

***1997 Southern Division American Fisheries Society***

***Mid-year Meeting***

***13 - 16 February 1997***

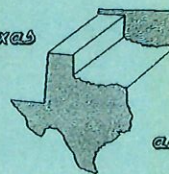
***Camberley Gunter Hotel, San Antonio, Texas***



***Program***

**Southern  
A  
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Division**

*Hosted by the Texas*



*and Oklahoma Chapters*



## PROGRAM OVERVIEW

### THURSDAY - 13 FEBRUARY 1997

8:00am - 5:00pm	Marine and Estuarine Resources Committee Meeting - Vance Room
8:00am - 5:00pm	Pollution Committee Meeting - Frontier Room
8:00am - 5:00pm	Reservoir Committee Meeting - Alamo Room
8:00am - 5:00pm	Small Impoundments Committee Meeting - Trail Drivers Room
8:00am - 12:00pm	Striped Bass Committee Meeting - Baker Room
12:00pm - 1:00pm	Lunch
1:00pm - 5:00pm	Warmwater Streams Committee Meeting - Mahncke Room
1:00pm - 5:00pm	Environmental Concerns Committee Meeting - Baker Room
5:00pm - 6:00pm	Joint Committee Workshop on Fundraising - Alamo Room

### FRIDAY - 14 FEBRUARY 1997

8:00am - 5:00pm	Southern Division Executive Committee Meeting - Crystal Ballroom
8:00am - 5:00pm	Slide Preview Area - Gunter Terrace
8:00am - 9:00pm	Trade Show Set-up and Exhibition - Gunter Terrace
8:00am - 12:00pm	GIS Workshop (no extra cost) - Yellow Rose Room
8:00am - 10:00am	Aquaculture Committee Meeting - Bluebonnet Room
10:00am - 10:20am	Coffee Break @ Gunter Terrace
10:00am - 12:00pm	Instream Flow Committee Meeting - Bluebonnet Room
12:00pm - 1:00pm	Lunch
1:00pm - 2:00pm	Instream Flow Workshop (\$40; contact Steve Filipek) - Bluebonnet Room
1:00pm - 5:00pm	AFS Leadership Training - Robert E. Lee Room
1:00pm - 5:00pm	Student Career Development Workshop (no extra cost) - Mahncke Room
1:00pm - 5:00pm	Poster Set-up - Gunter Terrace
3:00pm - 3:20pm	Coffee Break @ Gunter Terrace
5:00pm - 6:00pm	Fish Management Section Meeting - Bluebonnet Room
7:00pm - 9:00pm	Student-Professional Mixer - Gunter Terrace

### SATURDAY - 15 FEBRUARY 1997

8:00am - 9:00am	Plenary Session - Welcome & Opening Remarks - Crystal Ballroom
9:00am - 12:00pm	Plenary Session - Point / Counterpoint - <b>Privatization of Public Agency Fisheries Management Activities: How Will the Resources be Affected?</b> - Crystal Ballroom
8:00am - 5:00pm	Slide Preview Area - Gunter Terrace
8:00am - 5:00pm	Poster Display / Trade Show Exhibitions - Gunter Terrace
10:00am - 10:20am	Coffee Break @ Gunter Terrace
12:00pm - 1:00pm	Lunch
1:00pm - 5:20pm	Technical Sessions & Symposia
3:00pm - 3:20pm	Coffee Break @ Gunter Terrace
7:00pm - 12:00am	Social - Lone Star Brewery

### SUNDAY - 16 FEBRUARY 1997

8:00am - 12:00pm	Technical Sessions & Symposia
8:00am - 5:00pm	Slide Preview Area - Gunter Terrace
8:00am - 5:00pm	Poster Display / Trade Show Exhibitions - Gunter Terrace (note: posters and trade show exhibitions must be removed by 5:00pm)
10:00am - 10:20am	Coffee Break @ Gunter Terrace
12:00pm - 1:00pm	Lunch
1:00pm - 5:00pm	Technical Sessions & Symposia
3:00pm - 3:20pm	Coffee Break @ Gunter Terrace

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STUDENT CAREER DEVELOPMENT WORKSHOP

FRIDAY - 14 FEBRUARY 1997

1:00PM-5PM; MAHNCKE ROOM

Time

Advice from Professionals

1:00pm - 1:40pm **Written Communications, Interviewing, Dress and Image, Networking**  
Rosemary Droke and Ronda Boyles, St. Mary's University Career Services, San Antonio, Texas

1:40pm - 2:00pm **Graduate School**  
Elise Irwin, Alabama Cooperative FWRS

2:00pm - 2:20pm **State Jobs**  
Loraine Fries, Texas Parks and Wildlife Department, San Marcos, Texas

2:20pm - 2:40pm **Federal Jobs**  
~~Stuart Jacks, U.S. Fish and Wildlife Service, Corpus Christi, Texas~~

2:40pm - 3:00pm **Internships**  
Mike Reed, Texas Parks and Wildlife Department, Mathis, Texas

3:00pm - 3:20pm **Consulting**  
Fred Heitman\*, American Aquatics, Harriman, Tennessee

3:20pm - 3:40pm **BREAK**

Mock Interviews and Networking

3:40pm - 4:00pm **Graduate School**  
William Fisher, Oklahoma Cooperative FWRC, and Craig Paukert, Oklahoma State University

4:00pm - 4:20pm **State Jobs**  
Karen Meador, Texas Parks and Wildlife Department, Rockport, Texas

4:20pm - 4:40pm **State Jobs**  
Lance Robinson and Bill Balboa, Texas Parks and Wildlife Department, Seabrook, Texas

4:40pm - 5:00pm **Open Discussion**

\* Contributor supporting student travel awards

## TECHNICAL SESSIONS

**HUMAN DIMENSIONS OF FISHERIES (SYMPOSIUM) - Moderator: Bob Ditton, Texas A&M University**  
**SATURDAY - 15 FEBRUARY 1997 1:00PM - 5:00PM; ALAMO ROOM**

Time		Abstract Page
1:00pm - 1:20pm	<b>Human Dimensions Research: an Introduction and Overview</b> Bob Ditton, Texas A&M University, College Station, Texas	1
1:20pm - 1:40pm	<b>Understanding Differences Between Tournament and Non-tournament Bass Anglers in Texas</b> Kevin M. Hunt, Texas A&M University, College Station, Texas	1
1:40pm - 2:00pm	<b>Proactive Fisheries Management Implications of the 1996 Texas Saltwater Angler Surveys</b> Brian L. Bohnsack, Texas A&M University, College Station, Texas	1
2:00pm - 2:20pm	<b>Development and Application of an Index of Recreation Specialization for Largemouth Bass Anglers</b> Gene R. Wilde, Texas Tech University, Lubbock, Texas	2
2:20pm - 2:40pm	<b>A Management Overview of Spotted Seatrout Anglers</b> Robin K. Riechers, Texas Parks and Wildlife Department, Austin, Texas	2
2:40pm - 3:00pm	<b>Towards an Understanding of the Economics of Artificial Reef Use in Offshore Texas Waters</b> David W. Britt, Texas A&M University, College Station, Texas	2
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 3:40pm	<b>Angler Demographics and Opinions Over the Past Three Decades</b> Greg Summers, Oklahoma Department of Wildlife Conservation, Norman, Oklahoma	3
3:40pm - 5:00pm	<b>Open Discussion</b>	

**INSTREAM FLOW - Moderator: Steve Filipek, Arkansas Game and Fish Commission**  
**SATURDAY - 15 FEBRUARY 1997 1:00PM - 4:40PM; CRYSTAL BALLROOM**

1:00pm - 1:20pm	<b>An Approach for Incorporating Instream Flow Needs in Basinwide Management Models</b> Mary C. Freeman, John M. Nestler, Peter N. Johnson, and Jerry Ziewitz	3
1:20pm - 1:40pm	<b>Instream Flows for Trout, Paddlefish, and a Delta River Fishery: a 3 for 1 Example</b> Steve Filipek	4
1:40pm - 2:00pm	<b>Current Status of Instream Flow Initiatives in Georgia</b> Russ England	4
2:00pm - 2:20pm	<b>Florida's Instream Flow Program</b> Dale Jones	4
2:20pm - 2:40pm	<b>Changes in Fish Community Structure Resulting from a Flood Control Dam in a Flintheads Stream, Kansas, with Emphasis on the Topeka Shiner</b> William G. Layher	5
2:40pm - 3:00pm	<b>Instream Flows for an Agriculturally Impacted Low-Gradient Bayou</b> William G. Layher	5
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 3:40pm	<b>Considerations for Establishing Instream Flows for Freshwater Mussels</b> James B. Layzer and Lesa M. Madison	5
3:40pm - 4:00pm	<b>Successes, Failures, and All Points in Between: the Outcome of Instream Flow Enhancement Efforts at South Carolina's Recently Licensed Hydroelectric Projects</b> Gerrit J. Jöbsis	6
4:00pm - 4:20pm	<b>Preliminary Report of an Instream Flow Evaluation of the Upper San Marcos River, Hays County, Texas</b> Ken Saunders, Karim Aziz, Roy Kleinsasser, Kevin Mayes, Randy Moss, and Gordon Linam	6
4:20pm - 4:40pm	<b>Survival of Freshwater Mussels Associated with Flow Rate and Water Level</b> Robert G. Howells	6

**ATCHAFALAYA RIVER BASIN ECOLOGY - Moderator: Allen Rutherford, Louisiana State University**  
**SATURDAY - 15 FEBRUARY 1997 2:00PM - 4:40PM; MAHNCKE ROOM**

Time		Abstract Page
2:00pm - 2:20pm	<b>Effect of Hypoxia on Instantaneous Growth of Bluegill <i>Lepomis macrochirus</i></b> David Derek Aday and D. Allen Rutherford	7
2:20pm - 2:40pm	<b>Habitat Influences on Littoral Zooplankton Assemblages in the Lower Atchafalaya River Basin, Louisiana</b> Mary C. Griffon and William E. Kelso	7
2:40pm - 3:00pm	<b>Effects of Hypoxia on Hooking Mortality of Largemouth Bass in the Atchafalaya Basin</b> David S. Hickman and Matthew J. Sabo	7
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 3:40pm	<b>Habitat Influences on Parasite Assemblages of Young-of-the-Year Largemouth Bass in the Lower Atchafalaya River Basin, Louisiana</b> Randy C. Landry and William E. Kelso	8
3:40pm - 4:00pm	<b>Effects of Environmental Hypoxia on Larval Fish Abundance in the Atchafalaya River Basin, Louisiana</b> Quenton Fontenot and D. Allen Rutherford	8
4:00pm - 4:20pm	<b>Diel and Seasonal Patterns of Movement and Habitat Use of Spotted Gar in the Lower Atchafalaya River Basin, Louisiana</b> Gregg A. Snedden and William E. Kelso	8
4:20pm - 4:40pm	<b>Diet Overlap and Parasite Sharing Within Piscivores in the Atchafalaya River Basin</b> Bernard J. Wright and D. Allen Rutherford	9

**FISH ASSEMBLAGES - Moderator: Fran Gelwick, Texas A&M University**  
**SATURDAY - 15 FEBRUARY 1997 1:00PM - 3:40PM; YELLOW ROSE ROOM**

1:00pm - 1:20pm	<b>Temporal and Spatial Distribution of Cyprinid Fishes in the North Canadian River Drainage, Oklahoma, Between 1921 and 1995</b> Jimmie Pigg and Robert Gibbs	9
1:20pm - 1:40pm	<b>Factors Influencing Fish Assemblage Structure in an Unfished Southeastern Reservoir</b> Michael H. Paller	9
1:40pm - 2:00pm	<b>Linkage of Fish Assemblages to Lake Mesohabitats: a GIS Application?</b> Scott Chappell	10
2:00pm - 2:20pm	<b>Stability of the Fish Assemblage in a Southwestern Reservoir (Lake Texoma, Oklahoma-Texas)</b> Keith B. Gido and William J. Matthews	10
2:20pm - 2:40pm	<b>Potential Establishment of Red Shiner Minnows in Upland Streams of Eastern North America: Consequences to Native Fish Faunas Under a Global Warming Scenario</b> Frances Gelwick, Bill Matthews, Jeff Stewart, and Hank Ray	11
2:40pm - 3:00pm	<b>Measuring Change: the Tallapoosa River Fish Community in 1951 and 1996</b> Elise R. Irwin	11
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 3:40pm	<b>Impacts of Small Stream Impoundments on Fish Community Assemblages in South Carolina</b> Ronald C. Ahle	12

**INTENSIVE MANAGEMENT OF SMALL IMPOUNDMENTS - Moderator: Shari Bryant, North Carolina Wildlife Resources Commission**  
**SATURDAY - 15 FEBRUARY 1997 3:40PM - 5:20PM; YELLOW ROSE ROOM**

3:40pm - 4:00pm	<b>Virginia's Urban Fishing Program</b> John S. Odenkirk	12
4:00pm - 4:20pm	<b>Private Pond Technical Guidance Program Customer Survey, 1995</b> Dan Crochet, David E. Allen, Harold R. Beard, Richard W. Christie, John S. Crane, Willard E. Hayes, and Scott D. Lamprecht	12

