off Little Egg Inlet, New Jersey, in accumulations of surf clam (*Spisula solidissima*) valves. Individuals from this cohort also occurred in an adjacent estuary (Great Bay - Little Egg Harbor), in marsh creeks and along peat banks during the same time period. By October, individuals from the continental shelf and the estuary were 18-91 mm TL. These moved into deeper waters on the continental shelf from southern Massachusetts to Cape Hatteras. They reappeared in the estuary by March, at the same approximate sizes as in October. By July they were approximately 85-165 mm TL. Thus, the accumulated data suggest that *C. striata* utilize estuarine and continental shelf habitats as nurseries during the first summer before migrating offshore in the winter. They reach relatively small sizes by the end of the first year, in part, because growth does not occur between October and March.

Alshuth, S. and R.G. Gilmore, Jr. Harbor Branch Oceanographic Institution, 5600 Old Dixie Highway, Fort Pierce, FL 34946. TRACKING SCIAENID EGGS AND LARVAE FROM ISOLATED ESTUARINE SPAWNING SITES RELATIVE TO ENVIRONMENTAL PARAMETERS. The reproductive seasonality of the three dominant sciaenid species *Pogonias cromis, Bairdiella chrysoura* and *Cynoscion nebulosus*, distributed in the Indian River lagoon in Florida were studied during the spawning season of 1991 and the beginning of 1992. To characterize the estuarine spawning and nursery areas of these multiple spawning sciaenid fish species, hydrophones were used to record vocalization of adult sciaenid males. They produce sounds which are known to be associated with spawning, which takes place within two to three hours after sunset. Furthermore, quantitative surface ichthyoplankton tows were taken on a number of stations at different spawning sites to determine whether there exist a relationship between sound production of the three sciaenid species, spawning activities and abundance of newly spawned eggs. Distribution and abundance of sciaenid eggs and larvae in the Indian River lagoon were investigated in relation to oceanographic, meteorological, astronomical and other environmental factors. Moreover, the developmental characteristics of sciaenid eggs and laboratory-reared larvae were studied under controlled conditions of temperature, salinity and photoperiod. The description of sciaenid larvae, collected in the ichthyoplankton, will allow the identification of each developmental stage relative to various environmental parameters such as water temperature, salinity and oxygen within the estuarine system.

Beck, A.D.[1] and M.P. Crosby[2]. [1]Manager, Narragansett Bay National Estuarine Research Reserve, Prudence Island, RI 02872. [2]Chief Scientist and National Research Coordinator, NOAA Sanctuaries and Reserves Division NOS/OCRM, 1825 Connecticut Ave., N.W. Washington, DC 20235. NOAA'S NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM AND STUDIES RELATED TO PROTECTING THE EARLY LIFE STAGES OF FISH. The National Estuarine Research Reserve System (NERRS) was established as part of the Coastal Zone Management Act of 1972 to protect and manage representative estuarine types. The NOAA Sanctuaries and Reserves Division in partnership with the individual states in which the Reserves are located administer the System. In 1992, twenty years later, 22 Reserves have been designated encompassing nearly 320,000 acres of estuarine waters, marshes, shoreline and adjacent uplands. Additional sites are under consideration for further expansion of the system. The research and monitoring programs of the Reserves focus on long-term studies to characterize the ecosystem, detect change, determine effects of human activity on the resources and manage for preservation of these fragile and valuable ecosystems. The current SRD approach utilizes a competitive grants program coupled with an emphasis on cooperative studies with other funding sources including Sea Grant, EPA and other federal, state and private institutions. The present thematic area for the NERRS research and monitoring is comparative ecology and cause/effect relationships in changing estuarine habitat and water quality. The Reserves provide a stable, protected natural field laboratory for the use of interested investigators. The results of the research and monitoring in the Reserves provide essential information to support Reserve management and overall coastal zone protection and decision making.

Bengtson, D.A.[1] and D.J. Hansen[2]. [1]Department of Zoology, University of Rhode Island, Kingston, RI. [2]Environmental Research Laboratory, U.S. Environmental Protection Agency, 27 Tarzwell Drive, Narragansett, RI. USE OF ESTUARINE AND MARINE FISH LARVAE IN TOXICITY TESTING. Toxicity testing with marine and estuarine fish is conducted on a relatively small number of species. Species that are cultured year-round in the laboratory for testing of embryos and larvae are predominantly in the families Atherinidae and Cyprinodontidae. Other species are available for testing on a seasonal basis (e.g., cod, striped bass, several species of flatfish, etc.). Standards published by the American Society for Testing and Materials recommend 17 saltwater species for use in acute toxicity tests, but only 5 species for the longer duration early life-stage (ELS) effluent toxicity are now performed routinely with *Menidia beryllina* and *Cyprinodon variegatus*. Full life cycle tests have been performed only with *C. variegatus*. Thus, the data base for correlation of results of acute or ELS tests with those of life-cycle tests is extremely limited and should be expanded. The development of new species for testing is most pronounced on the West Coast. The development of new methods, especially biochemical measurements correlated with reproduction and embryo/larval survival and growth, represent an exciting area of current research.

Bertram, D.F., R.C. Chambers, and W.C. Leggett. Department of Biology, McGill University, Montreal, PQ H3A 1B1, Canada. CORRELATIONS BETWEEN LARVAL AND JUVENILE GROWTH RATES: AN ANALYSIS USING WINTER FLOUNDER. In marine fishes, growth rates during early life stages have been correlated with stage duration and survival. Through their action on life stage duration, variation in growth rates could result in differential survival among individuals. The assumption that fish which grow most rapidly as larvae also grow most rapidly as juveniles was evaluated by rearing winter flounder, *Pseudopleuronectes americanus*, a flatfish that expresses clear morphological and habitat separation between larval and juvenile stages (i.e. metamorphosis). The fastest growing larvae were not found to be the fastest growing juveniles, in fact, growth rates of larvae and juveniles varied inversely. This negative covariance resulted in growth compensation for larvae that grew slowly. The observed ontogenetic pattern of growth variation is consistent with two selective processes: size-dependent predation and/or size-dependent overwinter mortality. We conclude that growth dynamics in early life stages of marine fishes are not likely to be as simple as was previously thought. Greater insight into growth dynamics will result if individual variability, expressed in both the larval and juvenile stages, is examined than if either stage is studied in isolation. Further, we anticipate that by investigating the nature of the relationship between individual growth dynamics and important agents of mortality such as predation risk during early life, fresh insight into the relative survival probabilities of phenotypes within a cohort will emerge.

Birge, W.J.[1], R.D. Hoyt[2], J.A. Black[3], and W.A. Robison[1]. [1]Biology/ Toxicology,University of Kentucky, Lexington, KY 40506. [2]Biology, Western Kentucky University, Bowling Green, KY 42101. [3]E.A. Engineering Science and Technology, Inc., Sparks, MD 21152. EFFECTS OF CHEMICAL STRESSES ON BEHAVIOR OF LARVAL AND JUVENILE STAGES OF FISH AND AMPHIBIANS. A series of investigations was conducted to determine the effects of chemical stresses on avoidance/attraction and feeding behavior of larval and juvenile stages of fish and amphibians. Avoidance/attraction experiments were conducted with eight aquatic contaminants, including Cd, Cu, Hg, Zn, chloroform, dioctylphthalate (DOP), trisodium nitrilotriacetic acid (NTA), and phenol. Tests were performed with a dual-channel fluviarium. Syringe and peristaltic pumps were used to regulate flow rate and toxicant concentrations. Juvenile stages of largemouth bass, bluegill sunfish, and rainbow trout, and tadpoles of the American toad proved to be suitable animals for evaluating avoidance or attraction responses. Avoidance was significant ($p < 0.01$) in tests with Cd, Zn, and phenol, and significant attraction resulted from exposures to chloroform, DOP, and Hg. Animals generally avoided lower concentrations of Cu but were attracted to higher exposure levels. NTA produced variable responses. The trout was the most sensitive species tested. With this species, threshold concentrations for avoidance or attraction were estimated to be 0.0002 mg/L Hg, 0.047 mg/L Zn, 0.052 mg/L Cd, 0.074 mg/L Cu, 11.9 mg/L chloroform, and 56.6 mg/L NTA. The threshold for phenol, determined with the bluegill, was 39.0 mg/L. Aluminum exposure and pH were observed to affect feeding behavior in larval fathead minnows. Organisms in low pH (< 6.5) and moderately hard water exhibited reduced feeding. Aluminum-treated animals also exhibited reduced feeding, depending upon the pH. Additional feeding trials were conducted on 18 to 24 day-old fathead minnows at pH levels of 5.0, 7.0, 10.0; 4.5, 7.0, 11.0; and 3.5, 7.0, 11.5. Total mortality was observed at pH 3.5 and 11.5. Appetitive behavior was not affected by pH, as frequencies of occurrence of feeding ranged from 93 to 100% among 9 test trials of sixty fish each. Vision was not impaired at any pH, as 99.9% of the brine shrimp, both live and dead, were consumed during light trials. During dark trials, intensity of feeding was altered as significantly fewer live and dead brine shrimp were consumed than in the light. Likewise, significantly fewer brine shrimp were consumed than in the light. pH values of 7.0 and greater did not appear to impact feeding in the dark, as 98.9% of live brine shrimp were consumed. However, a pH of 5.0 or lower significantly affected feeding, with 31% of live brine shrimp remaining after dark feeding trials. Chemoreception also was noticeably impaired at a pH of 5.0 or lower, as an average of 19% of dead brine shrimp remained following dark feeding trials. The effect of low pH on mechanoreception was not determined. The major conclusions of these findings are: 1) sublethal pH concentrations do not affect appetitive behavior, 2) fathead minnow larvae are predominantly daylight, visual feeders, 3) a pH of 5.0 or lower significantly affects the sense of chemoreception and reduces feeding, and 4) chemeroception and mechanoreception are strongly correlated with vision in feeding.

Bodammer, J.E. Fisheries, Aquaculture, and Veterinary Science Department, University of Rhode Island, Kingston, RI 02881. THE TERATOLOGICAL AND PATHOLOGICAL EFFECTS OF CONTAMINANTS ON FISH LARVAE EXPOSED AS EMBRYOS: A BRIEF REVIEW. Typically, the effects of laboratory exposure to contaminants upon fish during their early life history has been measured in terms of hatchability for embryos and/or lethality for larvae. Too few studies have dealt with the less precise, sublethal effects of contaminants on embryos or larvae that express themselves as terata or lesions. The review presented herein is restricted to the sublethal effects of chlorinated hydrocarbons, heavy metals, organophosphate pesticides, the water soluble fraction of crude oil (aromatic hydrocarbons), and low pH as observed in late-stage embryos or larvae of fish exposed as embryos. As will be noted, there can be an amazing similarity in some of the resulting abnormalities observed in both embryos and larvae regardless of the type (class) of contaminant to which they were exposed. This is particularly true for skeletal malformations which will also be covered elsewhere in this symposium.

Boreman, J.[1], S. Correia[2], and D.B. Witherell[2]. [1]UMass/NOAA CMER Program, Blaisdell House, University of Massachusetts, Amherst, MA. [2]Massachusetts Division of Marine Fisheries, 18 Route 6A, Sandwich, MA 02563. POPULATION-LEVEL EFFECTS OF CHANGES IN AGE-0 SURVIVAL OF WINTER FLOUNDER IN THE GULF OF MAINE. The decline in abundance of inshore populations of winter flounder has prompted the Atlantic States Marine Fisheries Commission to undertake development of a coastwide management plan for the species. Fishery managers can restore populations by adjusting fishing regulations to reduce fishing-induced mortality, and improving habitat quality, thus increasing survival of early life stages. Even if the true reason for population decline is increased mortality of the early life stages, managers need to determine if, and to what degree, the decline is exacerbated by fishing mortality. We adapted the Eggs-Per-Recruit methodology to examine the potential effectiveness of improving habitat quality versus reducing fishing mortality to increase abundance of the inshore population of winter flounder north of Cape Cod. The relative change in the baseline rate of age-0 survival, both positive (due to habitat restoration) and negative (due to habitat loss), is approximately equivalent to the relative change in fishing mortality rate necessary for the population to maintain a stationary level of abundance. Regulating fisheries to increase population abundance and yield represents less risk to managers than undertaking habitat restoration programs. However, undertaking habitat restoration programs may result in longer-term benefits and allow managers to increase fishery yield from the populations gradually.

Bulak, J.S.[1], N. Hurley[2], and J.S. Crane[3]. [1]South Carolina Wildlife and Marine Resources Department, P.O. Box 170, Columbia, S.C. 29202. [2]U.S. Geological Survey, 720 Gracern Road, Columbia, S.C. 29210. [3]S.C. Wildlife and Marine Resources Department, 1921 Van Boklen Road, Eastover, S.C. 29044. TRANSPORT AND MORTALITY OF STRIPED BASS EGGS IN CONGAREE AND WATEREE RIVERS, SOUTH CAROLINA. The Santee-Cooper striped bass (*Morone saxatilis*) population spawns in the soft, freshwaters of the Congaree and Wateree Rivers. Natural recruitment indices have declined since 1977. Studies were initiated in 1983 to characterize factors affecting success of natural reproduction. In 1988 through 1990 striped bass egg collections were made at eight to twelve hour intervals at two sites on both the Wateree and Congaree Rivers. Annual standing crop estimates of eggs at each site were calculated by adding interval specific estimates that were calculated by multiplying discharge by egg density. The age, in hours, of a subsample of eggs was determined for one collection daily at each site. The transport of striped bass eggs in Congaree, Wateree and Santee Rivers was studied using a one-dimensional unsteady-flow model and a Lagrangian-type transport model. A dye study was used to calibrate the transport model. Model results were used to develop equations that predicted the distance to egg spawning and hatching sites from each sampling site. Egg mortality estimates between sampling sites on each river were estimated by using age and transport equations to restrict consideration to eggs spawned above the uppermost site on each river. Additional information on specific gravity and critical settling velocity of Santee-Cooper eggs was also obtained.