**INTENSIVE MANAGEMENT OF SMALL IMPOUNDMENTS (continued)**

Time		Abstract Page
4:20pm - 4:40pm	<b>A Comparative Performance Study of Two Native Strains of Largemouth Bass in South Carolina Farm Ponds</b> Jean Leitner and James Bulak	13
4:40pm - 5:00pm	<b>Mechanisms Regulating Age-0 Gizzard Shad <i>Dorosoma cepedianum</i> Interactions with Age-0 Bluegill <i>Lepomis macrochirus</i> in Small Pond Experiments and a Public Fishing Lake</b> Gene W. Kim, Dennis R. DeVries, and Jay B. Haffner	13
5:00pm - 5:20pm	<b>Use of High Density Largemouth Bass Populations to Improve Total Fisheries of Small City and State Park Impoundments in Texas</b> John Prentice and Robert Betsill	13

**CATFISH BIOLOGY AND MANAGEMENT - Moderator: Don Jackson, Mississippi State University**  
**SATURDAY - 15 FEBRUARY 1997 1:00PM - 3:00PM; BLUEBONNET ROOM**

1:00pm - 1:20pm	<b>Relative Abundance of Catfishes in Main Channel and Secondary Channel Habitats in the Lower Mississippi River</b> M. T. Driscoll and H. L. Schramm, Jr.	14
1:20pm - 1:40pm	<b>Management Benefits of Stocking 175-mm Channel Catfish in Oklahoma Reservoirs</b> Larry Cofer, Garland Wright, Hutchie Weeks, and Lonnie Cook	14
1:40pm - 2:00pm	<b>Gear Biases Associated with Collecting Catfishes in Alabama</b> Melissa Smith and Elise Irwin	14
2:00pm - 2:20pm	<b>Comparability of Channel Catfish Stock Descriptors Obtained from Different Hoopnet Configurations</b> John R. Jackson, Joseph E. Flotemersch, and Donald Jackson	15
2:20pm - 2:40pm	<b>Comparison of Low-Frequency Electrofishing with Hoop Nets for Assessing Riverine Blue Catfish Populations</b> Galen D. Jons	15
2:40pm - 3:00pm	<b>Evidence That Fluctuations in Prior Feeding Activity and Solar Radiation Influence Subsequent Feeding Activity in Commercial Channel Catfish Ponds</b> John Barry Taylor, John A. Hargreaves, and David J. Wise	15

**RESERVOIR FISHES BIOLOGY AND MANAGEMENT - Moderator: Chris O'Bara, Tennessee Tech University**  
**SATURDAY - 15 FEBRUARY 1997 3:20PM - 5:00PM; BLUEBONNET ROOM**

3:20pm - 3:40pm	<b>Population Dynamics of Paddlefish <i>Polyodon spathula</i> in the Keystone Reservoir System, Oklahoma</b> Craig Paukert and William Fisher	16
3:40pm - 4:00pm	<b>The Commercial Fishery for Paddlefish in Grand Lake of the Cherokees, Oklahoma, 1972-1991</b> Mark Ambler	16
4:20pm - 4:40pm	<b>First Year Characteristics of Sympatric Populations of Largemouth Bass and Spotted Bass in a Tennessee Reservoir</b> Lawrence G. Dorsey, Phillip W. Bettoli, and Steve M. Sammons	16
4:40pm - 5:00pm	<b>Genetic Distance Between the Largemouth, Smallmouth, and Spotted Basses (Genus <i>Micropterus</i>) as Determined by Mitochondrial DNA Analysis</b> Timothy Hodge and Ronald L. Johnson	17

**RESERVOIR FISHES BIOLOGY AND MANAGEMENT - Moderators: Jeff Boxrucker (am), Gene Gilliland (pm); Oklahoma Department of Wildlife Conservation**  
**SUNDAY - 16 FEBRUARY 1997 8:00AM - 4:40PM; CRYSTAL BALLROOM**

8:00am - 8:20am	<b>Using Angler Log Data to Estimate Size Distribution of Angler-Caught Largemouth Bass from a Total Catch-and-Release Fishery</b> Wesley F. Porak, Steve Crawford, Dennis Renfro, and Bob Eisenhauer	17
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**RESERVOIR FISHES BIOLOGY AND MANAGEMENT (continued)**

Time		Abstract Page
8:20am - 8:40am	<b>The Relationship Between Fluctuating Reservoir Level, Diet, and Growth of Age-0 Largemouth Bass in Kentucky Lake, Kentucky and Tennessee</b> David P. Dreves and Tom J. Timmons	17
8:40am - 9:00am	<b>Characteristics of Age-0 Largemouth Bass in Sale Creek Embayment, Chickamauga Reservoir</b> Scott Loftis, Christopher O'Bara, and Michael Eggleton	18
9:00am - 9:20am	<b>Influence of Phytoplankton, Primary Productivity and Temperature on the Dynamics of Zooplankton Populations in Hugo Reservoir, Oklahoma</b> William C. Wolfenbarger	18
9:20am - 9:40am	<b>Variability in Dissolved Oxygen Concentration Within Aquatic Macrophyte Beds</b> L. E. Miranda and M. S. Allen	18
9:40am - 10:00am	<b>An Experimental Evaluation of Growth of Juvenile Bluegill and Largemouth Bass in Diverse and Monospecific Aquatic Plant Beds</b> Sherry L. Harrel and Eric D. Dibble	19
10:00am - 10:20am	<b>COFFEE BREAK - Gunter Terrace</b>	
10:20am - 10:40am	<b>Movement of Triploid Grass Carp <i>Ctenopharyngodon idella</i> in Small Hydropower Reservoirs on the Guadalupe River, Texas</b> John Prentice, Wilfred J. Dean, Jr., Michael Reed, and Earl W. Chilton II	19
10:40am - 11:00am	<b>Intraspecific Competition and Habitat Selection by Size Classes of Largemouth Bass</b> James M. Long, Daniel W. Beckman, and Alicia Mathis	19
11:00am - 11:20am	<b>A Comparison of Natural and Synthetic Forms of Man-Made Habitat in Two Oklahoma Reservoirs</b> Alan McGuckin and Gene Gilliland	20
11:20am - 11:40am	<b>Temporal and Ontogenetic Variation in Feeding by Larval Bluegill</b> David G. Bruce and Michael J. Van den Avyle	20
11:40am - 12:00pm	<b>Angler Exploitation and Movement of Two Spawning Cohorts of Walleye</b> Christopher O'Bara, Judd Cornell, Scott Loftis, and Douglas Peterson	21
12:00pm - 1:00pm	<b>LUNCH</b>	
1:00pm - 1:20pm	<b>Assessment and Restoration of Sauger Stocks in Tennessee Reservoirs</b> Michael Fischbach and Phillip W. Bettoli	21
1:20pm - 1:40pm	<b>Hatching Periodicity and Growth of Black and White Crappie from Two Tennessee Tributary Reservoirs</b> Dale Kernahan, Christopher O'Bara, and Scott Loftis	21
1:40pm - 2:00pm	<b>Supplemental Stocking of White Crappie and Largemouth Bass in Two Impoundments</b> Christopher O'Bara, Charles Drumright, Bobby Wilson, David Rizzuto, Douglas Peterson, and James Negus	22
2:00pm - 2:20pm	<b>Distribution and Food Habits of Larval Gizzard and Threadfin Shad in Ledbetter Embayment, Kentucky Lake</b> Kevin J. Frey and Tom J. Timmon	22
2:20pm - 2:40pm	<b>Changes in Abundance and Size Structure of Juvenile Shad Following a Winterkill of Threadfin Shad in Hugo Reservoir, Oklahoma</b> Jeff Boxrucker	23
2:40pm - 3:00pm	<b>Larval Shad Prey Selection and Influences on Zooplankton Community Structure</b> Phillip Gaines and Jeff Boxrucker	23
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 3:40pm	<b>Longitudinal and Vertical Distribution of Blueback Herring in J. Strom Thurmond Reservoir</b> Don Dennerline and Michael J. Van den Avyle	23
3:40pm - 4:00pm	<b>Estimating Forage Fish Abundance in Southeast Reservoirs by Use of Vertically and Horizontally Aimed Transducers</b> Donald Degan, Sandra Howie, and David G. Coughlan	24
4:00pm - 4:20pm	<b>Endangered Species and Sport Fishing - a Working Partnership</b> Gary P. Garrett	24
4:20pm - 4:40pm	<b>Sport Fishing Index - a Method to Quantify Sport Fishing Quality</b> Gary D. Hickman	25

**INSTREAM SAND AND GRAVEL MINING: SCIENCE AND PERSPECTIVES (SYMPOSIUM)**  
**SUNDAY - 16 FEBRUARY 1997 8:00AM - 5:00PM: AT AMO ROOM**

**PART 1 - Instream Sand and Gravel Mining: Are We Starved for Science? - Moderator: David Sager, Texas Parks and Wildlife Department**

Time		Abstract Page
8:00am - 8:20am	<b>Introduction</b> Michael Meador, U.S. Geological Survey, Raleigh, North Carolina	
8:20am - 8:40am	<b>Sand and Gravel Mining in Alluvial Systems</b> Robert B. Jacobson, U.S. Geological Survey, Rolla, Missouri	25
8:40am - 9:00am	<b>The Consequences of Sand and Gravel Mining Within and Adjacent to River and Stream Channels in Mississippi and Louisiana</b> Paul Hartfield, U.S. Fish and Wildlife Service, Jackson, Mississippi	25
9:00am - 9:20am	<b>Influence of Sand and Gravel Mining on Sediment Transport in the Brazos River, Texas</b> David D. Dunn, U.S. Geological Survey, Austin, Texas	26
9:20am - 9:40am	<b>Effects of Instream Gravel Mining on Fishes Using Different Habitat Types in Four Alabama Streams</b> Scott Peyton, Auburn University, Auburn, Alabama	26
9:40am - 10:00am	<b>Spatial and Temporal Variability in Gravel Availability, Current River, Missouri</b> Robert B. Jacobson and Karen E. Bobbitt, U.S. Geological Survey, Rolla, Missouri	26
10:00am - 10:20am	<b>COFFEE BREAK - Gunter Terrace</b>	
10:20am - 12:00pm	<b>Panel Discussion: Impacts of Sand and Gravel Mining: What Do We Know and Where Do We Need to Be?</b>	
12:00pm - 1:00pm	<b>LUNCH</b>	

**PART 2 - Instream Sand and Gravel Mining: Perspectives - Moderator: April Layher, Arkansas Game and Fish Commission**

1:00pm - 1:20pm	<b>Instream Sand and Gravel Mining and the Corps of Engineers Permit Program</b> Mark King, U.S. Army Corps of Engineers, Galveston, Texas	27
1:20pm - 1:40pm	<b>Pits, Permits, and Populism: Resource Regulation in the Age of Miscommunication</b> J. Rollin MacRae, Texas Parks and Wildlife Department, Austin, Texas	27
1:40pm - 2:00pm	<b>Instream Sand and Gravel Mining in North Carolina: the View from a Fisheries Biologist</b> Stephanie E. Goudreau, North Carolina Wildlife Resource Commission, Marion, North Carolina	27
2:00pm - 2:20pm	<b>The Politics of Gravel Mining: Now You See It, Now You Don't</b> Steve Filipek, Arkansas Game and Fish Commission, Little Rock, Arkansas	28
2:20pm - 2:40pm	<b>Sand and Gravel Mining: an Industry Overview</b> David Kurz, Sand Supply, Inc., Stafford, Texas	28
2:40pm - 3:00pm	<b>Panel Discussion: The Multiple Perspectives on Instream Mining: Searching for Common Ground</b>	
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 5:00pm	<b>Panel Discussion (continued)</b>	

**MARINE SCIAENID BIOLOGY AND MANAGEMENT- Moderators: Joan Holt (am), Scott Holt (pm); University of Texas Marine Science Center**  
**SUNDAY - 16 FEBRUARY 1997 8:00AM - 4:40PM; BLUEBONNET ROOM**

8:00am - 8:20am	<b>Movement of Adult Red Drum in the Central South Atlantic Bight</b> A. G. Woodward and Nick Nicholson	28
8:20am - 8:40am	<b>Utility of Trammel Nets for Sampling Subadult Red Drum in the Central South Atlantic Bight</b> Paul Medders and A. G. Woodward	29
8:40am - 9:00am	<b>Comparison of Red Drum Growth Models Among Texas Bays</b> Robert L. Colura and Roberta Buckley	29
9:00am - 9:20am	<b>Potential Impact of a Red Tide Bloom on Spawning Activity and Larval Survival of Red Drum on the Central Texas Coast</b> Scott A. Holt and Lawrence W. McEachron	29



MARINE SCIAENID BIOLOGY AND MANAGEMENT (continued)

Time		Abstract Page
9:20am - 9:40am	<b>Hook-Release Mortality of Red Drum <i>Sciaenops ocellatus</i> and Spotted Seatrout <i>Cynoscion nebulosus</i> from Common Angling Methods</b> R. Glenn Thomas, Claude Boudreaux, Julia Lightner, Elaine Lear, and Vivian Hebert	30
9:40am - 10:00am	<b>Red Drum and Spotted Seatrout Size Limits: They Work</b> R. Page Campbell, Lawrence W. McEachron, and Paul Choucair	30
10:00am - 10:20am	<b>COFFEE BREAK - Gunter Terrace</b>	
10:20am - 10:40am	<b>The Effects of Temperature on RNA/DNA Ratios in Larval Red Drum <i>Sciaenops ocellatus</i></b> Anna-Claire Fernandez and G. Joan Holt	30
10:40am - 11:00am	<b>Black Drum Life History in Texas Bays with Emphasis on the Upper Laguna Madre</b> Britt Bumguardner, Robert L. Colura, Eric Young, David Westbrook, and Roberta Buckley	31
11:00am - 11:20am	<b>Allozyme Analysis of Population Structure in Black Drum <i>Pogonias cromis</i> Along the Texas Gulf Coast</b> William J. Karel, Rocky Ward, and Ivonne R. Blandon	31
11:20am - 11:40am	<b>Stock Assessment of Spotted Seatrout <i>Cynoscion nebulosus</i> in Texas Coastal Waters</b> Mark R. Fisher	31
11:40am - 12:00pm	<b>Ontogenetic Trophic Patterns and Dietary Overlap of Larval and Juvenile Red Drum <i>Sciaenops ocellatus</i> and Atlantic Croaker <i>Micropogonias undulatus</i></b> Manuel Andres Soto, G. Joan Holt, and Scott A. Holt	32
12:00pm - 1:00pm	<b>LUNCH</b>	
1:00pm - 1:20pm	<b>Response of Atlantic Croaker Fingerlings to Practical Diet Formulations with Varying Protein and Energy Contents</b> D. Allen Davis and Connie R. Arnold	32
1:20pm - 1:40pm	<b>Genetic Variation in the Atlantic Croaker <i>Micropogonias undulatus</i>: Temporal Perspectives</b> Rocky Ward, Ivonne Blandon, William J. Karel, and Kevin L. Bowers	32
1:40pm - 2:00pm	<b>Effects of Parental Exposure to o,p'-DDT on the Behavior of Atlantic Croaker <i>Micropogonias undulatus</i> Larvae</b> C. Faulk and L. Fuiman	33
2:00pm - 2:20pm	<b>Development of Anti-Predator Behavior in Three Species of Sciaenids</b> Kirsten R. Poling and Lee A. Fuiman	33
2:20pm - 2:40pm	<b>Comparative Reproductive Biologies of Red Drum, Black Drum, and Spotted Seatrout from the Northern Gulf of Mexico</b> David L. Nieland and Charles A. Wilson	33
2:40pm - 3:00pm	<b>Growth and Yield-per-recruit Modeling of Spot <i>Leiostomus xanthurus</i> in the Chesapeake Bay</b> Kevin R. Piner and Cynthia M. Jones	34
3:00pm - 3:20pm	<b>COFFEE BREAK - Gunter Terrace</b>	
3:20pm - 3:40pm	<b>Cryopreservation of Sperm from Marine Sciaenid Fishes</b> William R. Wayman, R. Glenn Thomas, and Terrence R. Tiersch	34
3:40pm - 4:00pm	<b>Mechanisms of Chemical Interference with Reproductive Endocrine Function in Sciaenid Fishes</b> P. Thomas and I. A. Khan	35
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**BIOLOGY AND MANAGEMENT OF STREAM AND RIVER FISHES - Moderator: Gary Garrett, Texas Parks and Wildlife Department  
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***1997 Southern Division American Fisheries Society***

***Mid-year Meeting***

***13 - 16 February 1997***

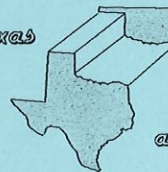
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***Abstracts***

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## ABSTRACTS

For Papers or Posters Presented at the 1997 Southern Division AFS Mid-year Meeting  
13 - 16 February 1997, Camberley Gunter Hotel, San Antonio, Texas

### Human Dimensions Research: An Introduction and Overview

ROBERT B. DITTON

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*Abstract.*—Human dimensions of natural resources management has been defined as “an area of investigation which attempts to describe, predict, understand, and affect human thought and action toward natural environments and to acquire such understanding for the primary purpose of improving stewardship of natural resources.” Besides the research component, there is also an application component where managers make effective use of human dimensions data and understanding in their day-to-day decision making. The objective of this paper is to increase awareness of human dimensions as an integrated part of fisheries management. First, six categories of human dimensions research are described to demonstrate the diversity of work in this area. Second, the most commonly used arguments for and against human dimensions research are reviewed and discussed. Third, some important human dimensions topics that have not received much attention at previous AFS meetings are featured to provide additional definition and focus for this research/management area. Fourth, the work of the AFS Committee on the Human Dimensions of Recreational Fisheries is described and an invitation to participate extended. Finally, each of the papers in the session is introduced and categorized in terms of the research categories presented earlier.

### Understanding Differences Between Tournament and Non-Tournament Bass Anglers in Texas

KEVIN M. HUNT

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*Abstract.*—Competitive fishing for black basses *Micropterus* spp. has become an increasingly popular form of recreational fishing. In 1995, over 21% of black bass anglers in Texas indicated they participated previously in a bass fishing tournament, up from 15% in 1992. With an increasing number of tournaments and tournament anglers, it appears management agencies have accepted competitive fishing as one of several specific fishing products demanded by the public. As a result, managers need to know more about tournament participants and their attitudes and preferences as well as those who do not participate to make informed management decisions. This paper presents results from the 1995 Texas Black Bass Angler Survey. Anglers who participated in tournaments in the previous 12 months and those who did not were compared on a variety of human dimensions variables. Specifically, anglers were compared on demographic variables, days and years of participation, attitudes toward competitive fishing and efforts to regulate it, and support for current and proposed black bass management tools. Similarities and differences between these two groups can help managers learn more about the tournament angler constituency, and quantify anecdotal information they receive on-site.

### Proactive Fisheries Management Implications of the 1996 Texas Saltwater Angler Surveys

BRIAN L. BOHNSACK

*Department of Wildlife and Fisheries Sciences, Texas A&M University, College Station, Texas 77843, USA*

*Abstract.*—Two variables that often characterize effective fish and game agencies include 1) tendencies towards proactive action on issues and 2) listening to constituents and understanding their desires. The Texas Parks and Wildlife Department, working in cooperation with Texas A&M University, has incorporated angler surveys into their management practices to improve effectiveness in managing both saltwater and freshwater fisheries throughout the state. Previous statewide angler surveys in Texas focused on contemporary problem solving. Instead of dealing with matters that are already contentious, an effort was made to predict future management issues and question anglers' opinions and attitudes regarding several broad policy and regulation topics. This will enable fisheries managers to better plan for necessary efforts in support of agency programs. A self-administered mail questionnaire was sent to 2,050 saltwater anglers during March 1996. Anglers were surveyed to evaluate their attitudes and behaviors on catch and release fishing, hooking mortality, live bait use, red drum allocation preferences, and fishing regulations. An effective response rate of 57% was achieved for the survey. Survey results have broad implications for the future of saltwater fisheries management in Texas, including red drum allocation, and the promulgation of fishing regulations.

## **Development and Application of an Index of Recreation Specialization for Largemouth Bass Anglers**

GENE R. WILDE

*Texas Tech University, Department of Range & Wildlife Management, Lubbock, Texas 79409-2125, USA*

*Abstract.*—Recreation specialization has been defined as a “continuum of behavior from a general to the particular reflected by equipment and skills used in the sport and activity setting preferences.” The location of anglers along this continuum is reflected in a number of characteristics such as frequency of fishing, technique preferences, and importance of catch. Despite the potential utility of the specialization concept, lack of a simple index has limited its adoption by fishery managers. Using results from a statewide survey of Texas largemouth bass *Micropterus salmoides* anglers, I developed an index that explains 80% of the variance in anglers' position along the specialization continuum. The index weights responses to four questions about anglers' orientation toward catch and release fishing, orientation toward catching trophy fish, use of fishing magazines, and the number of rod-reel combinations used on a typical fishing trip. I used an independent sample of anglers to validate and assess the utility of the index. Anglers, grouped by their index scores, differed significantly ( $P<0.01$ ) in several characteristics including their frequency of fishing, motivations and orientations toward fishing, and in their support for various management activities.

## **A Management Overview of Spotted Seatrout Anglers**

ROBIN K. RIECHERS

*Texas Parks and Wildlife Department, 4200 Smith School Road, Austin, Texas 78744, USA*

*Abstract.*—Management of fishery resources for maximum recreational benefits is often complicated by the differing opinions of a diverse set of user groups. In 1992, to obtain more information about anglers who prefer fishing for spotted seatrout *Cynoscion nebulosus*, a mail questionnaire was sent to 1,597 anglers who had indicated on a previous statewide survey that spotted seatrout was their most preferred species. The survey design included questions to obtain more detailed information about this sub-group of the general saltwater angling population, specifically their: demographics, participation rates, trip economic characteristics, and support or opposition of management and regulatory programs. Most (71%) anglers are moderately or extremely satisfied with their spotted seatrout angling in Texas. Anglers spent an average of 19 days fishing in saltwater each year and \$132 on average for a spotted seatrout fishing trip. Fifty-three percent indicated they would support a permit requirement for tournaments, but were split in their opinion over the effects of tournaments on spotted seatrout populations. Forty-two percent opposed the idea of specific catch and release areas for spotted seatrout. By obtaining information about angler sub-groups, management should be better able to maximize angler satisfaction by marketing for the different angling experiences desired, anticipating angler requirements, and predicting their reactions to various management programs.

## **Towards an Understanding of the Economics of Artificial Reef Use in Offshore Texas Waters**

DAVID W. BRITT

*Texas A&M University, Department of Wildlife and Fisheries Sciences, College Station, Texas 77843, USA*

*Abstract.*—A study of charter/headboat operators on the Texas Coast was conducted in 1994 to examine TPWD reef use of both recreational fishing and diving interests. The survey had a response rate of 47% from the dive boat captains but 72% response rate from fishing boat captains. The discrepancies in response rates between these two groups was attributed to misconceptions among dive boat operators that the study favored fishing interests. For this reason, the study will be replicated, but this time focusing on the diving community. The study will occur in two stages. The objective of the first stage is to identify the extent charter and head dive boat captains use TPWD artificial reefs. Reef use will be broken down to include the percentage of operators that use reefs, frequency of reef use, number of reef trips, and temporal and spatial patterns of reef use. Second stage objectives include collecting data from individual divers who use dive boats to access artificial reefs. Demographic characteristics, motivations, and economic value of recreational diving at TPWD artificial reef sites will be collected. Diver expenditures will be used to determine the regional economic impact of diving on the coastal economy.

## Angler Demographics and Opinions Over the Past Three Decades in Oklahoma

GREGORY L. SUMMERS

*Oklahoma Department of Wildlife Conservation, 500 E. Constellation, Norman, OK, 73072, USA*

*Abstract.*—Postal and telephone angler surveys were performed by the Oklahoma Department of Wildlife Conservation in 1969, 1977, 1985, 1990 and 1996. These surveys provided direction in policy and fisheries management decisions for the agency. Over time, little change was seen in how far or how long anglers fished. Largemouth bass, crappie and channel catfish were the three most sought species by Oklahoma fishers. Reservoirs and farm ponds were where a majority of angler preferred to fish. Oklahomans judged habitat improvement as the most important aspect of fisheries management and responded favorably to new agency programs over time.

## An Approach for Incorporating Instream Flow Needs in Basinwide Management Models

MARY C. FREEMAN

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*ASCI, Inc. WES Field Site, Bonneville Lock and Dam, Cascade Locks, Oregon 97014, USA*

JERRY ZIEWITZ

*U.S. Fish and Wildlife Service, 1612 June Ave., Panama City, Florida 32405, USA*

*Abstract.*—The states of Alabama, Florida and Georgia and the U. S. Army Engineer District, Mobile collaborated in a comprehensive study of water supplies and demands in the Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint river basins. Our objective was to develop models relating instream habitat value to streamflow at selected locations in the two basins, so that effects on riverine habitat could be included in evaluation of management alternatives. We applied the Riverine Community Habitat Assessment and Restoration Concept (RCHARC) to develop value functions that compared riverine habitat under alternative basin management strategies to habitat under reference conditions (in this case, simulated natural flow regimes). Habitat conditions were described by bivariate frequency distributions of channel depths and water velocities existing under a given flow regime, including seasonal and annual variability. The habitat-value functions interfaced with basinwide simulation models that projected flow regimes and water availability for instream (including habitat) and offstream uses under alternative management scenarios. The RCHARC approach facilitated comparison of alternative management proposals in terms of effects on riverine habitat and may also help identify proposals that could rehabilitate habitat to conditions more similar to those under natural flow regimes.

## **Instream Flows for Trout, Paddlefish, and a Delta River Fishery: A 3 for 1 Example**

STEVE FILIPEK

*Arkansas Game and Fish Commission, #2 Natural Resources Dr., Little Rock, Arkansas 72205, USA*

*Abstract.*—The formal setting of instream flows in Arkansas is a relatively new issue with enabling legislation giving this responsibility to the Arkansas Soil and Water Conservation Commission in 1985 (Act 1051). Since the mid-1980's, the Arkansas Game and Fish Commission has been working on this important issue but can only recommend instream flows to the ASWCC; it has no jurisdiction under Act 1051 to be on equal ground with ASWCC in actually setting flows. ASWCC did not formally start setting instream flows until the early 1990's and the first flow setting exercise was on the Arkansas River, the state's largest river (exclusive of the Mississippi making up the eastern border). There were few major conflicts over instream flows on the Arkansas between ASWCC and natural resource conservation agencies (AGFC, Pollution Control & Ecology, Parks & Tourism, Scenic Rivers, Natural Heritage) since this river has numerous navigational locks and dams on it which have changed it from a natural flowing system to a series of pools. The second river to receive attention in the state was the White River, which while impounded in its upper basin, is relatively natural in its lower section. Preliminary flow setting by ASWCC on the White gave little attention to AGFC and other natural resource agency recommendations on instream flow needs for fish and wildlife in this river. Fish and wildlife, navigation, and upstream farming interests pressured ASWCC into a reconsideration of the instream flow needs for the White with a strong recommendation from the public to let the experts in each field recommend flows for the White. This was done and this presentation will highlight the flows that a Fish and Wildlife, Recreation, and Water Quality Committee gave to ASWCC. These include IFIM results from earlier USFWS work on the trout section of the White, IF recommendations from paddlefish biotelemetry for the middle section of the river, and a method utilizing wetland vegetative communities (Florida method) along with a standard setting method (Arkansas Method) for the lower gradient, floodplain section of the river.