Chambers, R.C., A. Ferron, and W.C. Leggett. Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, Quebec H3A 1B1, Canada. MAGNITUDE AND CORRELATES OF MATERNAL INFLUENCE ON EARLY LIFE HISTORY TRAITS IN CAPELIN. The condition of a female fish before and during spawning may be predictive of her offspring's status and chances for survival in early life. Maternal contributions to early life history traits were evaluated in an experimental design in which eggs from 60 female capelin, Mallotus villosus, were artificially fertilized, incubated in the laboratory, and followed through the yolk-sac stage. Females were characterized by their sizes (length, body depth, wet weight) body components (wet,dry, lean, and lipid weights of soma, wet and dry weights of ovaries), and condition indices (Fulton's *k*, lipid index, and GSI). Offspring were characterized by size of egg; age, length, and yolk and oil reserves of larvae at hatching; size of larvae at first feeding; and their age at starvation. Correlations were calculated between female traits, between family-averaged ELH traits, and between female and offspring sets of traits. All measure of female size (lengths, masses) were directly correlated. Ovary size and fecundity increased with female size but varied inversely with both absolute and weight-specific lipid quantity of soma. The suite of offspring traits differed significantly among females. Correlations between offspring traits revealed a family expressing large egg size had, on average, larger larvae at hatching that possessed greater energy reserves and hatched later. Larvae from these families were also larger at first feeding. Female size was directly correlated with egg size and size of larva at hatching and first feeding. No measured female characteristic covaried with average ages of larvae at hatching and starvation.

Chittenden, M.E., Jr. College of William and Mary, Virginia Institute of Marine Science, Gloucester Point, VA 23062. FORMATION OF DEMERSAL FISH COMMUNITIES IN THE NORTHWESTERN GULF OF MEXICO. Two major demersal fish communities are distributed across the continental shelf of the northwestern Gulf of Mexico (Gulf). They include a largely estuarine-related white shrimp community from 5 m, and shallower, to 18 m off Freeport, Texas, and a largely estuarine-independent brown shrimp community from 36 m to at least 100 m. Sandwiched between these communites is a transition fauna from 18 to at least 27 m. The two communities are distinct at the family level. The white shrimp community is dominated by the Family Sciaenidae, especially the Atlantic croaker, *Micropogonias undulatus*; the brown shrimp community is dominated by the Family Sparidae, especially the longspine porgy, *Stenotomus caprinus*. Formation of the white and brown shrimp communities probably reflects community differences in current transport and recruitment processes. Their members recruit to the bottom in the northwestern Gulf along the inshore portions of the respective communities, then gradually disperse offshore. The fauna of these two communities is distinct from that in the eastern Gulf. That difference also probably reflects current transport and recruitment processes. A separate gyre exists in the northwestern Gulf, and it encompasses both the white and brown shrimp communities.

Cowan, J.H., Jr. Department of Marine Sciences, University of South Alabama, Mobile, AL 36688. ENCLOSURE EXPERIMENTS ON SURVIVAL AND GROWTH OF BLACK DRUM EGGS AND LARVAE IN LOWER CHESAPEAKE BAY. Experiments in 2.2 m^3 *in situ* mesocosm enclosures indicate that black drum *Pogonias cromis* eggs and larvae potentially can survive in the lower Chesapeake Bay at ambient microzooplankton prey levels (~200 prey l^{-1}) in the absence of predators. In growth experiments, larva mean growth rates to 10 days post hatch were similar (0.17 and 0.18 mm d^{-1}) when fed at prey levels of 50 and 200 prey l^{-1}. Individual growth rates, however, were more variable at 50 prey l^{-1}. Mortality rates also were comparable in 50 (27%) and 200 (23%) prey l^{-1} enclosures. In a second experiment, the predation potentials of the hydromedusa *Nemopsis bachei* and the lobate ctenophore *Mnemiopisi leidyi* were estimated in relation to 1) initial black drum egg prey density, 2) presence of alternative <1 mm zooplankton prey, and 3) estimated daily abundance of the jellyfish on the black drum spawning grounds. Mortality rates per medusa and ctenophore were similar (0.02 - 0.03 d^{-1}), were not effected by presence of alternative prey, and were directly related to initial egg density. Results suggest that the gelatinous predators, especially the hydromedusa, could have cleared a high (~38%) but variable fraction of the water column daily of fish eggs and yolk-sac larvae during the black drum spawning season. It is hypothesized that the poor or episodic recruitment success of black drum in Chesapeake Bay results from a short spawning season that often coincides with abundance peaks of gelatinous predators and that predation on eggs and yolk-sac larvae may control recruitment.

Cyrus, D. and S. Kriel. Coastal Research Unit of Zululand, Zoology Department, University of Zululand, Private Bag X1001, KwaDlangezwa, 3886, Natal, South Africa. PHYSICAL FACTORS ASSOCIATED WITH THE RECRUITMENT OF LARVAL SPRINGER (*ELOPS MACHNATA*) INTO LAKE ST. LUCIA ON THE SOUTH EAST COAST OF AFRICA. *Elops machnata* occurs from Mossel Bay, on the South Coast of South Africa, up the east coast of Africa to the Red Sea and India, and possibly the western Pacific. In Africa it occurs commonly in estuaries where it is considered to be a prize angling fish. The occurrence and diet of adults in estuaries has been investigated but nothing was known about the occurrence of the larval stages of this species. Nighttime high tide sampling was undertaken over a three day period on alternated spring tides for twelve months during 1987/88 at a station situated some five kilometers upstream of the estuary mouth. A 500 micron nybolt net was deployed at hourly intervals over the rising tide with top and bottom samples being collected. During each sampling a set of physical data were also collected. These included salinity, turbidity, water temperature and oxygen concentration. Rainfall data from two weather stations on the lake were also used in the study. Samples were also collected during the daytime high tides with a fine mesh small seine net. Results showed that early metamorphic larvae of *E. machnata* were present in very low numbers (<5 per $100m^3$) throughout the year except during March 1988 when numbers peaked at 44 per $100m^3$. A similar pattern was shown by the small seine data but with a peak reaching 20 per haul. No significant differences were found between top and bottom samples. Comparison of the catch data with the physical factors showed that the months of maximum immigration coincided with highest values of turbidity, rainfall and temperature and lowest oxygen concentration. These values are typical of those recorded during the peak of the summer period and tend to indicate that *E. machnata* relies on one or a combination of these factors to stimulate mass movement and to guide them into the estuary.

Danila, D.J. Northeast Utilities Environmental Laboratory, P.O. Box 128, Waterford, CT 06385. DIFFERENCES IN GROWTH AND SURVIVAL OF METAMORPHOSED AGE-0 WINTER FLOUNDER *(PLEURONECTES AMERICANUS)* BETWEEN NIANTIC RIVER AND NIANTIC BAY, CT. Some larvae produced by adult winter flounder spawning in the Niantic River, CT estuary each year are flushed into Niantic Bay. Others are carried into the area from Long Island Sound by tidal currents. By late May most of the larvae have metamorphosed onto demersal juveniles. A 1-meter beam trawl was used to collect young-of-the-year winter flounder at two stations each in the Niantic River (1983-90), a semi enclosed high salinity embayment, and in Niantic Bay (1988-91), which is contiguous to the Connecticut waters of Long Island Sound. Annual sampling started in late May and continued weekly through the end of September. Objectives were to determine the abundance, growth, and mortality of young and provide information on year-class strength and eventual recruitment to the spawning population and the fisheries. Generally, initial settlement of young was greater in the bay than in the river. However, by mid-summer no individuals remained at the bay stations. Rates of growth were greater and apparent mortality rates were lower in the river than in the bay, although they varied from year to year at each station. Differences between the length-frequency distributions of these two populations and otter trawl and seine sampling records provided no evidence of substantial numbers of young emigrating to other areas of the bay or into the river. Apparently, the more open bay is not as conducive to survival of age-0 winter flounder as the shallower, warmer Niantic River embayment. Despite its smaller geographical size, the river most likely provides more recruits to the adult spawning population than the much larger bay.

David, A.W., J.J. Isely, and C.B. Grimes. NMFS, Southeast Fisheries Science Center, Panama City, FL 32408. DIFFERENCES IN THE SAGITTA, LAPILLUS, AND ASTERISCUS IN ESTIMATING AGE AND GROWTH OF JUVENILE RED DRUM (*SCIAENOPS OCELLATUS*). Age and comparative growth rates of sagittae, lapillii, and asteriscii from juvenile Red Drum (*Sciaenops ocellatus*) were compared in order to determine accuracy and precision of back-calculated size and age information. Otolith diameter was regressed on standard length for each otolith from 50 fish through a range of sized between 10-50 mm SL. Sagittaie provided the highest correlation (r^2 = .956). Lapillii and asteriscii were similar in their ability to predict standard length but accounted for a lower proportion of the variability (r^2 = .880 and.899 respectively). Age estimates in days were determined from otolith increment counts from known age fish. The asteriscus provided the most accurate estimate of age. Both sagittae and lapillii underestimated the true age by 18 and 20 days respectively. Errors in estimating age varied by $\pm$ 3 days on average. Underestimations for sagittae and lapillii were due primarily to low differentiation of rings in the nuclear region. We conclude that the asteriscus should be used for age estimates in juvenile Red Drum.

de Lafontaine, Y. and J.M. Sevigny. Fisheries and Oceans, Canada Institute Maurice Lamontagne, P.O. Box 1000, Mont-Joli, Quebec G5H 3Z4, Canada. GENOTYPIC VARIATION, SPAWNING TIME AND RECRUITMENT OF REDFISH (*SEBASTES* SP.) IN THE GULF OF ST. LAWRENCE. Redfish in the Gulf of St. Lawrence comprised two species (*Sebastes mentella* and *S. fasciatus*) which are sympatric and morphologically similar but genetically distinct. Assuming the existence of reproductive isolating mechanisms, we tested the hypothesis that spawning time and/or spawning site differ between the two species and act as an ecological barrier contributing to the maintenance of two genetically distinct groups. Using the genotypic variation at the liver malate dehydrogenase (MDH) locus for separating the two species, species composition of 750 larvae and 2,000 juveniles of redfish caught in 1991 was determined. Results reveal that 1) both species spawn in the Gulf of St. Lawrence, 2) genotypes frequency varies with larval size indicating different spawning time for the 2 species, and 3) genotypes frequency varies with sampling stations suggesting possible different spawning locations of the 2 species within the Gulf. Genotypic frequency for juveniles show that both species are retained within the Gulf during their first year of growth, but that their distribution is not sympatric. Juveniles genotypic frequency varies also with age leading to alternance in the species composition of redfish annual recruitment. We put forward the hypothesis that the difference in spawning times for the 2 species coupled with different larval drift patterns could ensure the maintenance and ecological (and genetic) isolation of two distinct redfish species in the Gulf of St. Lawrence.

Dorf, B.A. Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882. THE WEIGHT-TO-LENGTH RELATIONSHIP OF JUVENILE TAUTOG (*TAUTOGO ONITIS*) IN NARRAGANSETT BAY, 1990–1991. The weight-to-length relationship of young of the year tautog (*Tautoga onitis*) from 18 stations in Narragansett Bay is described using estimates of least squares regression parameters, and the condition factors Fulton's K (W/L^3) and Ricker's K (W/L^b). The least squares regression parameter 'b' was found to be significantly different from 3 ($p<0.001$). Condition varied over both month and location in Narragansett Bay with highest values occurring in summer and decreasing in the fall. Tautog from locations with highly structured macroalgal habitat had higher condition values and greater abundances than those from less structured habitats. Hurricane Bob in August, 1991 resulted in changes in length distribution with location, and concurrent changes in mean condition values. Condition factors were found to be useful in looking at the relative well-being of juvenile tautog of similar size, and when used in conjunction with abundance data may be useful in to evaluating the relative value of different habitat types.

Eldridge, M.B. NOAA, National Marine Fisheries Service, Southwest Fisheries Science Center, Tiburon Laboratory, 3150 Paradise Drive, Tiburon, CA 94920. DEVELOPMENT OF EMBRYOS AND LARVAE DURING GESTATION IN VIVIPAROUS YELLOWTAIL ROCKFISH, *SEBASTES FLAVIDUS*. One of the problems facing researchers who attempt to estimate spawning biomass of viviparous rockfishes (*Sebastes* spp.) by the larval production technique is the lack of information on the rate and sequence of gestation. That is, the time course for embryonic and larval development is needed to estimate the date of parturition. During the gestation periods (December - March) of the 1990-91 and 1991-92 reproductive seasons, we conducted laboratory experiments that involved monitoring the rate and sequence of gestation in 20 female yellowtail rockfish that had been transported from the Cordell Bank seamount to research aquaria at the University of California Bodega Marine Laboratory. Samples of embryos and larvae were obtained by catheterization of anesthetized fish at approximate weekly intervals until eggs were fertilized, then subsampled at 1-5 day intervals from fertilization to parturition. The sequence of embryonic development followed the 33 stage pattern previously established for *S. schlegeli* from the western Pacific, but rates of both embryonic an larval development were faster in *S. flavidus* than those reported for other rockfishes. A photomicrographic record was established for the early life stage development of yellowtail rockfish. Mean observed time to hatch was 22.7 days post-fertilization and that from hatching to parturition was 6.2 days. Total elapsed time required for development from fertilization to larval release ranged 27-33 days with a mean of 29 days.

Fairchild, J.F. National Fisheries Contaminant Research Center, U.S. Fish and Wildlife Service, 4200 New Haven Rd., Columbia, MO 65201. USE OF MESOCOSM STUDIES IN PESTICIDE REGISTRATION: DIRECT AND INDIRECT IMPACTS OF INSECTICIDES ON EARLY LIFE-STAGES OF FISH. Studies in aquatic mesocosms (i.e., replicate experimental ponds 0.300 m^3 volume) can offer significant advantages over studies in natural systems due to increases in experimental control and statistical inference. In 1988 the U.S. EPA published guidelines for the use of mesocosms in pesticide registration to determine the impacts of chemicals on non-target aquatic organisms including fish. These studies are conducted to refute a presumption of risk derived from hazard assessments which compare laboratory toxicity data and predicted environmental exposure concentrations. Extensive monitoring of fish (mortality, growth, and reproduction), invertebrate dynamics (abundance and species composition), primary production (biomass, species composition, and production), water quality, and contaminate fate is conducted in these mesocosm studies. Results commonly indicate that laboratory data is predictive of direct impacts of fishes; indirect impacts on fish are less predictable due to deterministic (e.g. intra-specific competition for food) and stochastic (e.g. spawning/chemical application sequence) factors. Indirect effects of pesticides on critical life-stages (e.g. survival during shift to exogenous feeding) could be better studied using alternative, mechanistic mesocosm studies. Larval fish ecologists have significant knowledge and expertise which could contribute to this area of regulatory science.