## **Current Status of Instream Flow Initiatives in Georgia**

RUSS ENGLAND

*28 Wildlife Resources, 2070 U.S. Hwy 270 SE, Social Circle, Georgia 30279, USA*

*Abstract.*—The Wildlife Resources Division (WRD) of the Georgia Department of Natural Resources (DNR) developed recommendations for protecting instream flows throughout the state, and published them in December 1995. DNR's Environmental Protection Division (EPD) was asked to consider adopting these recommendations as state policy and/or incorporating them into the state's water quality regulations in lieu of current policy, which reserves the 7Q10 flow below permitted water withdrawals. EPD has not adopted WRD's recommendations, but because of considerable interest from several non-governmental organizations, the directors of EPD and WRD established a Minimum Streamflow Work Group to review the various economic, environmental, and other impacts associated with the current vs. proposed policy and make recommendations to the directors. This work group is composed of representatives of both DNR divisions, five environmental/conservation citizens organizations, and other members representing public utilities, industry, regional development interests, and local governments. This is an on-going process that is expected to take several months to resolve. The eventual outcome is uncertain at this time, and could range from no change in existing 7Q10 policy to adoption of WRD's recommendations, or perhaps some compromise between the two.

## **Florida's Instream Flow Program**

DALES JONES

*Florida Game and Freshwater Fish Commission, St. John's River Water Management District, Environmental Sciences Division,  
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*Abstract.*—An overview of Florida's water management legislation and rules will be presented. The current status of instream flow evaluation techniques and projects will be reviewed, some of which are being utilized in other states. Emphasis will be given to the St. John's River Water management District's Minimum Flows and Levels Project Plan and the Wekiva River System Instream Flow Project. These flow recommendations are especially relevant to large, low-gradient floodplain rivers in the Southeastern United States.

## **Changes in Fish Community Structure Resulting from a Flood Control Dam in a Flinthills Stream, Kansas, with Emphasis on the Topeka Shiner**

WILLIAM G. LAYHER

*U.S. Geological Survey, Biological Resources Division, University of Arkansas at Pine Bluff,  
1200 North University, Box 4912, Pine Bluff, Arkansas 71611, USA*

*Abstract.*—Two streams were included in a study to determine the influence of a watershed dam on fish populations, especially native cyprinids and specifically the Topeka shiner. One stream was the site of a watershed dam development while the other was selected as a control. Sampling of the streams occurred for two years pre-impoundment and one-year post-impoundment. No significant difference was found between streams or between years during pre-impoundment. Highest cyprinid populations occurred in the control stream in the post-impoundment year with virtual elimination of cyprinids in the dammed stream in the post-impoundment year. Dams may act as a barrier to recruitment of cyprinids upstream into headwater areas following drought conditions. Introduction of predators such as largemouth bass into watershed reservoirs may also influence decline of native cyprinids. No conclusive evidence of precise cause of the decline in cyprinid populations in the dammed stream was found; the decline of populations after damming was established.

## **Instream Flows for an Agriculturally Impacted Low-Gradient Bayou**

WILLIAM G. LAYHER

*U.S. Geological Survey, Biological Resources Division, University of Arkansas at Pine Bluff,  
1200 North University, Box 4912, Pine Bluff, Arkansas 71611, USA*

*Abstract.*—Water quality variables, physical habitat variables, and fish standing stocks were estimated for the Bayou Bartholomew at thirteen sites from headwaters to the Arkansas-Louisiana border. Suitability indices were assigned to each site for each physicochemical variable measured by taxonomic guilds from suitability curves derived from population data previously collected in other river systems. Multiple regression models were developed from data collected in 1992 and 1993. Standing stocks of fishes and predicted standing stocks from model output were compared. Short lived species such as cyprinids and centrarchids showed highly correlated population levels between observed and predicted biomass suggesting that they closely track existing environmental conditions while other species guilds showed less relation to existing variables. Variables used in model development were examined for relation to flow levels in the bayou. Accurate assessment of flows in such a low-gradient stream remain a challenge and may need to be examined in relation to alluvial groundwater levels to better assess fish habitat conditions.

## **Considerations For Establishing Instream Flows for Freshwater Mussels**

JAMES B. LAYZER AND LESA M. MADISON

*Tennessee Cooperative Fishery Research Unit, U.S. Geological Survey  
Tennessee Technological University, Cookeville, Tennessee 38505, USA*

*Abstract.*—Defining the instream flow needs of freshwater mussels presents a unique challenge. Mussels, unlike other macroinvertebrates and fish, have limited mobility and cannot respond to rapid changes in stream discharge caused by storm events or operation of hydroelectric projects. This sessile behavior poses several problems for determining flow requirements for mussels. Firstly, methods such as the Instream Flow Incremental Methodology (IFIM) require data on the differential use of microhabitats (suitability curves) by the target organism. The sessile nature of mussels means that data obtained on microhabitat use are flow-conditional. That is, measured values of variables such as water depth are dependent upon the flow conditions when the measurements are made. Secondly, typical applications of IFIM assume that target organisms can track hydraulic conditions and move to suitable microhabitats as discharge changes. Thus, the total weighted usable area (WUA) for a stream reach may change little with a change in discharge, but the specific location of the suitable habitat may change and may not be readily available to the existing population of mussels. Options are available in the Physical Habitat Simulation Model (PHABSIM) that don't require making this assumption; however, the output is less easily summarized and interpreted. Although the boundaries of established mussel beds often are well defined, attempts to define them in terms of simple hydraulic variables such as water velocity are futile. Recently completed research in small and medium-sized streams suggest that complex hydraulic characteristics such as shear stress at the time of juvenile excystment, or shortly thereafter, may be a key factor in determining the location of mussel beds. Finally, the life history requirement of a fish host for mussel larvae necessitates identifying the host(s) and providing for suitable habitat conditions for the host in the immediate area of the established mussel bed.



## **Successes, Failures, and All Points in Between: the Outcome of Instream Flow Enhancement Efforts at South Carolina's Recently Licensed Hydroelectric Projects**

GERRIT J. JÖBSIS

*South Carolina Department of Natural Resource, P.O. Box 167, Columbia, South Carolina 29202, USA*

*Abstract.*—In the late 1980's, the South Carolina Department of Natural Resources (formerly Wildlife and Marine Resources Department) increased its efforts to improve instream flow for aquatic resources at hydroelectric projects undergoing relicensing. An instream flow policy was developed and subsequently accepted by the Federal Energy Regulatory Commission as a State Comprehensive Plan. The Department made instream flow recommendations based on site-specific studies and/or its instream flow policy at 11 hydroelectric projects in South Carolina. These projects affect flow of more than 90 river miles. The Federal Energy Regulatory Commission has recently made final decisions on these projects. Eight of the 11 decisions improve instream habitat for aquatic resources. Experiences gained from these projects should be useful for others attempting to improve instream flows at hydroelectric projects.

## **Preliminary Report on an Instream Flow Evaluation of the Upper San Marcos River, Hays County, Texas**

KEN SAUNDERS, KARIM AZIZ, ROY KLEINSASSER, KEVIN MAYES, RANDY MOSS, GORDON LINAM

*Texas Parks and Wildlife Department, River Studies Program, P.O. Box 947, San Marcos, Texas 78667, USA*

*Abstract.*—The upper San Marcos River is fed by thermally constant springs emanating from the Edwards Aquifer and has historically been home to four federally listed species: Texas wild rice *Zizania texana*, fountain darter *Etheostoma fonticola*, San Marcos Gambusia *Gambusia georgei*, and San Marcos salamander *Eurycea nanc*. As a result of increased pumping from the aquifer and the resulting concerns about preserving springflows, the Texas Parks and Wildlife Department initiated an instream flow study in April 1993. A combination of hydrologic modeling, habitat mapping, and biological survey data are being used along with water quality data to define flow requirement for the affected species. A series of 27 transects were placed in the river and data has been collected during three different flow regimes. Information collected along each transect included depth, water surface elevation, velocity, substrate types, and coverage by aquatic macrophytes. Faunal characterization occurred with a series of grid quadrats.

## **Survival of Freshwater Mussels Associated with Flow Rate and Water Level**

ROBERT G. HOWELLS

*Texas Parks and Wildlife Department, Heart of the Hills Research Station, HC 07, Box 62, Ingram, Texas 78025, USA*

*Abstract.*—Freshwater mussels (Family Unionidae) have gained increasing recognition as important elements of aquatic ecosystems, indicators of environmental degradation, and economically significant objects of commercial and sport fisheries. However, they have also been recognized as the most rapidly-declining faunal group in North America. Texas Parks and Wildlife Department began to address these issues in January 1992 when Heart of the Hills Research Station (HOH) initiated statewide unionid surveys and research into mussel biology. These efforts have subsequently revealed relationships between flow rates and water levels associated with mussel survival and losses. Initial results indicated numerous waters in Texas where mussel populations had been reduced or eliminated due to changes in flow rates and water levels. River bed scouring was found to be one of the most widely ranging factors in mussel declines. Overgrazing, land clearing, highway construction, impervious surfaces associated with general human development, increased rainfall, increasing frequency of severe storms, and patterns of reservoir water releases have contributed to scouring problems. Many of these same factors have also resulted in excess deposition of sand and silt in other areas resulting in smothered mussel beds and unacceptable habitat changes. Some manipulation of reservoir water levels has also been found to be detrimental to mussel survival. Rapid, dramatic, and long-duration changes in water level have been observed to be far more destructive than slow, limited changes for shorter time periods. Some such factors are necessarily linked to human activity, but others are unnecessary or could be easily modified or eliminated.

## Effect of Hypoxia on Instantaneous Growth of Bluegill *Lepomis macrochirus*

DAVID DEREK ADAY AND D. ALLEN RUTHERFORD

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*Abstract.*—The Atchafalaya River Basin (ARB) in southern Louisiana is North America's largest bottomland hardwood swamp. The ARB supports a variety of different habitats, which become markedly different physicochemically throughout the year. Temporal changes result in widespread hypoxia throughout the Basin. Our research focused on the effect of hypoxia on instantaneous growth of bluegill *Lepomis macrochirus*. We measured RNA-DNA and protein-DNA ratios, which have been shown to be sensitive indicators of short-term growth in fishes. Our objectives were to: 1) determine the effect of hypoxia on instantaneous growth by comparison of RNA-DNA and protein-DNA ratios of bluegill collected in hypoxic and normoxic waters of the ARB, and 2) test the effects of starvation and hypoxia on the RNA-DNA and protein-DNA ratios of bluegill through controlled laboratory experimentation. Bluegill were collected by electrofishing in both oxygen rich and hypoxic areas of the ARB. Dorsal epaxial muscle samples of approximately 200 mg were taken from each fish and stored in liquid nitrogen. A total of 57 fish were collected from both water types. We predict RNA-DNA and protein-DNA ratios will be significantly lower in bluegill collected from hypoxic water, indicating slower growth in these fish.

## Habitat Influences on Littoral Zooplankton Assemblages in the lower Atchafalaya River Basin, Louisiana

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*Abstract.*—Many factors may influence the abundance and species richness of littoral zooplankton, including plant type, plant density, and water quality. The Atchafalaya River Basin (ARB) is a forested floodplain swamp that supports large expanses of two exotic macrophytes, hydrilla *Hydrilla verticillata* and water hyacinth *Eichornia crassipes*. These macrophytes provide substantially different habitats, and we wanted to determine whether these differences in growth habitat were reflected in the abundance and species composition of resident cladocerans. In summer 1996, we collected zooplankton in hydrilla and water hyacinth beds. Preliminary results indicate that: 1) total cladoceran abundance was high in hyacinth beds, but cladocerans were a higher percentage of total zooplankton abundance in hydrilla beds; 2) plant-associated cladocerans were more abundant in hydrilla than in water hyacinth; 3) cladoceran abundance was positively related to macrophyte density in plant types, and 4) total chlorophyll a (phytoplankton and periphyton) differed among sites but not between plant types. The ARB is also characterized by substantial changes in physicochemistry during flooding, and analyses reveal that although cladoceran abundances were higher after the flood pulse, diversity was higher during the flood pulse.

## Effects of Hypoxia on Hooking Mortality of Largemouth Bass in the Atchafalaya Basin

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*Abstract.*—The Atchafalaya River Basin is the most popular bass fishery in Louisiana and contains areas that are chronically hypoxic. We used hook and line to capture largemouth bass from a normoxic habitat (daily minimum dissolved oxygen > 5 mg/L) and a hypoxic habitat (daily minimum dissolved oxygen < 2 mg/L) and released the fish into net pens that were checked daily for 14 d. Four treatments were performed: fish caught from the normoxic habitat and released into pens in the normoxic habitat, fish caught from the normoxic habitat and released into pens in the hypoxic habitat, fish caught from the hypoxic habitat and released into pens in the hypoxic habitat, and fish caught from the hypoxic habitat and released into pens in the normoxic habitat. Fish caught from the normoxic habitat and released into pens in the hypoxic habitat experienced higher mortality rates than fish from the other treatments. We concluded that largemouth bass can be angled from hypoxic water without greatly increasing their susceptibility to hooking mortality, but when angled from normoxic water and released into hypoxic water their incidence of hooking mortality rises. Angling tournaments in the Basin should adopt guidelines governing the handling and release of fish in relation to prevailing oxygen conditions.

## Habitat Influences on Parasite Assemblages of Young-of-the-Year Largemouth Bass in the Lower Atchafalaya River Basin, Louisiana

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**Abstract.**—Parasitism is common in wild fish populations, and the species and numbers of parasites that infect fishes are influenced by many factors, including physicochemistry of aquatic habitats. The objective of this study was to assess differences in parasite assemblages of young-of-the-year largemouth bass among lacustrine, riverine, and swamp habitats in the lower Atchafalaya River Basin. We collected 244 largemouth bass ranging from 37 to 123 mm TL and identified 14 parasite taxa from those fish. Kruskal-Wallis tests were used to assess differences in median (m) parasite loads among size and habitat groups. Fish (> 80 mm TL) collected from lacustrine habitats had total-parasite loads (m=139) that were significantly higher than total-parasite loads of fish collected from riverine habitats (m=76.5;  $P<0.05$ ). *Posthodiplostomum minimum* loads (m=33) of fish (>80 mm) collected from lacustrine habitats were significantly higher than in riverine (m=5.5;  $P<0.05$ ) or swamp (m=4;  $P<0.05$ ) habitats. Tapeworm plerocercoid prevalence was higher in riverine habitats (65 and 50%) than in swamp (37 and 8%) and lacustrine (13 and 10%) habitats. These data suggest that physicochemical characteristics of Basin habitats may significantly influence parasite assemblages of young-of-the-year largemouth bass.

## Effects of Environmental Hypoxia on Larval Fish Abundance in the Atchafalaya River Basin, Louisiana

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**Abstract.**—The Atchafalaya River Basin (ARB) is inundated each year by a spring flood pulse (~ 2 m). Increasing temperatures and river stage create large areas of water with dissolved oxygen concentrations < 20% saturation (hypoxia) during the spawning season of many fishes (May - July). Environmental hypoxia could significantly reduce survival of individual larvae and affect overall fish production of the entire ARB. The principle objective of this study was to determine if naturally occurring hypoxia was related to the abundance patterns of larval fishes of the ARB. Chi square analysis of presence-absence data indicated that *Lepomis* spp. ( $P < 0.672$ ) and *Dorosoma* spp. ( $P < 0.236$ ) were common in both hypoxic and normoxic water. Presence absence data on the following taxa show they were obviously more common in normoxic than hypoxic water: catostomids (10 to 0), cyprinids (8 to 0), ictalurids (13 to 0), and sciaenids (15 to 1). Also, when *Lepomis* spp. and *Dorosoma* spp. are included with all other taxa, chi square analysis indicate overall, larval fishes are not as common in hypoxic as in normoxic water ( $P < 0.001$ ). We feel these data suggest that hypoxia in the ARB is limiting overall fish production.

## Diel and Seasonal Patterns of Movement and Habitat Use of Spotted Gar in the Lower Atchafalaya River Basin, Louisiana

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**Abstract.**—Although spotted gar *Lepisosteus oculatus* are ecologically important in terms of their impact on trophic structure of aquatic communities, little is known about their basic ecology. We used radiotelemetry to determine movement and habitat use for 39 fish in the Atchafalaya River basin. Median (m) daily movement rates were greater during the spring flood-pulse (m=123.92 m/d) than during fall/winter (m=22.80 m/d) or summer (m=34.58 m/d). Median diel movements were greater in summer (m=40.42 m/h) than in fall/winter (m=15.13 m/h), and night movement (m=29.32 m/h) was greater than day movement (m=17.42 m/h), regardless of season. Spotted gar preferred fallen trees and avoided littoral stretches without cover. Permanent water bodies within the river-floodplain system were used during fall/winter and summer, and fish did not stray from initial capture sites. During the spring flood-pulse, fish showed lateral migration onto seasonally inundated floodplain habitats or to vegetation-rich backwater regions. Home ranges were restricted during summer (10.4 hectare) and fall/winter (5.7 hectare), but were larger during the spring flood-pulse (296.1 hectare). These data show the importance of backswamp and seasonally inundated floodplain habitats to spotted gar during spring, and the spatial extent of their use of these regions.

## Diet Overlap and Parasite Sharing Within Piscivores in the Atchafalaya River Basin

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*Abstract.*—Four species of fish were selected as a group of piscivores that collectively span range of habitats available within the Atchafalaya River basin. White bass *Morone chrysops* were considered specialists for normoxic lake and river water, while spotted gar *Lepisosteus oculatus* and bowfin *Amia calva* represent the other end of the continuum as hypoxic water specialists in bayous and swamps. Largemouth bass *Micropterus salmoides* were considered to be habitat generalists. On the basis of available literature, we predicted that fishes foraging in flooded swamp sites would feed predominantly on crawfish and that diet overlap of piscivores in lakes would be different from those in canals. We collected fishes by electrofishing, gillnetting and angling from lake, canal and flooded swamp sites. Fish diets were compared to determine diet similarity among species and between habitat types. We also examined the importance of host diet, habitat and phylogenetic relationships in structuring parasite assemblages in these fish species.

## Temporal and Spatial Distribution of Cyprinid Fishes in the North Canadian River Drainage, Oklahoma, Between 1921 and 1995

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*Abstract.*—A 20-year (1976-1995) survey of fishes in the North Canadian River (known as Beaver in the Oklahoma Panhandle), Lake Eufaula, and the Canadian River below Lake Eufaula produced 23 species of cyprinids. A review of 261 past and recent fish collections (1921 - 1995) by others revealed an additional eight species from the drainage. The distribution of relative abundance of these 31 cyprinid species over time is contrasted to changes in land use and habitat requirements of each species.

## Factors Influencing Fish Assemblage Structure in an Unfished Southeastern Reservoir

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*Abstract.*—The fish assemblage in L Lake, a 400-hectare former reactor cooling reservoir, has been periodically sampled since Steel Creek was impounded in 1985, permitting an evaluation of temporal changes in assemblage structure and the factors that influenced them. The fish assemblage in L Lake was initially composed largely of relatively small stream fishes (e.g., *Lepomis marginatus*) that were able to successfully colonize L Lake from Steel Creek. This assemblage was quickly replaced by larger species more typical of reservoir ecosystems (e.g., *Micropterus salmoides*) as they were intentionally or fortuitously introduced into L Lake. More recently, small species and phytophilous species (e.g., *Labidesthes sicculus*) have again increased in abundance as a result of the proliferation of aquatic vegetation following a macrophyte propagation program. The structure provided by the vegetation beds has increased species diversity by permitting colonization or recolonization by at least five species. Changes in the L Lake fish assemblage appear to be the result of predation and competition among species with the outcome of these processes strongly influenced by changes in the physical and chemical environment.

## Linkage of Fish Assemblages to Lake Mesohabitats: A GIS Application?

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*Abstract.*—GIS technology can be an effective tool in the inventory of aquatic habitats and associated biota. Matching the scale of habitat resolution with certain fish assemblage attributes so that precise relationships are developed has been problematic. This study will examine the degree to which mesohabitats in lakes influence fish assemblages over time and space. It will also explore how to link fisheries inventory information with regional GIS databases and current habitat classification systems. The research is being conducted on the Tishomingo National Wildlife Refuge in southcentral Oklahoma in a 5,443-hectare floodplain lake. Stratified random sampling will be performed over the two year study period using multiple sampling gears. Relationships between aquatic habitat types and fish assemblage attributes will be tested using different representations of the fish assemblage (morphological, reproductive, trophic guilds, etc.) with the objective of maximizing statistical precision. Early stages of the project have revealed some consistent differences in some species abundances between strata. The sampling design I have used could be used in similar systems, given standardized criteria for delineating mesohabitats (between macro- and microhabitat) in lakes, to identify critical habitat for certain species, size groups, or guilds.

## Stability of the Fish Assemblage in a Southwestern Reservoir (Lake Texoma, Oklahoma-Texas)

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*Abstract.*—North American reservoirs are relatively new ecosystems that have established artificial assemblages of both native and introduced fish. Because of the artificial nature of these ecosystems, the long-term stability of the fish assemblage is uncertain. To evaluate the stability of the fish community in the Red River arm of Lake Texoma, we conducted an intensive gill net survey between 1981-1984 and began this survey again in January 1995. Multivariate analyses were used to characterize the variation in the fish assemblage over this time period. In addition, relationships of species abundance with abiotic conditions (e.g., water level, turbidity) were examined. We found considerable seasonal variation in the abundance of *Morone saxatilis* and *Aplodinotus grunniens* while *Dorosoma petenense* showed high annual variation. Overall, the fish community of Lake Texoma appeared to be relatively stable, regardless of high annual variability in water levels and turbidity.



# Potential Establishment of Red Shiner Minnows In Upland Streams of Eastern North America: Consequences to Native Fish Faunas Under a Global Warming Scenario

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*Abstract.*—Red shiners have not successfully established in upland streams, where cooler water prevails, and communities are dominated by a complex group of other smaller fishes, many endemic. If streams warm 3-5°C, the movement of red shiners into these streams may occur. Introduction of red shiners has had devastating effects on native fishes in other areas. We test the effects of red shiners and warming on a suite of four native upland fishes, selected for different phylogenetic and ecological predictors of competition with red shiners. Experimental streams (3 pools, 2 riffles each) were constructed to model these communities. Behavioral interactions, and habitat use were recorded in experiments replicated in four seasons and three years. Final numbers of adult survivors, larval and juvenile production were determined. Aggression rates among other species were lower when red shiners were present, and increased at higher temperatures. Highest aggressivity was due to red shiners in summer during reproductive activities. Some species shifted mesohabitat use in the presence of red shiners by using different stream pools. Cooler temperatures delayed reproductive activity by female more than male red shiners, which spawned with other species. Initial samples indicate higher larval production at ambient upland temperatures, than warmed streams, and in streams with red shiners. However, specific identification of larval fishes is in progress.

## Measuring Change: the Tallapoosa River Fish Community in 1951 and 1996

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*Abstract.*—Historical rotenone data can be used to quantify temporal variation in fish communities. In 1951, the Tallapoosa River, Alabama, was free-flowing from its headwaters to Lake Martin ( $\approx 128$  km) and a rotenone survey was conducted 8 km upstream of the lake. Harris Dam, a peaking hydropower facility, became operational in 1981 (72 km upstream of Lake Martin), causing daily stage fluctuations of 1.5 m at the historic rotenone site. Perceived declines in recreational harvest of catfishes, downstream of Harris Dam, was the impetus to repeat the 1951 rotenone survey. Changes in the fish community were measured by comparing the 1951 and 1996 data. Biomass declined from 51.8 kg/ha ( $N = 2,331$ ) 1951 to 32.6 kg/ha ( $N = 366$ ) in 1996. Composition shifted from a cyprinid/ictalurid (47/44%) dominated community (1951), to a centrarchid (73%) dominated community (1996). Cyprinids declined from 1,380/ha (1951) to 37/ha (1996), most representative of the overall decrease in fish abundance. Juvenile catfishes ( $< 150$  mm) declined from 1,201/ha (1951) to 77/ha (1996), indicating recruitment may be impacted and realized in decreased harvest of adult catfishes. The shift to a centrarchid dominated community is consistent with the hypothesis that “generalist” species are more tolerant of disturbance regimes.

## **Impacts of Small Stream Impoundments on Fish Community Assemblages in South Carolina**

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*Abstract.*—South Carolina has many miles of streams that traverse five major ecoregions (e.g., Blue Ridge Mountain, Piedmont, Sandhills, Upper Coastal Plain and Lower Coastal Plain). Many of these streams, particularly in the Piedmont and Sandhills regions, have been impounded during the last two centuries. As a result, changes have occurred in the resident fish communities. Stream surveys have shown that indigenous fish assemblages have been altered by dam placement. Index of biotic integrity (IBI) applications using fish communities have indicated negative effects on stream health below and between impoundment locations. Potential effects of impoundments include altered flow regimes, blockage of nutrient transfer and fish migration, changes in water quality, species introductions, and erosion due to substrate scouring. To reduce impacts from impoundments, in 1989 we developed an ecoregion specific instream flow policy and guidelines for siting new impoundments. We have used these documents for evaluating FERC relicensing projects and Corps 404 permit applications. Analysis of case histories found these policies to be somewhat effective in assuring usable flow releases from existing facilities and protecting free-flowing streams.

## **Virginia's Urban Fishing Program**

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*Abstract.*—The Virginia Department of Game and Inland Fisheries initiated a 2-year, 3-site prototype urban fishing program in 1993 to increase angling participation in urban and suburban areas. The program has since become permanent, and the initial 3 sites were joined by a fourth in 1995 and 2 new sites in 1996. Program components consist of: Department-locality partnerships, a 2-phase catchable stocking schedule, support features and creel evaluation. Objectives are to support fishing pressures of 2,470 hrs/ha per site, to produce average annual catch rates of 1 fish/hr and to attract a significant number of novice and junior anglers. Stocking adjustments were made in 1995, and current annual rates are 2964 trout/ha and 1235 catfish/ha. per site. Stocking frequencies are twice per month Nov-Apr (trout) and monthly May to Aug (catfish). Pressure objectives were substantially exceeded, but catch rates averaged only 0.5 fish/hr. Return of stocked fish was high, and the program continued to diversify the Department's traditional constituent base while increasing license sales. The program is successful and growing; however, catch rates of 1 fish/hr. are likely unrealistic. Cooperative localities are mandatory for the program - which is truly a series of partnerships - to succeed.