Ferron, A., R.C. Chambers, and W.C. Leggett. Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, Quebec H3A 1B1, Canada. MATERNAL CONTRIBUTION TO EGG AND LARVAL NUCLEIC ACIDS, PROTEIN AND TOTAL WEIGHTS IN CAPELIN, *MALLOTUS VILLOSUS*. Non-genetic maternal contribution to offspring characteristics may influence survival during their early life. In fish, the egg quantity and quality (composition) is the first potential source of variability the offspring may experience. In order to determine the maternal contribution to the expression of early life history traits, 60 female capelin, *Mallotus villosus*, were crossed with milt drawn from 10 males. The sibling eggs were incubated at constant temperature in separate containers, and the hatchlings followed until starvation. Protein, DNA, RNA, and total weights were recorded on individual unfertilized eggs from 16 families and newly hatched larvae from 42 families. all measured egg and larval traits differed significantly between families. The calculation of variance components revealed the among-female contribution to that variance being greater in eff than in larval traits. Total weight had the highest variance due to female, followed by protein, DNA, and RNA weights. Using family averages, none of these egg and larval traits was found to be significantly correlated with any of a suite of morphological characters measured on the mothers. Total weight was significantly correlated with protein weight in both unfertilized eggs and newly hatched larvae. Further, females possessing eggs with greater total and protein weight gave rise to larvae also having higher total and protein weight at hatching. Therefore, even if egg and larval characteristics could not be predicted from female traits, they still showed strong maternally based variability detectable at least up to the time the larvae hatch. If any of these egg and larval traits influence survival of the early larvae, then their maternal origin and the factors responsible for the among-female differences are important contributors to early survival.

Frankovich, L.[1], M.A.Q. Khan[1], M.O. Allum[2], G. Chapman[2], and D. Stephens[2]. [1]Department of Biological Sciences, University of Illinois at Chicago, Chicago, IL. [2]Western Fish Toxicology Station, USEPA, Corvallis, Oregon. BIOTRANSFORMATION OF HEXACHLOROBENZENE IN STEELHEAD LARVAE. Hexachlorobenzene offered daily in feed to 1.5-gm fry of the steelhead trout *(Salmo garidneri)* was absorbed and retained in the body reaching a steady state equilibrium in 14 to 16 days. Further exposure did not increase the body burden of HCB. Following the cessation of 17-or 21-day exposures, the fry eliminated half of the HCB load within one week. The next phase of depuration was slower and may be followed by a third phase in which low levels of the remaining HCB in the body take more than a month for elimination at extremely slow rate. Thus, low sublethal concentrations of HCB and other lipophilic aquatic pollutants and their mixtures to which larval fish are commonly and continuously exposed must be exerting both acute and chronic effects - the effects which should be determined and quantified. The analysis of the exposed fish showed the presence of HCB and its metabolites. Immediately after the cessation of feeding the fry showed pentachlorophenol (PCP) and its glucuronide and GSH conjugates. During depuration PCP appeared to be converted to dichloro- and trichloro-phenols which were retained in the body. While free PCP and its glucuronide are excreted readily the GSH conjugates are retained in the body. The hepatic microsomal oxygenases of the fry, as active as that of the adult fish, can convert HCB to PCP as well as PCP to lower hydroxylated phenols. Whether the exposure of fry to HCB causes induction of specific monoxygenases and conjugation mechanisms which in turn metabolize HCB, PCP and other products needs further investigations.

Fuiman, L.A. and R.S. Batty. University of Texas at Austin, Marine Science Institute, Port Aransas, TX, and Dunstaffnage Marine Laboratory, Oban, Argyll, Scotland. SUSCEPTIBILITY OF ATLANTIC HERRING AND PLAICE LARVAE TO PREDATION BY JUVENILE COD AND HERRING AT TWO CONSTANT TEMPERATURES. Predation encounters were stage in the laboratory to 1) compare the responsiveness of herring and plaice larvae to predatory attacks of herring and cod; 2) compare the attack success of the two species of predator; and 3) assess importance of water temperature to the interaction of predator and prey. Prey species represent two different morphologies: the relatively short, fast developing plaice, and the more elongate, slowly developing herring. The predator species differ in their style of attack: juvenile herring intercept prey while swimming toward them, while juvenile cod approach more slowly and ingest prey using suction. Water temperatures of 8 and 13 C were compared. Temperature effects on responsiveness of herring larvae (14 to 24 μTL) were not significant. Herring larvae responded in 2.6% of attacks by cod and 5.7% of attacks by herring. The difference was not significant. Plaice larvae were largely unresponsive: in all four treatments, only a single larva responded. Herring larvae were significantly more responsive to attacks by herring than were plaice larvae (5.7% vs. 0.0%); they were equally responsive to attacks by cod. Temperature effects on predator capture success also were not significant. Cod caught 91% of herring larvae attacked and juvenile herring caught 87%. When plaice were the prey, cod were successful in 96% of attacks. Juvenile herring caught significantly fewer (83%) of the plaice they attacked. capture success for each predator did not vary significantly with prey species.

Gadomski, D.M. VANTUNA Research Group, Occidental College, Los Angeles, CA 90041. U.S. Fish and Wildlife Service, National Fishery Research Center, Columbia River Field Station, Cook, WA 98605. THE USE OF LARVAL FISH CULTURE IN FISHERIES MANAGEMENT: THE CALIFORNIA HALIBUT *PARALICHTHYS CALIFORNICUS* AS AN EXAMPLE. In 1985, a 5 year study of the California halibut *Paralichthys californicus* (Paralichthyidae) was initiated as part of the Ocean Resources Enhancement and Hatchery Program (OREHP). Research was conducted in Redondo Beach, California, and co-funded by the California Department of Fish and Game and the Southern California Edison Company. A primary objective was to develop methodology to culture larval halibut, with the ultimate goal of enhancing ocean populations through juvenile release. An additional objective was to gather basic information concerning the development of halibut early life history stages. Our most successful halibut broodstock was held in a 20,000-L outdoor tank; fish spawned naturally every year during 1986-1989. The spawning period differed between years, occurring during winter, spring, or summer months. Larvae were reared in a variety of tanks sizes (maximum: 300-L) and fed rotifers and brine shrimp. Various experiments were conducted to determine how growth and survival of halibut early life history stages are influenced by factors such as starvation, food density, and temperature. As halibut developed, highest survival occurred at increasingly higher temperature ranges; eggs hatched at 12-20°C, larval survival was best at 16-24°C, and juvenile survival was highest at 20-28°C. Overall survival rate in the laboratory decreased after larval settlement, however. Because of low survival during the early juvenile stage, a hatchery operation with the goal of large-scale releases of older juveniles is not feasible without further research. Results of our experiments have been of use to fishery managers in the development of a California halibut life history model.

Grimes, C.B. and D.A. Devries. NMFS, Southeast Fisheries Science Center, Panama City, FL 32408. SPATIAL VARIATION IN GROWTH AND MORTALITY OF KING MACKEREL AND SPANISH MACKEREL LARVAE IN THE VICINITY OF THE MISSISSIPPI RIVER PLUME. Previous studies in the vicinity of the Mississippi River discharge plume have demonstrated that fish larvae and their food are concentrated in the mixing (frontal) zone between plume and Gulf of Mexico shelf waters. We hypothesized that if fish larvae in the frontal zone utilized the concentrated food resources they would grow faster and survive better. To evaluate this hypothesis sagittae from 124 king mackerel, *Scomberomorus cavalla*, 2.9 - 23 mm SL and 616 Spanish mackerel, S. maculatus, 1.7 - 24 mm SL, collected primarily about the Mississippi River plume during both low flow (fall) and high flow (spring) periods in 1986-1989 were examined whole at 500X using a compound microscope-video system. Least squares regression of SL on age indicated that absolute growth was curvilinear. Spanish mackerel growth averaged 1.27 mm/d (1.20 in the spring, 1.29 in the fall), while king mackerel averaged 0.86 mm/d. Preliminary spatial comparisons suggest that fall caught Spanish mackerel may grow faster (0. 35 mm d^{-1}) in the frontal zone, i.e., intermediate salinities between low salinity plume waters and high salinity Gulf of Mexico shelf waters. Instantaneous daily mortality rates based upon larval catch curve analysis suggest that mortality is higher in the plume region than outside it for both species, possibly because mechanisms that concentrate food in plume area also aggregate predators and increase mortality from predation. However, mortality estimates may be biased upward in the plume area by the interaction of size-selective sampling (gear bias) and increased larval growth. If higher mortality in the plume region results from concentrated predators and predation is size-selective, then higher growth rates observed in the frontal region could be partially apparent, i.e., result from higher size-selective mortality on the slowest growing larvae at age. Back-calculated length at age data for king mackerel larvae indicate that size-selective mortality enhances growth by 0. 07 mm d^{-1}, i.e., about 20% of the total increase in growth observed for Spanish mackerel in the frontal region. Thus, while fish larvae may experience "real" faster growth in the frontal region they also may experience poorer survival, presumably for increased predation.

Halavik, T.A., L.J. Buckley, G.C. Laurence, B. Burns, and P. Long. NOAA/NMFS, Northeast Fisheries Science Center, Narragansett Laboratory, Narragansett, RI, 02882. AN OPEN-MESH *IN SITU* ENCLOSURE FOR MARINE LARVAL FISH STUDIES. With early success in open-mesh enclosure systems (Laurence 1979), we felt that this technology offered considerable insight into larval fish growth and survival. New modular chamber systems were designed and deployed at contrasting sites in Narragansett Bay, USA. Design criterion included ease of deployment and retrieval, shoal draft (less than 3m), portability, cost and construction with off the shelf materials. Chambers with a volume of $5m^3$ were constructed in two mesh sizes (200μ and 300μ) and deployed in both open and protected sites. Experiments were conducted with larval winter flounder (*Pleuronectes americanus*) and tautog (*Tautoga onitis*). Prey density and composition were monitored both in the chambers and the surrounding water. Temperature, salinity and dissolved 0_2 were also monitored. Larvae survived only at the most protected site. Larval growth was very high in the chambers at one point exceeding $25\%*d^{-2}$. The limitations and advantages on open-mesh enclosures are discussed relative to other technologies used for the study of larval fish.

Hall, L.W., Jr.[1], M.C. Ziegenfuss[1], and S.E. Finger[2]. [1]The University of Maryland System, Maryland Institute for Agriculture and Natural Resources, Agricultural Experiment Station, Wye Research and Education Center, P.O. Box 169, Queenstown, MD 21658. [2]U.S. Fish and Wildlife Service, National Fisheries Contaminants Research Center, Columbia, MO 65201. A REVIEW OF *IN-SITU* STRIPED BASS CONTAMINANT AND WATER QUALITY STUDIES IN THE CHESAPEAKE BAY WATERSHED. Pollution and fishing pressure have been postulated as the major factors responsible for declining stocks of striped bass along the east coast of the United States. The Chesapeake Bay watershed is the primary spawning area for this anadromous species. Therefore, most of the research designed to evaluate the effects of water quality and contaminant conditions on the susceptible early life stages of striped bass has been conducted in this estuary and it's freshwater rivers. The goal of this review paper is to compare survival data from in-situ striped bass prolarval tests conducted in major Chesapeake Bay striped bass habitats from 1984 through 1990 and discuss possible adverse effects of water quality and contaminant conditions on survival of young larvae in these habitats. Survival of striped bass prolarvae was generally greater in the Upper Chesapeake Bay when compared with the other habitats. Acidic conditions (low pH and Monomeric aluminum) were reported to reduce survival of prolarvae in the Nanticoke River although these conditions were not present every year. Potentially toxic trace metals and naturally occurring reductions temperature (cold shock) were suspected as contributing factors in reducing survival of prolarvae in the Potomac River in four different years.

Hare, J., J. Zehr, and F. Juanes. Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY. A MOLECULAR METHOD FOR THE SPECIES IDENTIFICATION OF FISH LARVAE WITH A RESULTING DESCRIPTION OF *XYRICHTYS NOVACULA* (PISCES: LABRIDAE) LARVAE. Three basic techniques are used for the identification of larval fish: rearing, literature comparisons and the series method. These techniques are of limited use when trying to make species identifications in genera with a large number of closely related species typical of many tropical families. Recently, molecular techniques have been developed which allow meristic and morphological similarity exhibited within some genera to be circumvented by direct comparison of DNA sequences. This paper describes a method which uses the polymerase chain reaction and comparisons of DNA sequences to identify larvae of a tropical wrasse, *Xyrichtys novacula* (Pisces: Labridae). A description of the larvae is also given, as well as possible morphological traits for the separation of X. *novacula* larvae from the other two western Atlantic *Xyrichtys* species.