## **Private Pond Technical Guidance Program Customer Survey, 1995**

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*Abstract.*—In 1996, we mailed a questionnaire to all pond managers who received site visits from Freshwater Fisheries Section (FFS) biologists during 1995. The purpose of the questionnaire was to obtain pond managers' opinions of the FFS technical guidance program and to evaluate those opinions to improve the quality of service delivered. Of 1,250 surveys mailed, 433 were returned, representing every county in the state. The survey indicated that FFS biologists were timely, courteous, attentive, professional and that recommendations were consistent with the needs and abilities of pond managers. The survey also indicated that pond managers would like to have more information included in management recommendations, and would like to have increased follow-up contact for the FFS. Managers want to be present when their pond is inspected. From an internal perspective, the survey revealed a need for individual FFS district biologists to make adjustments to their technical guidance routine for the purpose of standardization. The customer survey is a good tool to use in maintaining contact with constituents for the purpose of improving service.

## **A Comparative Performance Study of Two Native Strains of Largemouth Bass in South Carolina Farm Ponds**

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*Abstract.*—A statewide reciprocal transplant study was initiated to compare the performance of two strains of largemouth bass. Allozyme surveys have shown South Carolina coastal largemouth bass populations possess 98% Florida alleles, while Piedmont populations possess as few as 36% Florida alleles. Thirty seven new or renovated farm ponds were stocked in 1994 and 1995 with fingerlings produced from either the coastal or Piedmont strain of largemouth bass. Our objective was to characterize performance differences between the two strains by evaluating growth of original stocks at one and three years, and the change in allelic frequencies over subsequent year classes. Selected water quality parameters were monitored to define productivity differences among ponds. First year growth was analyzed using multiple regression. The model, using region and strain stocked as main effects, and pond as a nested effect, was a significant predictor of growth rate ( $p=.01$ ;  $R^2=0.62$ ). However, adjusting computed F-statistics to account for the random effect of the variable pond indicated that only region and pond were significant predictors of growth. Water quality parameters did not explain a significant portion of among pond variation. Further analysis of age-1 growth data, and genetic analysis of subsequent year classes are on going. Year three growth data will be collected beginning June 1997.

## **Mechanisms Regulating Age-0 Gizzard Shad *Dorosoma cepedianum* Interactions with Age-0 Bluegill *Lepomis macrochirus* in Small Pond Experiments and a Public Fishing Lake**

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*Abstract.*—We are investigating the influence of larval gizzard shad *Dorosoma cepedianum* on larval bluegill *Lepomis macrochirus*, and indirectly on largemouth bass *Micropterus salmoides* in Southern waters. Our hypothesis is that competition by larval shad negatively affects larval bluegill survival, reducing age-0 bass survival through their first winter. To date we have conducted (1) a series of small pond experiments exploring competition between larval shad and bluegill, and (2) a study of larval dynamics in an intensively-managed fishing lake in Walker County, AL after removal of 36.9 lbs of shad/acre. Preliminary results indicate that in Walker County Lake after shad removal, juvenile shad exhibited tremendous first-year growth relative to our ponds. Also, between systems, peak larval shad density did not exceed 10 fish/m<sup>3</sup>, versus 2-90 fish/m<sup>3</sup> for larval bluegill. Rapid juvenile shad growth in Walker County Lake suggests that age-0 shad do not provide valuable forage for largemouth bass. The low larval shad abundance common to both systems, coupled with differential growth of juvenile shad between systems, is likely to affect competition among the species. Further analysis of the dynamics of this competition continues, including other sources of age-0 shad mortality.

## **Use of High Density Largemouth Bass Populations to Improve Total Fisheries of Small City and State Park Impoundments in Texas**

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*Abstract.*—In a series of small ( $\leq 10$  hectare) city and state park impoundments, creation and maintenance of a high density ( $\geq 150$  fish per hour in electrofishing samples) largemouth bass ( $\geq 150$  mm TL) population was attempted to monitor response of sunfish populations and change in angler catch rates. Spring, summer and fall electrofishing and spring and fall angling samples were taken in treated and untreated impoundments. Angler catch rates of both largemouth bass and sunfishes and growth of sunfishes appears to be increasing in treated impoundments. Use of largemouth bass under the legal harvest size in small impoundments may provide a means of improving multiple fisheries with one management action and expense.

## Relative Abundance of Catfishes in Main Channel and Secondary Channel Habitats in the Lower Mississippi River

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**Abstract.**—The U.S. Army Corps of Engineers maintains a commercial navigation channel in the Lower Mississippi River by managing water flow with rock wing dikes and bank paving (revetments). Revetments prevent the river from carving new channels in the alluvial plain. Wing dikes, by diverting flow, accelerate sedimentation of downstream secondary channels and loss of aquatic habitat. Losses of secondary channel habitats may hold important ecological implications. We compared the abundance of catfishes (*Ictalurus furcatus*, *I. punctatus*, and *Pylodictis olivaris*) in shallow sandbar and steep bank habitats at two main channel and four secondary channel locations in the Lower Mississippi River by sampling with electrofishing from August to December 1994. Electrofishing indicated numbers of all three catfishes were significantly ( $P < 0.10$ ) higher in main channel habitats in August, whereas numbers of channel catfish and flathead catfish were significantly higher in secondary channel habitats in October. Our results do not support a unique need to maintain secondary channel habitats, but secondary channels seem to provide beneficial habitat for catfishes at certain river stages. We conclude that important catfish habitat would be lost if sedimentation eliminated the secondary channels.

## Management Benefits of Stocking 175-mm Channel Catfish in Oklahoma Reservoirs

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**Abstract.**—Long-term stockings of 75- TO 125-mm channel catfish were ineffective at increasing catfish populations in Oklahoma reservoirs, based on pre- and post-stocking gill net evaluations. Beginning in 1993, channel catfish were raised to 175-mm in one growing season (June through October) by stocking fry at lower densities in hatchery ponds (30,000/ha). Objective criteria were established for stocking catfish in Oklahoma reservoirs, and lake stocking densities were reduced to evaluate survival of 175-mm channel catfish. Stockings of these advanced fingerlings for 2-3 years in 14 reservoirs (10 to 2560 surface-hectare ) significantly increased channel catfish catch rates in gill nets in 13 cases, and met a goal of raising populations to above the state average in 12 cases. Gillnet catch improvements persisted as catfish recruited to the fishery ( $>300$  mm) following stockings. A reduction in the relative weight of channel catfish was noted in some lakes, and alternate-year stockings or reduced stocking densities were implemented to improve condition. Based on these results, existing reservoirs with below-average populations receive 175-mm channel catfish in Oklahoma, and stockings of smaller fingerlings are now limited to new impoundments.

## Gear Biases Associated with Collecting Catfishes in Alabama

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**Abstract.**—Three gears were evaluated for collecting flathead catfish *Pylodictis olivaris* and channel catfish *Ictalurus punctatus* in Alabama; small and large hoop nets, electrofishing grids, and a catfish "rigged" electrofishing boat. Catfishes were collected monthly from four sites on the Tallapoosa River, May-September 1996. Type of gear and time of day introduced bias in terms of both species and size of fish captured. Small and large hoop nets selected for large flathead catfish ( $>350$  mm). Electrofishing grids set at night targeted small channel catfish (8-200 mm), but captured only two flathead catfish. Daytime electrofishing grids were not effective for catching catfishes. The electrofishing boat captured both species and a larger size range of catfish (20-950 mm) than the other two gears. However, catfish  $> 550$  mm were rarely captured. Electrofishing technique was also important, whereas, catch-per-unit-effort usually doubled when a "chase boat" was employed. Gear biases are likely caused by temporal and spatial variation in habitats sampled and size selectivity. For example, electrofishing grids sample shallow water and are effective only at night for small individuals. Because of differences in species and size of catfishes collected and the habitats targeted by each gear type, all three gears are needed to sample catfish populations effectively.

## Comparability of Channel Catfish Stock Descriptors Obtained from Different Hoopnet Configurations

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**Abstract.**—Channel catfish *Ictalurus punctatus* stock characteristics were compared from samples collected using three different hoopnet configurations (large hoopnet LH(3.81): 4.3-m long; 7-hoops with 1.07-m diameters; 3.81-cm bar mesh netting, small hoopnet SH(3.81): 1.3-m long; 4-hoops with 0.51-m diameters; 3.81-cm bar mesh netting, and small hoopnet SH(2.54): 1.3-m long; 4-hoops with 0.51-m diameters; 2.54-cm bar mesh netting) in the Yockanookany River, a small floodplain river in central Mississippi (1994-1995). Channel catfish were fully recruited at 35-cm total length (TL) in LH(3.81) and SH(3.81) and at 30-cm TL in SH(2.54). Approximately three times the number of channel catfish were collected with SH(2.54) than with LH(3.81) and SH(3.81) combined. Due to differences in length at full recruitment relative to mesh size, comparative analyses were conducted only on channel catfish  $\geq 35$ -cm TL. Mean lengths, mean weights, length-frequency distributions, proportional stock densities, and mean daily catch per unit effort values (CPUE: g/hoopnet night) were similar among hoopnet configurations. Sample size was identified as an important consideration due to variability in catch rates and poor CPUE correlation between large and small hoopnet configurations. Use of small hoopnets would reduce logistical challenges associated with sampling small rivers. Additionally, use of the smaller mesh size would allow inclusion of smaller channel catfish in stock assessments.

## Comparison of Low-Frequency Electrofishing with Hoop Nets for Assessing Riverine Blue Catfish Populations

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**Abstract.**—Catfish rank second in popularity among Texas anglers. Hoop nets have been traditionally used to collect catfishes in lotic systems. However, catch may be seasonally biased toward periods when fish movement is greatest. Texas Parks and Wildlife Department biologists conduct river fishery surveys during summer months when flows are typically low. Although blue catfish *Ictalurus furcatus* are predominant in the south Texas coastal plains region, baited hoop net catch rates are typically low. Recently, low-frequency electrofishing has been employed to collect flathead catfish *Pylodictis olivaris* in the southeastern U.S. We compared baited hoop nets with electrofishing to determine if the latter could provide population characteristics data for blue catfish. Catfish were collected from two south Texas rivers using baited hoop nets and electrofishing in July and August, 1995 and 1996. Preliminary analyses indicate that electrofishing required 3.3 man-hours of effort to collect 30 stock-size (300 mm) fish, while nets required 170.0 man-hours of effort. One hundred seventeen catfish were collected by electrofishing, ranging in size from 45 to 775 mm. Only two fish, 320 and 398 mm in length, were collected with nets. Low-frequency electrofishing appears to hold promise as an efficient sampling method for collecting blue catfish in southern rivers.

## Evidence That Fluctuations in Prior Feeding Activity and Solar Radiation Influence Subsequent Feeding Activity in Commercial Channel Catfish Ponds

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**Abstract.**—Although feeding activity of catfish has been shown to be related to water temperature, fish size and health, and density and biomass, large daily variation in feeding activity has been observed in commercial ponds despite maintenance of these conditions at a constant level. Anecdotal evidence suggests that fluctuation of dissolved oxygen, as well as other water quality and meteorological parameters, also influence feeding activity. We used state-space time series modeling to relate daily fluctuations in feeding activity (as measured by amount of feed applied to each pond) to fluctuations in amount fed, early morning dissolved oxygen, mean water temperature, and total cumulative solar radiation from preceding days for 25 commercial channel catfish ponds in Mississippi. The model indicated a significant inverse relationship between amount fed and the amount fed the previous day in 24 of 25 ponds. Additionally, amount fed was significantly and directly related to total cumulative solar radiation the previous day in 22 of 25 ponds. No consistent relationships were found between amount fed and early morning dissolved oxygen or mean water temperature on previous days. Knowledge of feeding activity and meteorological conditions from previous days can assist commercial producers in prediction of daily variation in feeding activity.



## Population Dynamics of Paddlefish *Polyodon spathula* in the Keystone Reservoir System, Oklahoma

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*Abstract.*—Paddlefish *Polyodon spathula* are native to the Arkansas River, including Keystone Reservoir in northcentral Oklahoma. Since creation of the reservoir in 1964, there have been anecdotal reports that paddlefish are increasing in abundance; however, to date there has been no surveys to verify this. Our objective was to determine the abundance and distribution of the paddlefish in the Arkansas River below Kaw Dam, the lower Cimarron River, and Keystone Reservoir. In winter 1996, paddlefish were captured in large-mesh gill nets at 19 randomly selected sections of the reservoir. Captured fish were measured, weighed, and jaw tagged with a monel tag. Eighty-four percent of the 443 fish collected were in the Cimarron River arm, 12% in the Arkansas River arm, and 4% in the main pool. Catch rates were significantly higher in the Cimarron River arm than the Arkansas River arm and main pool, but the mean size of fish in the Cimarron Arm was smaller. Using a modified Schnabel procedure, we estimated a population of 7,779 paddlefish (95% CI of 5,734 - 26,044) for 1996. Limited spawning occurred in 1996 because of low water flow in the Arkansas and Cimarron rivers. We will compare these findings with those from winter 1997 collections to identify potential trends.