Heath, A.G.[1], J. Cech[2], J. Zinckle[2], B. Finlayson[3], and B. Fugimara[3]. [1]Virginia Polytechnic Institute and State University. [2]University of California, Davis. [3]California Department of Fish and Game, Pesticides Unit. SUBLETHAL EFFECTS OF RICE PESTICIDES ON LARVAL STRIPED BASS. In the Sacramento River, California, newly hatched striped bass (*Morone saxatilis*) larvae typically get exposed to rice approximately four days as they drift to the San Francisco Bay. This was simulated in the laboratory using individual pesticides and a combination of all three. Concentrations were 1/2 the 96 hr LC50 and a lower level similar to that recorded in the river. Tests on the larvae were performed immediately after the four-day exposures and then again after a 10 day period in non-contaminated water. The pesticides caused no mortality. Sublethal tests included forced swimming performance, spontaneous activity, acetylcholinesterase activity, RNA/DNA ratio, body weight, and several morphometric measures. The most interesting effects were a decreased swimming performance immediately after exposure to parathion at both concentrations. This was associated with a loss of acetylcholinesterase activity. After 10 days in clean water there was still a loss of swimming performance and decreased spontaneous activity in those having been exposed to the high concentration. Molinate caused decreased swimming performance at the high dose both immediately after exposure and subsequently. Surprisingly, molinate also caused an inhibition of acetylcholinesterase but an apparent stimulation of growth rate. Decreases in swimming performance, spontaneous ßactivity and acetylcholinesterase occurred at the high dose of carbofuran immediately after exposure but did not persist in the clean water. Each of the three pesticides caused a change in body shape resulting in a greater dorsal-ventral dimension but little or no change in length. Combining the pesticides yielded results suggesting a less than additive effect. Some of the sublethal effects seen could have implications for recruitment into the already declining populations of striped bass.

Hebert, K.P., W.W. Smoker, J.E. Joyce, and A.J. Gharrett. Juneau Center for Fisheries, Ocean Sciences School of Fisheries and Ocean Sciences, University of Alaska, Fairbanks, 11120 Glacier Highway, Juneau, Alaska 99801. DEVELOPMENT RATE AND INSTREAM SURVIVALS OF EARLY AND LATE-RUN PINK SALMON(*ONCHORYNCHUS GORBUSCHA*). Within each rum of salmon there exists substructure. The substructure may be so strong that the assumption of homogeneity of the run, which is often used in fisheries management and in fish culture, is invalid. For example, freshwater survival of fry from late returning pink salmon in Auke Creek (near Juneau, AK), may be 2 times that of fry from early returning fish, while marine survival of late returning fish may be only 30 percent of early fish. Disregarding these differences may substantially impact production. By breeding a genetic mark into the Auke Creek late returns, we have developed a model system in which the relative survivals of the subpopulations can be partitioned. These two subpopulations maintain some degree of genetic isolation and have different development rates; breeding experiments demonstrate relatively large phenotype variability of embryonic development rate in families spawned in the overlapping tails of the subpopulations. By separately raising a number of families within controlled artificial environments, differences in development rate of each subpopulation. Since the development rate is a key to maintaining these subpopulations and determines timing of major life history landmarks, characterization and comparison of the rates for these two identifiable subpopulations will produce basic biological information for a commercially valuable species that has application to both fisheries management and fish culture.

Higgs, D.M. and L.A. Fuiman. University of Texas at Austin, Marine Science Institute, Port Aransas, TX 78373. LIGHT INTENSITY AND SCHOOLING BEHAVIOR OF LARVAL GULF MENHADEN (*BREVOORTIA PATRONUS*). Schooling behavior was examined in larval (19-22mm SL) *Brevoortia Patronus* under a range of light intensities. Light intensity was decreased to near 0 and then increased back to the initial level while recording the behavior of a group of larvae. Schooling was measured in terms of mean nearest neighbor angle (NNA), mean nearest neighbor distance (NND) and mean speed. There was a significant increase in NNA and NND as light intensity decreased to 0.005 $uE \cdot m^{-2} \cdot s^{-1}$. A smaller, but significant, decrease in NNA occurred as intensity decreased to 0.019 $uE \cdot m^{-2} \cdot s^{-1}$. For a given light intensity NNA was higher when intensity was increasing than when it was decreasing, while NND was lower. Swimming speed decreased significantly as intensity decreased remaining depressed as intensity was decreased back to initial levels. These results suggest that larval menhaden do not school at light intensities below 0.005 $uE \cdot m^{-2} \cdot s^{-1}$ and that schooling ability is suppressed below 0.04 $uE \cdot m^{-2} \cdot s^{-1}$. It also appears that schooling ability is significantly affected by the direction of change of light intensity. We are also investigation the roles of neuromasts and retinal morphology in schooling.

Holt, G.J. The University of Texas at Austin Marine Science Institute, Port Aransas, TX 78373-1267. CAN LARVICULTURE PLAY A ROLE IN ALLEVIATING POPULATION AND HABITAT LOSSES? Water quality changes and habitat degradation are often detrimental to early life history stages of fish. Changes in chemical characteristics such as salinity and dissolved oxygen, and loss of specific habitats required as nursery grounds have been implicated in population declines. On the other hand, the stocking of hatchery reared young has been touted as the answer to declining populations and fisheries yields. There is much debate over the success of various enhancement programs in increasing or even maintaining natural stocks due to genetic changes in the target populations and loss of carrying capacity. The role of larviculture in stock enhancement and aquaculture production is critical for achieving the goals of increased production, but only when coupled with life history considerations. A thorough evaluation of fishery enhancement is needed including genetic characterization of each species, specific guidelines for hatcheries and habitat evaluation. Aquaculture production for food could replace natural production losses and reduce fishing pressure on over-harvested species once controlled spawning and larviculture are established. Closed system culture would reduce the probability of genetic and disease impacts on natural populations. Larviculture of threatened or endangered species would provide information on life history and physiological requirements as well as allow the establishment of gene banks. Aquaculture of tropical fishes would conserve populations by reducing collecting and reef habitat destruction in current practice in the ornamental trade. Finally, the production of test organisms for research, and water quality and habitat evaluation relies on advances in larviculture.

Holt, S.A. University of Texas at Austin, Marine Science Institute, Port Aransas, TX. DISTRIBUTION OF SCIAENID LARVAE ACROSS AN ESTUARINE TIDAL FRONT. Oceanic fronts have been shown to be areas of high productivity with higher densities of larval fishes than in adjacent water masses. Estuarine fronts may also be areas of high productivity tough these areas have not been as well studied as oceanic fronts. Data from a fixed-site study of larval transport in the Aransas Pass, Texas tidal inlet suggested that there were higher densities of red drum larvae associated with frontal boundaries as they moved past our study site. We designed a study to test whether larval sciaenids congregated (or were concentrated) near a tidal front within the estuary. A 15 km transect was established along the longitudinal axis of the Aransas Bay estuary extending from the tidal inlet to > 5 km beyond the maximum reach of the typical tidal prism. The transect was composed of 10 fixed CTD stations, 5 fixed ichthyoplankton stations and 1 or 2 mobile (frontal) ichthyoplankton stations. The transect was sampled eight times over an eight week period, usually during a flooding tide. In general, larval densities were not substantially elevated in the immediate area of the tidal front. Red drum, Atlantic croaker, and *Menticirrhus spp.* larvae (all marine larvae) were consistently more abundant on the oceanic side of the front than on the estuarine side while densities of spotted seatrout larvae (an estuarine spawner) showed no particular pattern relative to the tidal front. The tidal front acts as at least a temporary boundary impeding up-estuary movement of marine larvae.

Hoss, D.E. NOAA, NMFS, Beaufort Laboratory, Beaufort, NC 28516-9722. THE IMPORTANCE OF HABITAT TO THE EARLY LIFE HISTORY OF ESTUARINE DEPENDENT FISH. The statement is often made that "the size and vitality of coastal fish populations are dependent on the quantity and quality of their habitat." Intuitively, this statement must be true, but what do we really know about the importance of specific habitats to the survival of the early life stages of fish? What is habitat with respect to larval fish? In this paper, I review some of the various definitions of habitat that have been put forth and then review recent literature that has attempted to examine the association of early life history stages of fish with specific habitats. Most of my examples are taken from coastal estuarine dependent species but my conclusions apply to early life history stages in general. Finally, I speculate on what would happen if certain types of habitat were lost of degraded and suggest some research that might further our knowledge in this area.

Howell, P. Connecticut Department of Environmental Protection Marine Fisheries Division, P.O. BOX 248, Waterford, CT 06385. CERTAIN DECISIONS WITH UNCERTAIN DATA. Habitat issues usually present an intractable problem for fisheries managers. although all management strategies suggest that productive habitat is needed to sustain fish populations healthy enough to allow for substantial harvest, weighing the importance of losses due to poor environmental conditions against losses due to fishing is extremely difficult. In order to manage a fishery, managers need to know if, under certain levels of fishing mortality, that a population will persist, that the quantity of yield produced will be maintained, and most importantly that the quality of the remaining stock will be maintained. In order to superimpose habitat mortality - or lack of production - onto fishing mortality, a manager must obtain relative results to these questions with and without ideal habitat conditions. A relative scale of habitat quality can be generated by stylizing a pollutant effect which occurs with a patchy distribution through space. Each population in question must then be bounded in space, and the spatial structure of the populations and the pollutant become replicates on a relative scale of effects. These steps in simplification, as well as the bounding of populations that actually intermix, can make this process very subjective. In order to move this process into the realm of public law making, this subjectivity must be minimized. One approach, which compares winter flounder growth in five areas, is discussed.

Kaupp, S.E. Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093-0202. WHITE TRUNK MUSCLE CONCENTRATION OF RNA WAS FOUND TO TRACK GROWTH RATE IN LARVAL AND JUVENILE CHUB MACKEREL *SCOMBER JAPONICUS* NORTHERN ANCHOVY *ENGRAULIS MORDAX*, AND CALIFORNIA HALIBUT, *PARALICHTHYS CALIFORNICUS*. The concentration of RNA in the white trunk muscle of individual fish, from first-feeding larvae to juveniles (to about 1 g wet weight) was found to be directly proportional to growth rate regardless of species, fish weight, or life stage. The fast growing mackerel, moderate growth rate anchovy and very slow growing California halibut were found to have the same relationship between white muscle RNA concentration and growth rate. The halibut were reared at 6 different temperatures from 16C to 26C. Thermal compensation was seen in the concentration of muscle RNA of juvenile halibut, i.e. the concentration was inversely related to rearing temperature. The often useed ratio of the concentration of RNA to DNA was not used. The concentration of DNA was inversely proportional to the muscle fiber volumes, which increased throughout the early life of the fish. The use of florescent dye ethidium bromide to sequentially determine RNA and DNA concentrations of small tissue samples will be discussed. The work was completed while the author was supported, in part, as a Sea Grant trainee (Drs. G.N. Somero and J.R. Hunter, advisors), and the research was supported, in part, by National Sea Grant College Program, NOAA, and California Sea Grant projects RF-102 and RF-116.

Kaupp, S.E. Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093-0202. THE ACTIVITY OF METABOLIC ENZYMES OF THE WHITE TRUNK MUSCLE OF LARVAL AND JUVENILE MARINE FISHES CORRELATES WITH WHOLE FISH METABOLIC RATES. The activity of the metabolic enzymes citrate synthase (CS, mitochondrial) and lactate dehydrogenase (LDH, glycolytic) of the white trunk muscle of larval and juvenile fish was correlated with whole fish energetics. Whole fish energetics were determined in two different ways. 1) The ontogenetic scaling of power for locomotion was determined from hydrodynamic theory for low speed (sustained) and high speed (burst) swimming for the larval fish during the transition from a hydrodynamic regime dominated by viscous forces (first-feeding larva, $Re<10$) to that dominated by inertial forces (circa 10 mm or greater length, $Re>1000$). The larval fish swimming muscle CS activity was found to scale with fish mass as would be predicted for sustained swimming at the same relative speeds (BL/s). The activity of LDH in the larval swimming muscles scaled with a mass exponent similar to that predicted for burst swimming during ontogeny. 2) The whole fish oxygen consumption of larval and juvenile California halibut, Paralichthys californicus, was measured for resting and digestive) i.e. with full stomach and associated SDA) states. The activity of white muscle CS was found to correlate with the whole fish resting oxygen consumption, and white muscle LDH activity was found to correlate with maximum digestive oxygen consumption rates. The use of metabolic enzyme activities of white swimming muscle to track whole fish metabolic rates offers the potential to follow energetics in field-collected fish. The work was completed while the author was supported, in part, as a Sea Grant trainee (Drs. G.N. Somero and J.R. Hunter, advisors), and the research was supported, in part, by National Sea Grant College Program, NOAA, and California Sea Grant projects RF-102 and RF-116.

Kendall, A.W., Jr.[1], L.S. Inzce[2], P.B. Ortner[3], S.R. Cummings[3], and P.K. Brown[1]. [1]NOAA, Alaska Fisheries Science Center, 7600 Sandpoint Way N.E., Seattle, WA 98115. [2]Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME 04575. [3]NOAA, Atlantic Oceanographic and Meteorological Laboratory, 4301 Rickenbacker Causeway, Miami, FL 33149. FACTORS INFLUENCING THE DEPTH OF WALLEYE POLLOCK EGGS AND LARVAE IN SHELIKOF STRAIT, GULF OF ALASKA. The vertical distribution of walleye pollock eggs and larvae in Shelikof Strait, Gulf of Alaska, was investigated using the results of 36 MOCNESS tows taken through their April-May season of occurrence in 1986-88. These results are discussed in relation to environmental observations made concurrent with the tows and laboratory observations on feeding and behavior of the larvae. The eggs were found to reside mainly from below 150 m to the bottom near 300 m. A distinct pattern of differences in depth of occurrence during development was noted. However, the eggs seemed not to vary their vertical distribution in relation to differences in density of the ambient water, within the ranges observed here. Larvae hatch at the depths of occurrence of eggs, but rise quickly to the upper 50 m of the water column where they remain during larval development. Because of the inverted temperature structure of the water column in the area in spring, the larvae encounter lower temperatures in the upper water column than did the eggs at depth. The upper water column slowly warms from about 3° to 6° C during the larvae period. Within the upper 50 m of the water column the larvae undergo limited vertical migration on a diel cycle . Their mean depths of occurrence were between 21 and 37 m at all times. They are deepest during the day, shallowest in the evening, sink slightly at night, and sink more in the morning. This pattern allowed the larvae to remain at depths where sufficient light for feeding exists during twilight. Concentrations of prey (copepod nauplii) were above feeding threshold levels in this depth range. Larvae avoid the upper layers of the water column during midday and windy conditions. A pronounced temperature and density gradient was observed in the part of the water column inhabited by the larvae late in the season.