## The Commercial Fishery for Paddlefish in Grand Lake of the Cherokee, Oklahoma, 1972-1991

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*Abstract.*—The paddlefish fishery in Grand Lake was investigated to determine the population size and structure, the harvest, and rate of exploitation by sport and commercial fisheries. There were 5,900 paddlefish (400-1560 mm BL) tagged and released 1979-1993 for determination of population parameters and exploitation. The reported commercial exploitation increased from 1979-80 (0.7%) and 1980-81 (0.2%) to 1984-85 (6.1%) and 1986-86 (5.8%) stimulated by a demand for paddlefish caviar. A total of 15,565 pounds of caviar were legally obtained and sold by commercial fishermen from 1980-1991. In the 1983-84 commercial harvest season the average female observed being processed for caviar (N=383) weighed 63.7 pounds, yielded 11.5 pounds of raw eggs, and 7.7 pounds of processed eggs, or caviar. The commercial fishermen were able to target and harvest mature paddlefish at a rate at least two time higher than their proportional abundance in the population. There were many types of restrictions implemented to address the potential over-harvest. In 1990 and 1991, overwhelming public sentiment expressed at public hearings against the continued commercial use of paddlefish led to the closure of the commercial fishery in 1992.

## First Year Characteristics of Sympatric Populations of Largemouth Bass and Spotted Bass in a Tennessee Reservoir

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*Abstract.*—Young of the year largemouth bass *Micropterus salmoides* and spotted bass *Micropterus punctulatus* were sampled biweekly from early July until late September each year from 1992 to 1996 in Normandy Reservoir, TN. Bass were collected using hand-held electrofishing gear along 24 fixed transects divided equally among four areas of the reservoir. Both species were also collected from three cove samples collected annually over the same period. Sagittal otoliths were removed from both species to calculate hatch date frequencies and age-specific growth rates. Year class strength of largemouth bass was related to rising water levels in the early spring and was determined by late August each year. Varying densities of young-of-year threadfin shad *Dorosoma petenense* had no noticeable effect on year class strength of both bass species. In years when the reservoir achieved full pool by late April, largemouth bass exhibited bimodal length frequency distributions; early-hatched fish had faster growth rates than those hatching later. Spotted bass year-class strength was not correlated to water level events; growth rates were similar to largemouth bass but increased growth rates were not evident for early-hatched fish. Spotted bass catch rates varied unpredictably each sampling season and year class strength did not appear to be fixed during their first growing season.

## **Genetic Distance Between the Largemouth, Smallmouth, and Spotted Basses (Genus *Micropterus*) as Determined by Mitochondrial DNA Analysis**

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**Abstract.**—Geographic isolation and habitat specialization has aided in the evolution of and genetic integrity of the Micropterid bass species of North America. Extensive stockings of introduced species into waters previously containing native species has resulted in numerous hybridization events and loss of vigor of many natural bass populations. Our goal was to determine the genetic distance between the largemouth, smallmouth and spotted basses using mitochondrial DNA analysis. This will provide baseline information for future comparisons with the other Micropterid bass species having more restrictive ranges. Mitochondrial DNA was examined in 15 largemouth bass *Micropterus salmoides*, 15 smallmouth bass *M. dolomieu* and 15 spotted bass *M. punctulatus* using 13 restriction endonucleases. The smallmouth and spotted basses had the closest genetic similarity, which would be predicted by the numerous reports of hybridization between these two species. No evidence of past hybridization events was observed for the 45 individuals of the present study.

## **Using Angler Log Data to Estimate Size Distribution of Angler-Caught Largemouth Bass from a Total Catch-and-Release Fishery**

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**Abstract.**—Daily angler logs were used to obtain lengths ( $N = 697$ ) and weights ( $N = 589$ ) of angler-caught largemouth bass in Farm 13 Reservoir, Florida (2,632 hectares) from January through May 1993 where a catch-and-release regulation was in effect. Forty-three percent of the angler-caught fish were smaller than 0.9 kg (2 lb), 52% were 0.9 to 2.3 kg (2-5 lb), and 5% were larger than 2.3 kg. Anglers caught 71% of the bass using live bait (e.g., golden shiners) and 29% using artificial lures. The mean size of bass caught using live bait was significantly larger than bass caught using artificial lures. Size and weight distribution data from daily angler logs complemented data from an access point creel survey. Using both sampling methods, we estimated that 478 trophy largemouth bass ( $>3.64$  kg) were caught and released by anglers during the 5-month study period. Daily angler logs were an efficient method for collecting data on the sizes of largemouth bass caught by anglers where a restrictive harvest regulation was in effect.

## **The Relationship Between Fluctuating Reservoir Level, Diet, and Growth of Age-0 Largemouth Bass in Kentucky Lake, Kentucky and Tennessee**

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**Abstract.**—We examined the growth of age-0 largemouth bass in Kentucky Lake in 1993 and determined the diet and its effects on growth. Largemouth bass were divided into two size classes based on the mean length for each sampling date. There was a pivotal period in mid-July when the overall growth rate of the cohort slowed. This was a result of the growth of small age-0 fish slowing dramatically, while the growth of the large fish continued at near the previous rate. During this period the larger bass were consuming more fish prey by weight than small bass and less insects and zooplankton. The variation in growth within the cohort resulted in a multi-modal length-frequency distribution by the end of the summer. We also examined the relationship between diet and reservoir level fluctuations. Kentucky Lake experienced unusual water level fluctuations in the summer of 1993 because of flooding on the Mississippi River. Feeding by age-0 largemouth bass on fish prey was positively related to reservoir elevation. Insects in the diet were inversely related to reservoir level. No relationship was found between reservoir level and zooplankton in the diet.

## Characteristics of Age-0 Largemouth Bass in Sale Creek Embayment, Chickamauga Reservoir

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**Abstract.**—Age-0 largemouth bass *Micropterus salmoides* were collected bi-weekly from 22 May through 22 August 1995 using standard backpack electrofishing techniques in littoral areas. Hatching distribution and daily growth rates were determined by examining sagittal otoliths. Hatching duration extended for 68 d from 6 April to 13 June. Hatching success was disrupted for a 10 d period in mid April, when air and water temperatures dropped suddenly. Disjunctive spawning resulted in a bimodal hatching distribution, however no evidence of a bimodal length distribution existed in the fall. Mean growth rates ranged from 1.04 to 0.79 mm/day. A positive relationship was found for total length and age. Growth rates were similar among sub-cohorts age classes and size advantages for larger cohorts resulted from earlier hatching dates. Mid-summer grow rates increased significantly during intervals of decreased habitat complexity attributed to water level drawdown. Early-hatch subcohorts shifted to piscivory at a younger age (50d) than did mid-hatch subcohorts (65d). Late-hatch subcohorts were unable to shift to piscivory.

## Influence of Phytoplankton, Primary Productivity and Temperature on the Dynamics of Zooplankton Populations in Hugo Reservoir, Oklahoma

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**Abstract.**—I took weekly samples of zooplankton, phytoplankton, and primary productivity at four sites in Hugo Reservoir, Oklahoma between March and September 1996. My objectives were to assess the importance of producer abundance on the structure of the cladoceran populations. Limnological parameters (water temperature, phytoplankton abundance, and primary productivity) were used to predict zooplankton population parameters (abundance, egg ratio, and production) using multiple regression models. Preliminary results indicate that early in the year, as water temperature increased, *Bosmina longirostris* was the dominant cladoceran species. In June, as water temperatures exceeded 25 °C, blue-green algae increased in abundance. *Bosmina longirostris* abundance declined and *Ceriodaphnia lacustris*, *Diaphanosoma* spp., and *Moina* spp. abundance increased.

## Variability in Dissolved Oxygen Concentration within Aquatic Macrophyte Beds

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**Abstract.**—Dissolved oxygen concentrations in areas with abundant aquatic macrophytes are often reduced to levels seemingly unsuitable for most fish species. Yet, abundance of fish within aquatic macrophytes is high. Our objective was to investigate how juvenile largemouth bass are able to inhabit densely vegetated sites that often have unsuitable oxygen levels. We measured oxygen levels and largemouth bass abundance in vegetated and unvegetated sites, to document fish distributions relative to oxygen levels. Then, we tested (1) if fish left densely vegetated sites during periods of low oxygen concentrations, and (2) if variability of dissolved oxygen concentrations within densely vegetated sites allowed fish to find refugia with tolerable oxygen levels. Our results suggest that fish do not leave vegetated areas during periods of low oxygen. Instead, horizontal and vertical variability in dissolved oxygen concentrations within plant beds allow fish to find areas which meet minimum oxygen requirements.

## An Experimental Evaluation of Growth of Juvenile Bluegill and Largemouth Bass In Diverse and Monospecific Aquatic Plant Beds

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**Abstract.**--Aquatic plant beds containing high species diversity provide a suite of spatially complex habitats important to the growth of juvenile centrarchids. Concern has arisen over large dense monospecific stands of exotic aquatic plants in littoral zones of lakes and reservoirs, and their impact on the growth of small fishes inhabiting these areas. We investigated the relationship between aquatic plant beds and individual fish growth by conducting a pond experiment. Juvenile bluegill *Lepomis macrochirus* and largemouth bass *Micropterus salmoides* were introduced into enclosures with two aquatic plant treatments that consisted of either a bed of an exotic monoculture, *Hydrilla verticillata*, or plant beds containing diverse natives, *Vallisneria americana*, *Heteranthera dubia*, *Potamogeton nodosus*, and *Najas guadalupensis*. Plant treatments were replicated 6 times in 10 m diameter enclosures constructed within the experimental pond. Plant complexity and prey availability were measured, and individual growth rates of fishes were determined by use of dorsal marks with different color combinations of fluorescent elastomer dye. To determine seasonal variation in growth rate, pop-nets and strata-traps were used to obtain subsamples of fish in each treatment (monoculture n=42 and diverse n=38) midway into the experiment. After 6 months the pond was drained and all fish were collected, identified, and lengths (SL & TL; mm) and weights (g) measured. Even though plant complexity differed significantly ( $P < 0.05$ ) between plant treatments, no significant difference ( $P > 0.05$ ) was noted in individual growth rates of the fishes.

## Movement of Triploid Grass Carp *Ctenopharyngodon idella* in Small Hydropower Reservoirs on the Guadalupe River, Texas

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**Abstract.**--A total of one hundred-twenty-five adult triploid grass carp were surgically implanted with radio-transmitter tags and released into five Guadalupe River reservoirs in Texas. These fish were tracked to follow movement away from target areas over time and particularly during flood events. Radio tags were programmed to pulse at varying rates depending on temperature and to activate on/off cycles (4 days on and 3 days off weekly for 6 weeks followed by 5 days on and 25 days off for 5 months followed by 6 days on and 85 days off) continuing until batteries expire. After 1-year's tracking, most (109) radio frequencies are being found and nine fish have moved downstream past from one to four reservoir dams. Drought conditions, extremely low river flows and no flood events throughout the study have provided the least conducive conditions for fish movement from reservoirs.

## Intraspecific Competition and Habitat Selection by Size Classes of Largemouth Bass

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**Abstract.**--Intraspecific competition and selection for habitats by size classes of largemouth bass *Micropterus salmoides* were studied in a manipulative experiment. Largemouth bass ('small' and 'large') habitat preferences were evaluated in artificial pools with three equal-area structures (PVC pipe stand, concrete block, and artificial grass) and pools with no structure. In pools with structure, small fish preferred the concrete blocks while larger fish preferred the artificial grass regardless of whether alone or paired with an opposite size class fish. These data indicate that size-dependent habitat preferences may reduce intraspecific competition. In pools without structure, fish of both sizes preferred the same area when alone, but only the large fish remained in this area when paired with a smaller conspecific. Therefore, when habitat preferences do not differ between size-classes, larger individuals displace smaller individuals from their preferred habitat.

# A Comparison of Natural and Synthetic Forms of Man-Made Habitat in Two Oklahoma Reservoirs

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*Abstract.*—Preferences of three centrarchid genera were determined for four types of man-made habitat in Thunderbird Reservoir and Arbuckle Reservoir, Oklahoma from May, 1994 through April, 1995. Twelve habitat sites and three control sites were randomly chosen and sampled in each reservoir. Habitat consisted of cedar brush piles, hardwood brush piles, shoreline tree felling, and "pup-tent" shaped structures made of Geoweb, a synthetic plastic material. All structures were placed at depths of less than two meters. Electrofishing surveys conducted at night, twice monthly at all sites in each reservoir revealed that fish densities at man-made habitat sites were significantly higher than at control sites. Cedar brush piles contained the greatest overall densities of all sizes and species of fish collected. Largemouth bass *Micropterus salmoides* and Kentucky spotted bass *M. punctulatus* were found to be most dense at cedar piles. Crappie *Pomoxis spp.* showed no significant differences in habitat selection in this study. Sunfish *Lepomis spp.* selected cedar brush piles significantly more at both reservoirs. Although habitat type had a significant impact on witnessed fish densities, perhaps the biggest determinant of fish found at these sites was a function of available interstitial space within each differing form of habitat. Brush structures with larger interstitial spaces had higher numbers of legal-sized largemouth bass ( $\geq 351$  mm) and the largest crappie collected. A cost:benefit analysis indicated that addition of brush was a more efficient means of habitat enhancement than were synthetic materials such as Geoweb.