Kingsford, M. and I. Suthers. University of Sydney, NSW 2006, Australia. DYNAMIC ESTUARINE FRONTS: IMPORTANCE TO SMALL FISH. The coast of NSW, Australia, is characterized by large estuaries and enclosed bays that are bordered by reef environments, conspicuous plumes are generated in these areas. Estuaries are subject to intense tidal flushing and variable input of freshwater according to rainfall. Plumes from estuaries extend up to 10km across the continental shelf; the edge of plumes are demarcated by a front. The position of fronts change according to state of the tide, they were closest to shore on the flood tide. The shape of fronts is influenced by coastal currents that reverse in direction. Fish and plankton were sampled on small (100-200m each side of and in the fronts) and large scales (> 5km from fronts). Oceanography influenced the distribution of fish in the vicinity of fronts and for meroplankton in fronts transport was along the front. Fronts affected taxa in different ways, some fish accumulated in fronts while the front acted as a border in the distribution of other species. On large scales, the distribution patterns of some fish were unrelated to the presence of fronts. The importance of fronts to the early life history and subsequent survivorship of fish is discussed.

Landahl, J.T. and L.L. Johnson, Environmental Conservation Division, Northwest Fisheries Science Center, NMFS, NOAA, Seattle, WA 98112. MARINE POLLUTION AND FISH POPULATION PARAMETERS: ENGLISH SOLE IN PUGET SOUND, WA. The potential impact of contaminant-related mortality and reproductive impairment on the population growth rate in English sole was examined using techniques of simulation modelling. A preliminary Leslie matrix population model was constructed for use in investigating contaminant effects. Population mortality rates for English sole at contaminated and uncontaminated sites in Puget Sound and for animals with and without selected major hepatic diseases (e.g., neoplasms, preneoplastic lesions, and toxicopathic degenerative conditions) were estimated from recent historical data using catch-curve analysis. Age-specific fecundity was determined from previously collected English sole ovary samples. Existing data on the effects of contaminants on reproduction, including impaired gonadal development, reduced spawning ability, and decreased egg and larval viability, were incorporated into the fecundity component of the model. Predictions of this preliminary model indicate that the decrease in reproductive output in fish exposed to high contaminant levels is sufficient to produce a substantial reduction in the population growth rate.

Lankford, T.E. and T.E. Targett. University of Delaware, Graduate College of Marine Studies, Lewes, DE 19958. PREY SELECTION BY JUVENILE WEAKFISH, *CYNOSCION REGALIS*: EFFECTS OF RELATIVE PREY ABUNDANCE, BEHAVIOR, AND PROFITABILITY ON FORAGING SUCCESS AND GROWTH. Mysids (*N. americana)* and sand shrimp (*Crangon septemspinosa*) account for the majority of prey consumed by juvenile weakfish (50-80mm SL) in Delaware Bay. Field evidence suggests that qualitative differences in the diet of juvenile weakfish influence patterns of growth and condition in estuarine nurseries. Juvenile condition factor and gut fullness appear positively correlated with the proportion of *N. americana* in the diet. Using *N. americana* and *C. septemspinosa* as prey, we performed laboratory experiments to 1) assess juvenile weakfish prey selectivity at 5 relative prey abundance levels, 2) investigate pre- and post-consumptive factors which potentially influence selective predation by juvenile weakfish, and 3) compare the energetic response of juveniles preying exclusively on *N. americana* versus *C. septemspinosa*. In prey selection trials, juveniles exhibited positive selectivity for *N. americana* when allowed to forage on both prey. Overall foraging success declined as relative mysid abundance declined, despite a tendency for juveniles to increase their consumption of *C. septemspinosa*. While pre-consumptive factors (e.g. prey activity, evasiveness, capture success) undoubtedly contribute to selective predation by juvenile weakfish, we suggest that relative prey profitability was influenced primarily by gastric evacuation rate/feeding capacity. Dietary inclusion of *C. septemspinosa* occurs in response to decreased encounter rates between juvenile weakfish and their preferred prey *N. americana*. The energetic consequences of preying on *C. septemspinosa* appear to be reduced capacity for feeding and growth.

Libby, D.A. Maine Department of Marine Resources, West Boothbay Harbor, ME 04575. SOMATIC AND OTOLITH GROWTH OF REARED AND WILD ATLANTIC HERRING LARVAE (*CLUPEA HARENGUS* L.). Somatic and otolith growth were related to age for populations of reared and wild caught herring (*Clupea harengus* L.) larvae. Scottish Clyde and Baltic Sea herring eggs were fertilized, hatched and reared and subjected to four different feeding regimes. Two treatments of Clyde and Baltic larvae were fed Artemia nauplii, and three treatments of Clyde larvae were fed rotifers that were raised on yeast, *Isochrysis* and *Nanochoropsis* algae. Environmental variable, (water temperature, salinity and photoperiod) were ambient for all treatments. Clyde larvae were reared for 65 to 72 days; length at hatching was about 10 mm and final length was 26 mm. Baltic larvae were 7 mm at hatch and attained a length of 18.5 mm at 44 days. Two additional treatments were derived from herring larvae collected in two gulf of Maine coastal estuaries. Measurements were made on total larval length and the removed sagittal otoliths for all larvae. The ages of wild larvae were estimated form otolith ring counts. Parameters for somatic and otolith growth rates were compared between the seven treatments. Growth rates for larvae ranged from 0.18 to 0.39 mm. day $^{-1}$, and for otoliths, 1.5 to 3.8 μ . day $^{-1}$. There were significant differences (ANACOV) between some treatments for larval and otolith growth rates. The growth of otolith to somatic growth rates for treatments declined with increasing larval growth rates. Slower growing herring larvae have larger otoliths than faster growing larvae at the same size. Preliminary analysis shows that age is possibly a function of the relationship between larval and otolith lengths for the combined treatments.

Little, E.E. and A.J. DeLonay. U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, 4200 New Haven Rd., Columbia, MO 65201. BEHAVIORAL IMPAIRMENTS IN CONTAMINATED ENVIRONMENTS: IMPLICATIONS FOR THE SURVIVAL OF EARLY LIFE STAGE FISH. Early life stage fishes are typically less tolerant of environmental contamination than later juvenile or adult life stages. However, laboratory observations of contaminant-induced larval mortality do not always correlate will with the response of natural populations to contaminants, and are not necessarily the best predictor of survival in the field. In addition, incidents of mortality among early life stages are rarely observed in the field, and the more pervasive and subtle sublethal exposures that diminish long-term survival of these life stages would probably not be detected at all. Many behavioral functions essential for survival and growth are known to be dramatically impaired by sublethal exposure to toxicants, and impairments of these critical behavioral functions should be reflected in population-level responses such as reduced size, biomass, and year-class success. Habitat selection may be altered by contaminant-induced avoidance reactions that displace fish from preferred habitats to conditions less favorable for survival Contaminants may also reduce sensitivity or responsiveness to important environmental stimuli such as light, temperature, or salinity. Competition for limited resources and aggressive responses arising from competition may increase the stresses of contaminant exposure. Contamination also influences predator-prey interactions, both by decreasing foraging responses, as well as increasing vulnerability to predation by other organisms. Behavioral responses important in habitat selection, foraging, predator avoidance, and competition, such as swimming, feeding and social behaviors, can be effectively measured in a variety of fish species to characterize the consequences of sublethal exposure to a range of chemical stressors.

Litvak, M.K.[1] and W.C. Leggett[2]. [1]Huntsman Marine Science Centre, St. Andrews, NB EOG 2X0, Canada. [2]Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, PQ EOG 2X0, Canada. GAMBLING ON PREDATION: ANTI-PREDATION STRATEGIES IN THE EARLY LIFE HISTORY OF FISHES. Predation has been recognized as a major agent of Larval fish mortality. The potential for phenotypic selection through predation is therefore strong. The dominant hypothesis in the literature is that smaller larvae are at a survival disadvantage under predation pressure (the "bigger is better" hypothesis). However, our experimental research on the influence of larval size, within a single aged cohort, on vulnerability of capelin larvae *(Mallotus villosus)* to predation has shown that smaller size at age can actually provide a refuge against predation. We found that, contrary to expectation, when visual predators (three-spined sticklebacks; *Gasterosteous aculeatus)* were presented with a choice between large and small capelin larvae of the same age, they consistently consumed larger larvae. These results suggest that multiple strategies may be available to fish larvae to enhance their survival and, ultimately, their recruitment into the adult stock. In this paper we present a number of possible strategies based on these experimental results that could minimize a larva's vulnerability to predation. These are summarized as conceptual and mathematical models. We also present a framework for future analysis and experimentation this area.

Loeb, V.J.[1] and A.F. Amos[2]. [1]Moss Landing Marine Laboratories. [2] Marine Science Institute, University of Texas at Austin. ELH POSTER SESSION ABSTRACT: VERTICAL DISTRIBUTION OF LARVAL FISH AT A TIME-SERIES STATION IN GERLACHE STRAIT, ANTARCTICA, NOVEMBER 1989. Larval fish were obtained from 27 vertically stratified MOCNESS tows (9 depth strata, 0-290 m) taken at a time series station in Gerlache Strait during RACER (Research on Antarctic Coastal Ecosystem Rates) field operations in November 1989. All tows contained fish and yielded a total of 616 specimens representing 12 species. Three species of Nototheniidae, *Notatheniops larseni, Trematomus lepidorhinus and T. newnesi,* dominated. Most of the larval fish were collected in the upper 90 m. The three abundant nototheniid species had significantly different vertical distribution patterns and significantly different size distributions within depth intervals. The vertical distribution patterns of pooled larval fish do not show day-night changes. However, a general deepening occurred on the second day and was associated with a reduction in larval abundance. These changes are related to changes in water column structure over the study period.

MacLean, S.A. National Marine Fisheries Service, Northeast Fisheries Science Center, Narragansett, RI 02882-1199. GROSS AND MICROSCOPIC OBSERVATIONS ON NARRAGANSETT BAY YOUNG-OF-THE-YEAR WINTER FLOUNDER. Young-of-the-year (YOY) winter flounder were collected at three sites (Gaspe Point, Fogland, and Prudence-Patience Islands) within Narragansett Bay. A total of 61 specimens were collected from the three sites in June and 51 in August of 1990. Trematode metacercariae were rarely found in the June specimens at any site, but were common in the August specimens from the Fogland and Prudence-Patience sites (97% and 100% prevalence, respectively). Histologic observations revealed infections by gut trematodes, gill epitheliocystis and various protozoans. Results will be discussed relative to age and possible prey consumed.

Malloy, K.D. and T.E. Targett. University of Delaware, Graduate College of Marine Studies, Lewes, DE. THE INFLUENCE OF RATION LIMITATION ON THE GROWTH, SURVIVAL AND BIOCHEMICAL CONDITION OF JUVENILE SUMMER FLOUNDER *(PARALICHTHYS DENTATUS)* AT EARLY SPRING TEMPERATURES: EVIDENCE FROM THE LABORATORY AND THE FIELD. Laboratory studies are being conducted to determine the effects of restricted ration and temperature on the growth, condition, and survival of juvenile summer flounder *(Paralichthys dentatus)* from Delaware and North Carolina estuaries. Laboratory data show that growth rates of Delaware juveniles are sensitive to ration limitation at early spring temperatures (10-16°C), when growth first becomes positive. Feeding *ad libitum*, juveniles from North Carolina appear to have lower growth rates than those from Delaware at the same temperature. Various biochemical indices were tested for significant correlations with growth rates of fish in the laboratory. RNA:DNA ratio was found to be the best predictor of measured growth rates. RNA:DNA ratios of fish from nursery areas in Delaware and North Carolina are being determined throughout the winter and spring to assess the degree of growth limitation experienced in the field. Variability in the annual timing of the onset of temperatures conducive to positive growth and the timing of high prey densities may interact to affect growth and survival of juvenile summer flounder. Latitudinal differences in growth rates of juvenile summer flounder may provide additional evidence for the existence of multiple stocks. The results will also shed light on the importance of ration limitation to growth of early juveniles, and on the important factors controlling recruitment at different latitudes in Atlantic coast nursery grounds.

Marliave, J.B. Vancouver Aquarium, PO Box 3232, Vancouver, B.C. V6B 3X8, Canada. NATURAL HISTORY DISCOVERIES IN ENVIRONMENTAL SCIENCE. Institutions can play a role in environmental science complementary to academia and government through emphasis on descriptive natural history. Such basic research should anticipate the integration of discoveries into the study design. Too often, especially in the marine realm, environmental issues cannot be enunciated correctly, for lack of baseline data. Discoveries are equally likely in the field and in laboratory situations; the keys are presence and the latitude to pursue the discovery. Examples of discoveries from field versus lab situations involve gadoid and cottid species. An effort to document late larval herring habitat led to discovery of cod and pollack distributions in association with shoreline discontinuity boundaries. In the laboratory, observations from rearing of red Irish lord larvae led to a new interpretation of bimodal size distributions in field catches; intermediate larval stages may drop out of the plankton in favor of extreme nearshore distribution, then re-enter the plankton.

Martin, D.L. and T.E. Targett. University of Delaware, Graduate College of Marine Studies, Lewes, DE 19958. LATITUDINAL VARIATION IN GROWTH OF JUVENILE *TAUTOGA ONITIS* (LABRIDAE): PRELIMINARY LABORATORY AND FIELD OBSERVATIONS. The capacity to compensate for shorter growing seasons as a function of latitude (i.e. countergradient growth variation) is being investigated in the tautog, *Tautoga onitis*. This species has potential for population segregation given that it typically spawns near or within bays, returns each year to spawn at particular reefs, has only a 3 week larval (planktonic) stage, and overwinters in local waters. Seasonal growth rates of field-caught juvenile T. onitis from 5 bays, spanning 5 degrees of latitude, were estimated from size-frequency distributions, and show that fish from Virginia are 2x larger than fish from Rhode Island by age 1. However, previous research shows that annual growth rates of age 1^+ fish from these two sites are equal. Growth rates of field-caught juveniles (from VA, DE, and RI) are being evaluated over a broad range of temperatures (5-25°C). Our preliminary data show no significant growth differences between age O VA, age O RI, and age 1 RI fish when grown at 20°C in the laboratory. These data indicate that high latitude populations of T. onitis do not show genetic compensation for a shorter growing season, although the potential for low temperature compensation remains. Growth differences observed in the field are probably due to environmental factors (e.g. latitudinal temperature gradients).These results are further corroborated by observations on otolith weight.

Miller, J.D. Northeast Utilities Environmental Laboratory, Millstone Nuclear Power Station, P.O. Box 128, Waterford, CT 06385. TIDAL SAMPLING TO DETERMINE THE SOURCE OF WINTER FLOUNDER LARVAE IN NIANTIC BAY, CT. Winter flounder apparently return to their natal estuary to spawn and the major source of larvae in Niantic Bay was assumed to be the adjacent Niantic River, which has a known spawning stock. In 1991 three stations in Niantic Bay were sampled to determine larval winter flounder abundance and spatial distribution relative to tidal currents. Samples were collected with a bongo system during March through May, two days a week near the time of maximum ebb and flood tidal currents. Early in the larval season the primary source of larvae appeared to be the Niantic River, but as the season progressed the major source was from Long Island Sound. Many older larvae entered the bay from the east during a flooding tide and from the west during an ebbing tide. The results of this study suggested that many of the older larvae in Niantic Bay originated from spawning stocks other than the adjacent Niantic River. These results were compared to empirical mass-balance calculations and hydrodynamic model predictions.

Miller, T.J., T. Herra, and W. C. Leggett. Department of Biology, McGill University, 1205 Ave. Dr. Penfield, Montreal, PQ H3A 1B1, Canada. DISTRIBUTION AND CHARACTERISTICS OF INDIVIDUAL COD (*GADUS MORHUA*) LARVAE ON THE SCOTIAN SHELF. As a part of the Ocean Productivity Enhancement Network (OPEN) programme we conducted monthly sampling for cod eggs and larvae on the Scotian shelf. We collected samples on a 45 station grid covering approximately 110 km^2. The project focuses on identifying if individuals that survive to the benthic juvenile phase are a random subset of the entire spawned cohort. Cod eggs were first collected in October, over the centre of a bank within the sampled grid. They became more widely dispersed through the season, but remained restricted to the bank. Egg abundances peaked in December, and declined thereafter. There was evidence that spawning continues until May. Data from eggs incubated on board display a significant increase in larval hatching size during the spawning season, despite the lack of a similar trend in egg size. Analysis of morphometric data of larvae collected at sea indicate a prolonged spawning period. Larval distributions were patchy, but were most abundant over the bank, with larger larvae concentrated at the centre of the bank. This suggests either that there is little dispersion from the site at which individuals are spawned, or the presence of a mechanism on the bank concentrating larvae at centre of a retention zone.

Monosson, E. North Carolina State University, Raleigh, NC 27604. BIOCHEMICAL INDICATORS OF CHEMICAL CONTAMINATION: POTENTIAL USE IN ASSESSMENT OF POPULATION LEVEL CHANGES. Biological monitoring is an important aspect of many coastal and estuarine monitoring programs. The ultimate goal of many of these programs is to assess exposure to chemical contaminants with an emphasis on ecologically significant changes e.g. changes in population size or structure. Biological indicators employed in monitoring studies include measurements ranging from those at the cellular or biochemical level to measurements relating to population level responses such as reproductive success, growth and survival during the egg and larval stages. The advantages of biochemical markers include the ability to detect exposure to small concentrations of specific families of chemicals (thus providing an early warning system) may in some cases by outweighed by the desire to provide information concerning population level effects (which at this point may only be detectable after long term exposure or exposure or exposure to higher concentrations of pollutants). We have designed a study to assess the relationship between biochemical measurements in adult female white perch at the biochemical level to measurements of reproductive success (including early life history stages) following exposure to a common coastal contaminant. We have also explored the possible inclusion of select biochemical indicators in models designed to predict population level responses to environmental contamination.

Monteleone, D.M.[1], E.D. Houde[2], L.G. Morin[2], and D.H. Secor[2]. [1]Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY 11794-5000. [2]Chesapeake Biological Laboratory, Center for Environmental and Estuarine Studies, The University of Maryland System, Box 38, Solomons, MD 20688-0038. IMMERSION MARKING OF OTOLITHS OF STRIPED BASS, *MORONE SAXATILIS*, EGGS AND LARVAE USING TETRACYCLINE HYDROCHLORIDE AND ALIZARIN COMPLEXONE. Techniques to incorporate vital stains into otoliths of striped bass embryos and larvae as chemical time checks to be used in larva mark-recapture studies were developed using tetracycline hydrochloride (TC) and alizarin complexone (AC). Experimental variables included developmental stage of striped bass, temperature, chemical concentration, duration of exposure and water type (deionized vs. hatchery water). Survival and growth of larvae were monitored after immersion. AC did not require deionized water and overall was easier to use and more effective than TC. Embryos were immersion-marked within 10 h of hatching or at the time of tailbud separation from the yolk. Larvae were marked at 6-7 and 11 days after hatch. Embryos were easier to handle than larvae and could be concentrated at relatively high densities (800 L^{-1}) during the marking procedure. Using epifluorescent microscopy, marks were detected 24 h after immersion on the otolith cores of embryo-marked individuals and on daily rings of individuals marked as larvae. Both TC and AC produced high quality marks, but the AC mark was more distinct. Multiple marks, placed on otoliths by immersion of individuals on alternate days, were well-defined, serving as unique identifiers and time checks. Recommended concentrations for high survival and mark quality for either embryos or larvae were 6-h immersion at 16-19°C in 400 mg TC L^{-1} or 25-50 mg AC L^{-1}.

Monteleone, D.M.[1], E.D. Houde[2], L.G. Morin[2], and D.H. Secor[2]. [1]The University of Maryland System, Center for Environmental and Estuarine Studies, Chesapeake Biological Laboratory, Solomons, MD 20688-0038. [2]Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY 11794-5000. A LARVAL MARK-RECAPTURE EXPERIMENT TO STUDY EARLY LIFE POPULATION DYNAMICS AND RECRUITMENT IN STRIPED BASS. In April and May 1991 nearly seven million 9 and 12 day-old larvae were released on two occasions at two different sites in the upper Patuxent River (Chesapeake Bay). Release groups were marked uniquely by immersing eggs and larvae in solutions of alizarin complexone to mark their otoliths at different ages. Ichthyoplankton was sampled to measure recapture rates of released larvae and to estimate vital rates of released and naturally spawned larvae. Three egg production peaks occurred in April during periods of rising temperature and were separated by periods of low temperatures ($\leq 14^{o}C$). Few yolk-sac larvae survived from the two earliest peaks. A pattern of episodic losses of eggs and yolk sac larvae due to low temperature events was suggested by the data. In five sureys, spanning 7 days subsequent to the first group's release, 77% of sampled larvae in the size range of 5-7 mm, SL (N=110/77; marked/unmarked) contained an alizarin complexone mark. Otoliths from juveniles collected in the summer also were examined and 24% of sampled juveniles (N=20/63; marked/unmarked) contained a mark. Marks unique to the release groups indicated that 80% of the marked juveniles were from the first release group. In July 1991 tagged hatchery-reared juveniles were released into the Patuxent River. Based on the proportion of marked juveniles (larval-release) to tagged juveniles (juvenile-release), we estimated that 32,000 marked juveniles survived in the Patuxent River; survival over 83 days was 0.46 percent. Therefore, stocking 32 million 9-day old larvae could have resulted in a two-fold increase in juvenile abundance.

Muelbert, J.H. Department of Oceanography, Dalhousie University, Halifax, NS B3H 4J1, Canada. THE RELEVANCE OF THE FEEDING ENVIRONMENT OF HERRING (*CLUPEA HARENGUS*) LARVAE TO THEIR RETENTION OFF SW NOVA SCOTIA, CANADA. The herring stock hypothesis presumes that the spatial correspondence between large larvae aggregatios and well-mixed areas is determined through active behavior, and that these retention areas are occupied in spite of their particular food characteristics rather than because of them. Food availability, larval abundance and condition were compared in stratified and well-mixed waters, in order to evaluate the importance of the feeding environment to the maintenance of a persistent herring larvae aggregation off SW Nova Scotia. Two transects were made across this aggregation employing a 61 cm Bongo frame with a 505 um-mesh net towed obliquely to sample the larvae, and a 40 cm Bongo frame with 53 ,um-mesh hauled vertically to collect the microzooplankton. Larval abundance was always higher in the well-mixed waters, with mean densities changing abruptly from 256 to 5.9 larvae.m^{-2}. The biomass of different size classes of microzooplankton (50-400 um) was uniform along the transects, oscillating between 0.2 to 0.4 $g.m^{-2}$, and did not show any significant difference between areas. The results of larvae condition are expected to follow that of the food concentration. The evidence presented in this study is consistent with the interpretation that the larvae are found in the aggregation areas for reasons other than relative differences in food abundance.

Nixon, S.W. and C.M. Jones. Applied Marine Research Laboratory, Old Dominion University, Norfolk, VA 23529-0456. RECRUITMENT OF ATLANTIC CROAKER TO CHESAPEAKE BAY. We present the patterns of seasonal growth, and movement of Atlantic croaker, *Micropogonias undulatus*, based on the over 600 larvae and juveniles aged through daily increments in otoliths. Size and age distributions indicate estuarine migration from offshore spawning locations. Young Atlantic croaker in the Chesapeake Bay also reveal the seasonal pattern of growth shown by Warlen (1982) for croaker larvae collected in North Carolina's coastal waters, south of Cape Hatteras. Croaker born early in the spawning season grow faster than those born later. When comparable age ranges are considered between Chesapeake Bay and Warlen's Beaufort Sound fish, Chesapeake Bay fish are shown to grow almost twice as fast. Such differences in growth tend to support Conover's hypothesis of countergradient variation in growth in the early life stages of marine fishes. We also show that the patterns of growth are different between seaside and bayside caught fish.

Norcross, B.L. Institute of Marine Science, University of Alaska Fairbanks, Fairbanks, Alaska 99775-1080. LARVAL FISHES OF THE NORTH PACIFIC—ALASKA TO HAWAII. Ichthyoplankton were collected on a cruise from Seward, Alaska to Honolulu, Hawaii in February 1991. A MOCNESS was deployed at two stations nearshore at Resurrection Bay (Seward), six stations along the shelf break off Kodiak Island (149°W to 158°W), and approximately every 100 mm along 158°W (Shumagin Islands, 55°N, to Oahu, 22°N). The upper 500 m were sampled in 100 m depth increments. A total of 26 stations were sampled and 169 samples collected. Concurrent salinity and temperature profiles were recorded. The tow compositions changed from primarily zooplankton and few fish larvae in northern areas to greater numbers of fish and larvae and less volume of zooplankton in southern waters. Representatives of at least 26 families were collected. Of the 1,080 fish collected, 60% were Myctophidae, and 30% were Gonostomatidae. The remaining 10% contained some individuals rarely seen. This represents the first open ocean collection of larval fish in this area of the North Pacific in the winter.

Ozkizilcik, Sureyya, and Fu-Lin E. Chu. Virginia Institute of Marine Science, School of Marine Science, The College of William and Mary, Gloucester Point, VA 23062. EVALUATION OF OMEGA-3 FATTY ACID ENRICHMENT TECHNIQUES FOR *ARTEMIA* USED AS FOOD SOURCE FOR STRIPED BASS (*MORONE SAXATILIS*) LARVAE. Three enrichment techniques were evaluated for their efficiency in improving the dietary value of Artemia nauplii fed to striped bass larvae. Newly hatched Artemia nauplii from the Great Salt Lake (GSL, Utah) were enriched for 24 h by using the following diets; 1) gelatin-acacia microcapsules containing menhaden oil rich in omega-3 polyunsaturated fatty acids (PUFA), primarily 20:5w3 (eicosapentaenoic acid), 2) an emulsion of baker's yeast and menhaden oil and 3) marine *Chlorella* sp. Unfed San Francisco Bay (SFB, California) and GSL nauplii were used as controls. Enriched GSL (all three diets) and unfed SFB nauplii had significantly higher ($P<0.05$) levels of 20:5w3 than the unfed nauplii from GSL. Seven days post-hatched striped bass larvae were reared for 21 days on enriched or unfed nauplii. On day 21, wet weight and total length of striped bass larvae fed enriched GSL nauplii and unfed SFB nauplii were determined to be significantly greater ($P<0.05$) than those fed unenriched GSL nauplii. The enrichment of the GSL nauplii appeared to provide enhanced nutrition for the striped bass larvae including needs for omega-3 PUFA.

Papoulias, D.[1] and W.L. Minckley[2]. [1]U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, 4200 New Haven Rd., Columbia, MO 65201. [2]Department of Zoology, Arizona State University, Tempe, AZ 85287-1501. EFFECTS OF FOOD AVAILABILITY ON SURVIVAL AND GROWTH OF POND-REARED LARVAL RAZORBACK SUCKERS. The reasons for consistent failure of razorback sucker *Xyrauchen texanus* year classes in Lake Mohave, Arizona-Nevada, are not entirely understood. To date, egg and larval predation by nonnative fishes is considered the most likely explanation but food limitation may influence larval mortality. Our experiments in rearing of razorback sucker larvae in ponds fertilized at three levels, ("high", "medium", and "low"), with mean invertebrate densities of 43.3, 23.7, and 12.5 organisms/L respectively, did not result in significant differences in larval survival (77.0, 89.8, and 67.4%, respectively). However, total larval growth was greater at the two higher invertebrate densities. Biovolume of food but not numbers of food organisms in guts increased linearly with growth of larvae. Numbers and biovolumes of food items did not differ relative to fertilization treatment. First foods of larval razorback suckers were diatoms, detritus, and algae. Soon thereafter, small rotifers and chironomids were taken with larger organisms, primarily cladocerans, selected by larger larvae. Year-class failure of razorback sucker in Lake Mohave may be attributable to nutritional deficiency at the lowest recorded densities of reservoir zooplankton. However, starvation or food related problems do not seem likely explanations at the higher Lake Mohave zooplankton densities since these were greater than or equal to invertebrate densities in our "low" treatment ponds.

Pereira, D.L., R. Bruesewitz, T. Heinrich, and D. Williams. Minnesota Department of Natural Resources, Section of Fisheries, 1200 Warner Road, St. Paul, MN 55106. WALLEYE RECRUITMENT IN MINNESOTA'S LARGE LAKES: A SYNTHESIS OF CONTEMPORARY AND HISTORICAL ASSESSMENT. There are ten lakes in Minnesota classified as "large walleye lakes" (greater than 6,000 ha). Walleye (*Stizostedion vitreum vitreum*) is the top piscivore and yellow perch (*Perca flavescens*) is a dominant forage species in these lakes. We developed suitable log linear models using CPUE in standard assessment gillnets to index year class strength. As anticipated, walleye recruitment was highly variable within any given lake. Significant correlation in recruitment existed only between certain pairs of lakes and was stronger during recent years (i.e., 1984-1990). There was no single year with consistent recruitment across all lakes. We analyzed juvenile walleye assessment data for several lakes from 1984 to the present. Traditionally, juvenile walleyes have been indexed using standardized beach seining in mid-summer. It is quite common that seine CPUE does not index recruitment and we conjecture that year class strength is not determined until after the middle of the first growing season. However, size and growth of juveniles by mid-summer are correlated with eventual recruitment. In several lakes, either average size or growth of juveniles sampled by seining during July accounted for approximately 65% of the variation in recruitment. These finding suggest the possibility that conditions for growth during the larval stage may influence year class strength by controlling subsequent mortality rates. We discuss the relevance of these data to management objectives and review the need for sampling earlier life stages.

Pond, R.B. Executive Director, Stripers Unlimited, Inc., P.O. Box 3045, So. Attleboro, MA 02703. IS WATER QUALITY A FACTOR IN STRIPED BASS STARVATION? For 22 years Stripers Unlimited has observed and studied striped bass. Initially our observations were of the eggs and larvae of striped bass from the Choptank and Nanticoke Rivers in Maryland. There was high mortality at all levels of development. Analysis of the eggs revealed extremely high levels of PCBs and DDT. More recently we have been studying the scientific consensus that both male and female striped bass are able to spawn in successive years as stated by David B. Groman. Mature females spawn all their eggs and connective tissue in a single pulse. On the spawning grounds, males and females roll on the surface, the females expelling eggs and the males milt. In the hatchery, ripe females cannot be stripped of eggs until the blood supply to the ovaries is cut off. She then releases all her eggs and the connective tissue freely. During the past year we autopsied 100 striped bass taken from 6 distinctly different areas; 2 areas in Maryland, 1 in Massachusetts, 2 in Rhode Island and 1 in New York. From the results of this work, we believe that striped bass females spawn only 2 or 3 times in a lifetime, similar to the Atlantic salmon. Most of the fish we examined over 28" were showing subtle signs of starvation. The larger fish were resorbing their eggs. Only a few had any fat in the abdominal cavity. Smaller fish from 18" to 28" in Chesapeake Bay in the fall were developing very small gonads and had little fat stored for winter. 20 years ago all fish autopsied had fat and normal sized gonads.

Powles, P.M. and S. Scholten. Department of Biology, Trent University, Peterborough, Ontario K9J 7B8, Canada. PROBLEMS IN AGEING LONGNOSE DACE, *RHINICHTHYS CATARACTAE* (VALENCIENNES). It was difficult to age longnose dace accurately and with confidence primarily because an early false annulus was present in most otoliths. The location of this check was marked by micromanipulation and its position corresponded to from 30-60 DGIs (daily growth increments) past the hatch ring. Other apparent false annuli and the closeness together of some true annuli towards the outer part of otoliths caused poor agreement in ageing between the authors. The best ageing technique was based on frequency distribution of DGIs as follows: 110-140 (Age I); 151-201 (Age II); 221-270 (Age III); and, 281-321 (Age IV). These age classes corresponded well to length modes in females, but not in males. Males lived only to 3 years in our stream. It is speculated that the first check corresponded to an ecological shift from eddy to riffle, and that other checks may be results of stream perturbations.

Pryor, V.K. and C.E. Epifanio. University of Delaware, College of Marine Studies, Lewes, DE. THE INFLUENCE OF PREY SIZE, SPEED, AND DENSITY ON SELECTION BY LARVAL WEAKFISH (*CYNOSCION REGALIS*). The feeding habits of weakfish (*Cynoscion regalis*) larvae were examined in laboratory experiments. Five larval ages were used: 5, 8, 11, 14, and 17 days post-hatching (DPH). Size experiments involved the presentation of different sized prey of the same species and different sized prey of different species. All larval ages were found to prefer large rotifers over small; however, small brine shrimp nauplii were chosen over the larger. Across all larval ages, large rotifers were the predominantly preferred prey item. Swimming speeds of the prey items were found to have little effect on their selection by larval weakfish. Selection by weakfish larvae appeared to depend on the density of prey items. Early-stage larvae (5 DPH) did not discriminate among prey at low densities, while late-stage larvae (14 and 17 DPH) fed selectively at all densities administered. These results indicate that young weakfish larvae are opportunistic at prey densities typically found within the Delaware Bay; however, the larvae become selective feeders with age. Preferences within the lab were found for prey items within a given size range (200 400μ and these results have also been found for field-caught larvae. Results from these experiments indicate that the larvae are able to feed selectively, choosing items within a specific size range and that the density of the prey items and larval age influence selection.

Rose, K.A.[1], J.H. Cowen[2], C.C. Coutant[3], and E.D. Houde[4]. [1]Environmental Sciences Division, Oak Ridge National Laboratory, P.O. Box 2008, Oak Ridge, TN 37831. [2]Dept. of Marine Sciences, University of South Alabama, Mobile, AL 36688. [3]Environmental Sciences Division, Oak Ridge National Laboratory. [4]Chesapeake Biological Laboratory, University of Maryland, Solomons, MD 20688. [1]INDIVIDUAL-BASED MODELING OF THE EFFECTS OF ENVIRONMENTAL QUALITY ON EARLY LIFE STAGES OF FISH. Many factors affect environmental quality (e.g., Temperature, toxics, habitat), each of which may impact one or more life stages. Comparing effects of variables on environmental quality either singly or in combination across multiple life stages is a necessary but difficult task. The utility of using an individual-based population model to compare effects of altered environmental quality is illustrated for striped bass. Young-of-the-year striped bass population dynamics in the Potomac River is modeled by Monte Carlo simulation. The model begins with the spawning of females and follows each female's cohort of eggs through yolk-sac larvae to initiation of first feeding. The growth and mortality of larvae and juveniles are then followed day-by-day in one year simulations. Model predictions, given episodic or chronic changes in temperature, toxics, and habitat affecting spawning females, eggs, yolk-sac larva, larva, and juveniles are compared. Advantages and some shortcomings of individual-based modeling to examine changes in environmental quality and its effects on estuarine fish are discussed.

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Rotunno, T.K. and R.K. Cowen. Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, NY 11794-5000. SPECIES IDENTIFICATION AND TEMPORAL SPAWNING PATTERNS OF BUTTERFISH, *PEPRILUS* SPP., IN THE SOUTH AND MID-ATLANTIC BIGHTS. Three species of the stromateoid genus *Peprilus* can be found in the Atlantic along the eastern coast of the United States; *P. triacanthus* (Adantic butterfish), *P. burti* (Gulf butterfish) and *P. paru* (harvestfish). *P. triacanthus* and *P. paru* have reported summer spawning periods, May through August and June through July, respectively. *P. burti* reportedly spawns twice yearly; February through May and September through November. According to most fishery management reports, *P. triacanthus* is thought to be the most commonly found species in the western Atlantic. Larvae and juveniles of *Peprilus* spp. were collected in samples taken from the south and mid-Atlantic bights during both the spring and summer of 1988 and 1989. Morphometric data shows specimens occupied a size range consistent with those reported for all three species of *Peprilus* . Caudal vertebrae counts of specimens sampled are consistent with those known for *P. triacanthus* (18 - 19). The number of ventral midline melanophores agrees with the reported range for *P. triacanthus* of 11 - 15. Therefore, it was concluded that our samples contained specimens of *P. triacanthus* . Immersion of live butterfish in an oxytetracycline hydrochloride sea water bath was used to validate daily increment formation on otoliths. Ageing of fish by otolith analysis revealed larval and juvenile growth rates of approximately 0.23mm/day. Backcalculation of birthdates suggests either two distinct spawning events for *P. triacanthus;* late January through mid-March and early June through late July, or one extended spawning period beginning in late January and ending in late July. Therefore, it appears that *P. triacanthus* is spawning for a much longer duration than previously thought. To better manage this economically important fishery, it is important to have a more complete understanding of it's early life history.

Setzler-Hamilton, E.M.[1] and J.H. Cowan, Jr[2]. [1]Chesapeake Biological Laboratory, University of Maryland System, Center for Environmental and Estuarine Studies, Solomons, MD. [2]Department of Marine Sciences, University of South Alabama, Mobile, AL. SPATIAL AND TEMPORAL VARIATIONS IN AVAILABILITY OF ZOOPLANKTON PREY AND FEEDING SUCCESS OF STRIPED BASS LARVAE. Striped bass larvae prey on zooplankton; cladocerans and copepodite and adult stages of copepods typically dominate diets of larvae. We have reexamined four years of data on the size-specific feeding habits of striped bass larvae from the Potomac River, MD and one year of data on the size-specific feeding habits of striped bass larvae from the Choptank River, MD together with zooplankton samples and water quality parameters. Spatial, temporal, and interannual variations in the feeding success of striped bass larvae in relation to environmental parameters, zooplankton availability and changes in availability are being examined using multivariate clustering and ordination techniques. Particular emphasis will be placed on a comparison of feeding demographics between a year of relatively high (1980) vs. low (1977) flow in the Potomac River. Peaks in abundance of both copepods and cladocerans more closely mirrored peaks in abundance of striped bass larvae in 1977, whereas in 1980, peak abundance of larvae occurred further down-river and several weeks prior to peak abundances of both copepods and cladocerans. A 2-3°C drop in water temperatures occurred during the second week of May in 1977, whereas water temperatures gradually increased during 1980. Recruitment was poor in both years. We conclude that both a match of first-feeding larvae and their zooplankton prey and favorable environmental parameters are necessary for successful recruitment of striped bass larvae.

Shenker, J.[1,2], E. Maddox[2], R. Mojica[2], E. Wishinski[2], and N. Smith[3]. [1]Dept of Biological Sciences, Florida Institute of Technology. [2]Caribbean Marine Research Center. [3] Harbor Branch Oceanographic Institute. ONSHORE TRANSPORT OF SETTLEMENT-STAGE FISHES IN THE BAHAMAS: A SEASONAL COMPARISON. Transport of settlement-stage fishes from the pelagic environment of Exuma Bound to shallow nursery habitats on Great Bahama Bank was monitored continuously from late August through mid-September, 1991. Large surface and subsurface plankton nets moored in channels between islands on the edge of Exuma Sound were sampled at least twice daily. Comparison of taxa moving onshore in late summer with catches from similar sampling the previous winter indicated strong seasonal differences in kinds and abundance of recruits: Summer samples had higher densities of fishes and were dominated by scarids, labrids, apogonids and balostids, while leptocephali serranids and bothids were the most abundant fishes in winter collections. Peaks in the summer catch occurred at night during the new moon in September. The influence of meteorological, oceanographic, and other environmental conditions on daily recruitment were examined.

Sigurdson, R.E. University of Minnesota-Duluth, and Minnesota Cooperative Fish and Wildlife Research Unit. THE EFFECTS OF NAVIGATION-INDUCED SHEAR AND TURBULENCE ON THE EARLY LIFE HISTORY OF WALLEYE (*STIZOSTEDION VITREUM*), SAUGER (*STIZOSTEDION CANADENSE*), AND FATHEAD MINNOW (*PHIMEPHALES PROMELAS*) FROM THE UPPER MISSISSIPPI RIVER SYSTEM. Navigation-induced shear and turbulence is known to have deleterious effects on the early life stages of fishes. In order to better understand the impacts that these forces are having on ichthyoplankton populations of the UMRS, data is being gathered on immediate mortality and on the short and long term damage that these forces may have on development and growth of young fish. A test chamber which simulates shear and turbulence forces is being used to observe these effects on eggs and larvae of walleye, sauger and fathead minnows. Experiments are designed to examine these short and long term impacts. This type of information is critical for understanding the effects that the predicted increase in barge traffic may have on fish mortality and year-class recruitment

Sissenwine, M.P. and P.M. Mace. National Marine Fisheries Service, Silver Spring, MD 20910. CAN THE EFFECT OF POLLUTION STRESS AND FISHING BE EQUATED? The natural environmental variability, fishing and pollution effect the population dynamics of fishes. In general, research on these three types of effects has been conducted independently. In the case of pollution, the research has rarely addressed effects at the population level. On the otherhand, relatively simple "dynamic pool", "spawner-recruitment" and "production" models, are routinely used to assess the effects of fishing on populations. These models can be modified to take account of pollution effects on demographic parameters, such as reproductive output, early life stage survival rate, and growth rate. By doing so, the effects of pollution and fishing can be expressed in a "common currency" of population stress units (PSU). A large body of fisheries scientific literature can be used to judge the robustness of population to PSUs.

Stearns, D.E.[1], G.J. Holt[2], R.B. Forward, Jr.[3], and P.L. Pickering[2]. [1]Department of Biology, Rutgers University, Camden, NJ 08102 and Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08901; [2]University of Texas at Austin, Marine Science Institute, Port Aransas, TX 78373-1267; [3]Duke University Marine Laboratory, Pivers Island, Beaufort, NC 28516-9721. DEVELOPMENT OF LIGHT SENSITIVITY IN RED DRUM LARVAE (SCIAENIDAE: *SCIAENOPS OCELLATUS*). The ontogeny of photosensitivity in red drum larvae ranging in age from 1 to 17 days posthatch (in size from 2.47 to 7.49 mm SL) was assayed phototactically, to determine how that aspect of vision changed during early development. Percent phototactic response was determined for both dark- and light-adapted larvae upon exposure to different stimulus intensities of white light and compared with dark controls. Except for day 1 larvae, which were not photoresponsive, all larval stages showed positive phototaxis at higher stimulus intensities and negative phototaxis at lower light levels, with phototactic sign switching occurring at intermediate intensities. The light intensity range over which positive phototaxis occurred increased with larval age, as did the degree of positive phototactic response when tested at similar light levels. These results indicate an ontogenetic increase in photosensitivity at relatively higher intensities. A marked increase in photosensitivity occurred at approximately day 10, evidence of saltatory ontogeny. Light-adapted larvae as young as day 4 exhibited a lower response than dark-adapted larvae at similar stimulus intensities, indicating that dark adaptation begins early in development. The lowest intensity evoking a dark-adapted photonegative response that was significantly greater than controls was our estimate of the threshold for light perception. Interestingly, this threshold did not appear to change markedly once day 5 was reached. This threshold, while very low ($4\text{-}6 \times 10^{-6}$ $\mu E\ m^{-2}\ s^{-1}$) was above that published for many of the natural zooplankton prey of red drum larvae, indicating greater photosensitivity of the prey relative to this visual predator.

Stegeman, J.J. and R. Smolowitz. Biology Department, Woods Hole Oceanographic Institution, Woods Hole, MA 02543. CYTOCHROME P 4501A INDUCTION IN DEVELOPMENTAL STAGES OF FISH: CAUSES AND BIOLOGICAL SIGNIFICANCE. Cytochrome P450 refers to a superfamily of proteins that catalyze monooxygenase reactions involved in metabolism of foreign compounds and endogenous molecules. Proteins in the cytochrome P4501A (CYP1A) subfamily are prominent in the metabolism and activation of aromatic hydrocarbons. CYP1A occurs in all species of elasmobranch and teleost fish examined to date. CYP1A gene expression is induced in adult fish by exposure to toxic polynuclear aromatic hydrocarbons (PAH), planar polychlorinated biphenyls (PCB), and polychlorinated dibenzo-p-dioxins (PCDD). The induction of CYP1A is thought to be a critical factor in the toxicity and carcinogenicity of these and related compounds. CYP1A expression and action in early life stages could determine their sensitivity to such pollutants. Studies in *Fundulus heteroclitus* first showed the induction of aryl hydrocarbon hydroxylase (AHH) activity (an activity of fish CYP1A) in liver and extrahepatic tissues of embryos exposed to PCBs. The sensitivity to induction differed in embryos prior to and after hatching, with greater sensitivity evident in post-hatching embryos. Salmonid embryos treated with PCB also responded with increased AHH activity in the lever. Subsequent studies were carried out with rainbow trout embryos treated by injection with B-naphthoflavone (a known CYP1A inducer), and examined by immunohistochemistry with monoclonal antibody 1-12-3 to teleost CYP1A1. The studies showed that induction of CYP1A occurred in diverse cell types in most organs of the embryo body. These included epithelial cells in many organs. Endothelial cells lining the vasculature in many parts of the embryo showed particularly strong induction, like the response in these cells in adult fish. Induction similar to that seen experimentally has now been detected in salmonid embryos either directly or parentally exposed to contaminants. The induction of CYP1A appears to be a valuable marker for exposure of teleost embryos to toxic inducing agents, and may be instrumental in the toxic effects of such compounds (support by NIH ES-04220).

Steingraeber, M.T. U.S. Fish and Wildlife Service, National Fisheries Contaminant Research Center, P.O. Box 936, La Crosse, WI 54602-0936. EVALUATION OF CONTAMINANT EFFECTS ON THE OSTEOLOGICAL DEVELOPMENT OF LARVAL FISH. Many skeletal anomalies observed in teleosts have been attributed to environmental contaminants that may be either physical or chemical in nature. Reported incidents of early life skeletal abnormalities suspected to be the result of exposure to one or more chemicals have become more common in the last two decades, corresponding to a period of increased awareness of global environmental issues (e.g., waste disposal, oil spills, pesticide use, atmospheric transport and deposition of contaminants). Biochemical and physical mechanisms that may promote these maladies, particularly in vertebral structures, have been elucidated for a few synthetic organochlorine compounds using early life stages of various freshwater taxa as models. However, the mechanisms of altered bone development remain unknown for most suspected causative agents. The most recent reports of altered bone development during early life have emphasized the sublethal effects of an increased bioavailability of inorganic contaminants (e.g., hydrogen, aluminum, cadmium) that are associated with surface water acidification. Selective staining of bone tissue has been used in many of these studies to quantitatively document reduced ossification of repetitious structures (e.g., vertebral centra) at one point in time. A more sensitive strategy to evaluate bone staining results, which integrates both qualitative and quantitative aspects of bone development over a time-series, is presented for skeletal structures thought critical to the early life survival of *Salvelinus fontinalis*. This approach, developed to assess the effects of reduced pH on a relatively acid-tolerant species, could be used to evaluate the effects of a variety of contaminants on the early osteological development of many species.

Stevenson, D.K., M.A. Lazzari, and D.A. Libby. Maine Department of Marine Resources, West Boothbay Harbor, ME 04575. EARLY SPRING ABUNDANCE AND DISTRIBUTION OF ICHTHYOPLANKTON AND ZOOPLANKTON ALONG THE CENTRAL MAINE COAST. Catch rates of fish eggs, larvae, and zooplankton were estimated in inshore and offshore waters along the central Maine coast in early April 1989 and 1990, just prior to the spring phytoplankton bloom. Three replicate oblique 1 m Tucker trawl tows (0.33 mm mesh) were made between 0-40 m at six inshore and four offshore stations in 1989 and vertical net hauls (0.073 mm mesh) from 20 m at a number of locations in 1990. Significant differences existed between stations (ANOVA, p ,0.001) for log transformed densities of eggs, larvae, and macrozooplankton. Most fish eggs were either American plaice (*Hippoglossoides platessoides*) or one of the cod-haddock-witch flounder complex and were more abundant at the inshore stations. Larval densities were significantly greater inshore ($\bar{X}$ = 22.3/100 m^3, SD = 20.5) than offshore ($\bar{X}$ = 0.9/m^3, SD = 0.9) due to the dominance of three inshore species (*Myoxocephalus octodecimspinosus*, *Pholis gunnellus*, and *Lumpenus* sp.). Adult copepods were primarily oceanic species (*Calanus finmarchicus* and *Pseudocalanus minutus*) with significantly higher densities ($\bar{X}$ = 42.8/m^3, SD = 23.8) at the five stations (four offshore stations and the easternmost inshore station) with salinities .31 ppt than at the other (lower salinity) inshore stations ($\bar{X}$ = 2.1/m^3, SD = 3.4). Prey for small, recently hatched fish larvae were abundant inshore and offshore in 1990: barnacle nauplii were present inshore in densities exceeding 100/liter and copepod nauplii reached densities of 20-60/liter offshore. These results show that larval fish populations in this area of the Maine coast in early spring are primarily restricted to nearshore waters and have a sufficient food supply.

Sullivan, B.K. and G. Klein-MacPhee. Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882-1197. USING MESOCOSMS TO ASSESS THE INFLUENCE OF FOOD RESOURCES, PREDATION AND TOXIC MATERIALS ON LARVAL FISH SURVIVAL. Large enclosures (or mesocosms) have recently become an important tool in determining the relative importance of food limitation and predation to growth and survival of larval fishes. They are also one of the best tools for evaluating effects of toxic substances because of several advantages they provide the researcher: 1) very high rates of survival that are hard to achieve in the laboratory, at least in the absence of predators and food limitation, and 2) an experimental environment that more closely resembles *in situ* conditions than can be achieved in smaller systems. Properly designed, mesocosms allow observation of larval survival and growth at near natural densities while feeding occurs on natural particle assemblages. High survival rates of larvae in mesocosms indicate that physiology of the larvae is unaffected by the experimental conditions and simulation of the whole ecosystem increases the probability that exposure to toxics occurs through the route that will occur *in situ*. As a result, responses of the larvae to controlled alteration of food, predators or water chemistry (such as introducing toxic materials) can be extrapolated to natural systems with much greater confidence than for studies done in smaller laboratory systems. However, design of experiments is constrained by the number of experimental units available. We describe our experiences with mesocosms and some important conclusions about major factors affecting larval survival from studies on rates of predation by jellyfish predators, effects of *Phaeocystis* blooms on larval survival and effects of biodegradable plastics on survival and growth.

Theilacker, G.H.[1] and W. Shen[2]. [1]NOAA, Alaska Fisheries Science Center, Seattle, WA 98115. [2]Department of Pathology, University of Washington, Seattle, WA 98195. USE OF FLOW CYTOMETRY TO DETERMINE LARVAL FISH CONDITION. We describe a method for assessing nucleic acid content of larval fish at the cellular level. Histological studies have shown that the sensitivity of larval fish tissues to starvation differs. Thus analyzing the response of a single tissue to stress should yield a better index of condition, with a precise response time, than analyzing the whole larva. Here we examine the brain for signs of stress. We used a flow cytometer to measure RNA and DNA in single brain cells of larval walleye pollock, *Theragra chalcogramma*, raised in the laboratory. The fraction of brain cells showing increased RNA activity, thus increased potential to synthesize protein, was distinct among larvae that were always fed, always starved, and starved before feeding. Level of RNA measured in 8000 cells per larva differed significantly among feeding regimes. Starved animals had fewer active cells than continuously fed ones, and withholding food for 2 days and then feeding increased the fraction of active cells to a higher state than cells from continuously-fed larvae. We developed a method for freezing the dissociated brain cells. The method ensures nucleic acid stability during storage, thus permitting sampling and storage at sea. We envision that in the field, with a flow cytometer onboard the research vessel, a quick and accurate assessment of individual fish condition could be obtained on site.

Warlen, S.M. and P.A. Tester. NOAA, NMFS, SEFSC, Beaufort Laboratory, Beaufort, NC 28516-9722. RECRUITMENT OF LARVAL FISHES TO A NORTH CAROLINA ESTUARY DURING A RED TIDE, *GYMNODINIUM BREVE*, BLOOM. Densities of larvae of fall/winter spawning fishes were estimated from nighttime, mid-flood neuston net catches at a single site inside Beaufort Inlet as they recruited to the Newport River estuary from 10 November 1987 to 4 May 1988. Spatially and temporally coincident with early season recruitment of larvae was the first recorded red tide (*Gymnodinium breve*) outbreak in North Carolina nearshore waters. In Beaufort Inlet surface water samples taken by the NC Shellfish Sanitation Program cell counts remained high ($\geq 10^5$ cells/liter) from 3 November 1987 until about the first week in January 1988 afterwhich levels declined. During this period there was virtually no recruitment of Atlantic menhaden (*Brevoortia tyrannus*) or gulf flounder (*Paralichthys albiqutta*) although these species were recruited over the same period in 1985-86, 1986-87, 1988-89, 1989-90, 1990-91 and 1991-92. Menhaden recruitment was 4.5% and gulf flounder was 3.0% of the mean of the respective 2 pre-red tide and 4 post-red tide recruitment years. However, other larvae such as spot (*Leiostomus xanthurus*), Atlantic croaker (*Micropogonias undulatus*), pinfish (*Lagodon rhomboides*), speckled worm eel (*Myrophis punctatus*), southern flounder (*P. lethostigma*), bay whiff (*Citharichthys spilopterus*) and striped mullet (*Mugil cephalus*), usually recruited with menhaden and gulf flounder, were present during the red tide bloom in densities similar to or greater than in other years. Prolonged estuarine recruitment of larval fishes may provide a buffer against recruitment failure during short-term unfavorable conditions such as red tide blooms.

White, M.G. Marine Life Sciences Division, British Antarctic Survey, NERC, Madingley Road, High Cross, Cambridge CB3 OET, UK. DISTRIBUTION PATTERNS OF ICHTHYOPLANKTON AT SOUTH GEORGIA, ANTARCTICA. There are some 270 species of fish occurring in the Southern Ocean. Most of these are demersal species found over the continental shelves of the Continent and peri-Antarctic islands. Commonly relative fecundity is low and both incubation and development to metamorphosis requires several months to be completed. The larval and early juvenile stages are pelagic. Studies on the temporal and spatial distribution of larval fish have been undertaken at the island of South Georgia and these demonstrate distinct neritic and oceanic assemblages. The mechanisms maintaining neritic species with extended pelagic life histories at isolated island groups in the Southern Ocean is addressed. Comparisons between high- and low-Antarctic ichthyoplankton assemblages show the former to be more pelagic and less well described by bathymetry.

Witting, D.A. and K.W. Able. PREDATION ON JUVENILE WINTER FLOUNDER: EFFECTS OF PREY SIZE AND PREDATOR DENSITY. Rutgers University Marine Field Station, Institute for Marine and Coastal Sciences, P.O. Box 278, Tuckerton, NJ 08087. Preliminary laboratory and field observations in Southern New Jersey have suggested that the sand shrimp (*Crangon septemspinosa*) may be an important predator of juvenile winter flounder (*Pleuronectes americanus*). Two laboratory experiments were conducted to further investigate this predator-prey relationship. The first experiment tested the effect of winter flounder developmental stage and size on rate of predation by similar sized adult shrimp (45-55 mm TL). Flounder stages ranged from pelagic larvae (eyes symmetrical, 5-8 mm SL), to 60 mm (SL) juveniles. The highest predation was observed on winter flounder that were at immediately post-eye migration stages, with lower levels of predation observed during eye migration and on larger juveniles. These experiments suggests an interaction between winter flounder size, stage, settlement behavior, and susceptibility to predation by sand shrimp. The second experiment tested the effect of shrimp density on predation rate. Six predator densities (0 to 36 m^{-2}) were tested in pools (1 m^2 and 16 cm in depth). Winter flounder size and density was held constant (13 mm and 5 m^2, respectively). When predator densities were lower than 9 m^{-2}, flounder mortality was low (0-20%). However, in treatments where shrimp densities were 9 m^{-2} or greater, flounder mortality increased to nearly 100%. Together these laboratory experiments substantiate the significance of predator-prey interactions to survival of young-of-the-year winter flounder.