## Temporal and Ontogenetic Variation in Feeding by Larval Bluegill

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*Abstract.*—In the southern United States, bluegill larvae are present in the limnetic zone of lakes for a 5-month period. Zooplankton communities generally undergo distinct seasonal shifts and different cohorts of larval may face a prey base that changes in taxonomic composition and in mean size. Our objectives were to examine how feeding and diet of larval bluegills vary temporally and ontogenetically, and how this relates to seasonal succession of the zooplankton community. Feeding of 4-12 mm TL larvae was restricted to periods of daylight, and significant diel variation in the number of prey per larvae occurred primarily in the morning and evening. Prey numbers in larval guts were generally low in the spring and high in the summer; whereas estimated dry biomass ingested was highest in the spring and lower throughout the summer. In the spring, widths of ingested prey were near the limit imposed by gape diameter for all larval sizes, and the range of widths increased with larval length. During summer, prey widths were well below gape limits in all but the smallest larvae and the range of prey widths did not change with larval length. Rotifers and copepod nauplii numerically dominated the diet among all larval sizes. However dietary proportions of copepods, cladocerans, and *Chaoborus* larvae were seasonally important in terms biomass.

## Angler Exploitation and Movement of Two Spawning Cohorts of Walleye

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**Abstract.**—Norris Reservoir has traditionally supported an outstanding walleye *Stizostedion vitreum* fishery. The walleye population consists of a riverine spawning cohort and a lake spawning cohort. To determine the angler exploitation on these two distinct cohorts a tagging study was initiated in January 1994 and continued until January 1995. Eight-hundred and sixty-seven legal sized (380 mm) walleye were collected using electrofishing and gill netting techniques and implanted with Halprint Model T1043 tags. The riverine cohort subset consisted of 378 individuals and the lake cohort subset consisted of 489 individuals. A five dollar reward was offered for the return of the tag which was publicized via the print and radio media. Exploitation of the riverine and lake cohorts differed. Exploitation following one month of tagging was only 2 % for the lake cohort, but 13 % for the riverine cohort. Annual exploitation was 13 % for the lake cohort, but 24 % for the riverine cohort. This difference can be attributed to the increased and concentrated angling effort on walleye during the spawning period. Movement of walleye was minimal with 40 % harvested within close proximity of tagging. Interestingly, walleye have been captured in the same area of tagging 2 years following their initial capture. Riverine cohorts captured 1 or 2 years following tagging displayed a distinct homing behavior back to their original location of capture.

## Assessment and Restoration of Sauger Stocks in Tennessee Reservoirs

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**Abstract.**—Sauger *Stizostedion canadense* of the Tennessee and Cumberland Rivers, Tennessee, have exhibited wide fluctuations in year-class strength; however, a decline in sauger populations in the mid- to late-80's prompted concern over their status. Experimental gill nets were used to sample sauger in four Tennessee River tailwaters and one Cumberland River tailwater from 1990 to 1996 and catch-per-unit-effort was calculated to index year-class strength. Age-1 sauger abundance was modeled as a function of the amount of water discharged and number of fingerlings stocked in previous years. The catches of age-1 sauger below two upper Tennessee River dams were positively related ( $r=0.71$  and  $0.85$ ;  $P<0.05$ ) to the amount of water released from each dam the previous spring. Below Cordell Hull Dam on the Cumberland River, sauger abundance each year was not related to spring discharges in previous years but the catch of age-2 sauger was positively correlated to the number of fingerlings stocked two years earlier ( $r=0.99$ ;  $P<0.01$ ). No significant relationship between spring discharge and sauger abundances were detected below two lower Tennessee River dams. Current models suggest that there may be an optimum discharge range to enhance natural reproduction by sauger in some reaches of the Tennessee River. Efforts are currently underway to assess the contribution of stocked fingerlings using oxytetracycline marking techniques.

## Hatching Periodicity and Growth of Black and White Crappie from Two Tennessee Tributary Reservoirs

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**Abstract.**—Age-0 crappie were collected from Norris and Douglas reservoirs, Tennessee during routine cove rotenone sampling in August 1996. Sagittal otoliths were removed and daily ring counts made to estimate hatching dates and growth rates. Hatching dates and growth rates were compared between species as well as reservoirs to determine if temporal and spatial differences existed. White crappie *Pomoxis annularis* were only collected from Douglas Reservoir in adequate numbers for analysis. Hatching initiated on 27 April and continued until 18 May with a peak hatching in early May. Growth rates ranged from 0.56 to 1.06 mm/d with a mean of 0.77. Black crappie *Pomoxis nigromaculatus* were collected in adequate number from both systems for analysis. Hatching initiated in Norris Reservoir on 29 April and continued until 13 May, and on 2 May and continued until 16 May in Douglas Reservoir. Age-0 black crappie in Douglas Reservoir displayed a significantly greater growth rate than their Norris Reservoir counterparts (0.78 mm/d versus 71 mm/d).

## Supplemental Stocking of White Crappie and Largemouth Bass in Two Impoundments

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**Abstract.**—Recently, supplemental stocking of warmwater sportfish has become popular with fish and wildlife agencies because of increased angling pressure and the public's perception that stocking of more fish will always improve angling. White crappie *Pomoxis annularis* and largemouth bass *Micropterus salmoides* were introduced into two systems in an effort to enhance these important recreational fisheries. Both species were implanted with micro-wire tags prior to release. Two week post tagging survival exceeded 95 % for both species. Approximately 9,000 hatchery-reared tagged white crappie (100-150 mm in TL) were released into Herb Parsons Lake, a small highly-managed impoundment, in January 1994. A full-time complete creel survey was conducted beginning in the Spring 1994 with clerks instructed to determine the presence of micro-tags using a hand-held wand. Fewer than 100 micro-tagged white crappie have been harvested by anglers. Collections by trap nets and gill nets also have produced few tagged white crappie although naturally produced white crappie of the 1993 year class were well represented. Nine thousand tagged largemouth bass were introduced into two embayments of Norris Reservoir in October 1995. These fish (120-200 mm) were reared in a nursery pond adjacent to the reservoir. Attempts by electrofishing in the fall 1995, spring 1996, and fall 1996 have failed to produce a single tagged individual. The 1995 year class was represented in all samples. The stocking of white crappie and largemouth bass into systems with natural reproduction appears to be counter-productive. It appears that better education of the angling public concerning supplemental stocking may be more rewarding to both the angler and agencies.

## Distribution and Food Habits of Larval Gizzard and Threadfin Shad in Ledbetter Embayment, Kentucky Lake

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**Abstract.**—The distribution and food habits of larval gizzard shad *Dorosoma cepedianum* and threadfin shad *D. petenense* were examined in Ledbetter Embayment, Kentucky Lake during 1994. Two bow-mounted pushnets were used to sample shad at the surface and euphotic depth from May through early July. Distribution of both gizzard and threadfin shad was patchy during the day and night at both sampling depths. There was no indication of discrete movements of gizzard or threadfin shad within the embayment. Both species exhibited greater densities in the euphotic zone at night and at the surface during the day. Spatial overlap between gizzard and threadfin shad increased during the day and feeding overlap decreased during the night as the season progressed. Feeding selectivities of gizzard and threadfin shad were similar. Predation on zooplankton by both species of shad was partitioned by time (diel period) and by size of prey. Partitioning of prey was more pronounced during June when cladocerans received greater preference during the night and rotifers during the day by gizzard and threadfin shad. Additionally, prey was not selected by gizzard and threadfin shad in proportion to its abundance during May or June or by threadfin shad during July.



## Changes in Abundance and Size Structure of Juvenile Shad Following a Winterkill of Threadfin Shad in Hugo Reservoir, Oklahoma

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**Abstract.**—The severity of the winter of 1995-96 resulted in winterkills of threadfin shad *Dorosoma petenense* in most Oklahoma reservoirs. Mid water trawls were used to monitor juvenile shad abundance in Hugo Reservoir April through September, 1995 and 1996. Weekly samples were collected with a 500-micron net April through June. Bi-weekly samples were collected in July and August with a 3-mm net. Bi-weekly samples were collected in September using a 6-mm net. Juvenile shad abundance was dramatically reduced in 1996. Peak abundance of shad was 1200/1000 m<sup>3</sup> and 300/1000 m<sup>3</sup> in 1995 and 1996, respectively. The abundance of gizzard shad *D. cepedianum* remained unchanged following the winterkill with peak densities reaching 300/1000 m<sup>3</sup> both years. Threadfin shad abundance declined precipitously following the winterkill; peak abundance was 800/1000 m<sup>3</sup> and 75/1000 m<sup>3</sup> in 1995 and 1996, respectively. Threadfin shad abundance peaked in late September, 1996 compared to mid-July in 1995. Mean lengths of shad in the trawl samples was similar through early July both years. However, the size of shad in the 1996 samples exceeded those in the 1995 samples beginning in mid-July and by September shad averaged 10 mm longer in 1996 than in 1995. Historical rotenone data from Lake Texoma indicated that gizzard shad recruitment increased following threadfin shad winterkills. Trawl data from Hugo indicated that this was not the case in 1996.

## Larval Shad Prey Selection and Influences on Zooplankton Community Structure

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**Abstract.**—Larval shad food consumption and changes in zooplankton community structure were evaluated on Hugo Reservoir, in southeastern Oklahoma. The objectives of this study were to determine if larval gizzard shad (*Dorosoma cepedianum*) are selective as to prey type and size and if this may influence zooplankton community structure. Larval shad and zooplankton were collected weekly from May 1 through June 27, 1996. Crustacean zooplankton density (No./L) fluctuated, but generally increased during the study period. Chesson's alpha, a measure of prey preference, was calculated for each zooplankton taxa within larval shad length groups across collection dates. Larval shad in all length groups exhibited high preferences for cyclopoid copepods and the large cladoceran *Diaphanosoma* sp., and an avoidance of other cladocerans and rotifers as well. Differences between length groups were noted, with larval shad  $\leq 10.0$  mm also having a high preference for nauplii. Larval shad also selected for prey items of greater mean length than were found in the environment. However, these preferences for large individuals and specific zooplankton taxonomic groups do not fully explain the changes documented in zooplankton community structure and zooplankton mean length during this study.

## Longitudinal and Vertical Distribution of Blueback Herring In J. Storm Thurmond Reservoir

DON DENNERLINE AND MICHAEL J. VAN DEN AVYLE

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**Abstract.**—As part of a larger long-term monitoring project, blueback herring *Alosa aestivalis* have been sampled with experimental horizontal and vertical gillnets periodically since 1989. These targeted efforts were prompted by debate among resource managers regarding the longitudinal distribution of blueback herring within the reservoir across seasons. Specifically, some managers believed the distribution of blueback herring was restricted during stratified periods by the "temperature and dissolved oxygen squeeze" noted for striped bass and other species in southern impoundments. Therefore, the objectives of targeted blueback herring sampling were to characterize temperature selection by blueback herring, to determine the spatial distribution of blueback herring seasonally, and to relate the distribution of blueback herring to the availability of specific ranges of temperature and dissolved oxygen. Preliminary analysis shows that most herring are sampled at temperatures of 15.0 - 20.0 C during the summer regardless of depth and at dissolved oxygen levels of less than 2 ppm. Longitudinal distribution of blueback herring varies across years (i.e., fish are more widespread in some years) and can be related to differences in water quality across years. The influence of upstream reservoir operations on the longitudinal distribution of "available habitat" and implications regarding the suitability of blueback herring as forage for coolwater species in southern impoundments will also be discussed.

## Estimating Forage Fish Abundance in Southeast Reservoirs by Use of Vertically and Horizontally Aimed Transducers

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*Abstract.*—Hydroacoustics has become an accepted method for sampling limnetic forage fish populations in Southern reservoirs, however equipment limitations have resulted in varying success because clupeids are often surface oriented. Previous work with hydroacoustics was based on a sampling methodology where the transducer was mounted off the front or side of a boat and below the water surface 0.5 to 1 meter. Transducer limitations extend this unsampled area above the transducer 0.5 to 1.5 m below the transducer resulting in the top 1 to 2.5 meters of the water column unsampled. We sampled the limnetic fish population in 9 Southeast reservoirs with both single and dual beam acoustic systems to estimate the population size and distribution of threadfin shad *Dorosoma petenense*, gizzard shad *D. cepedianum*, and blueback herring *Alosa aestivalis* throughout the water column by sampling with the transducer mounted vertically to sample 2 meters below the surface to near bottom, and horizontally to sample near the surface. Sampling the near surface strata of a reservoir required a transducer with low side lobes and low winds for sampling. Fish densities were calculated by scaling the total reflected voltages by the mean fish size. This scaling factor was different than the scaling constant for the vertically aimed transducer, and is due to the different aspect of the transducer to the clupeid air bladder. Clupeid density in the top 2 meters of the water column ranged from 1% to 60% of the total fish population in the water column. Fish densities in the top 2 meters of the water column were similar to densities at 2-3 m depths in most reservoirs. Differences in vertical distribution of clupeids among and within reservoirs may be explained by water clarity, thermocline depth, or lunar phase. A larger database will provide clues to vertical distribution patterns by clupeids in Southern reservoirs.

## Endangered Species and Sport Fishing - a Working Partnership

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*Abstract.*—Although endangered species issues are usually typified by controversy, resolution is much more likely and effective when a win-win situation can be developed. Lake Balmorhea in West Texas has a degraded sportfishery and an exotic species (sheepshead minnow *Cyprinodon variegatus*) that has caused endangered species problems. Sheepshead minnow hybridize with a local endemic, the federally endangered Comanche Springs pupfish *C. elegans*, it has caused the nearby Pecos pupfish *C. pecosensis* to be federally listed and it poses a threat to other fishes of West Texas, New Mexico and northern Mexico. The sport fishery in Lake Balmorhea historically served a large geographic area of western Texas, but quality has declined in the last decade due to unbalanced fish populations. In order to solve these problems and reap multiple benefits, we are going to utilize rotenone to kill all fish in the reservoir. This will remove the sheepshead minnow threat and make habitat in the 500-acre reservoir available to Comanche Springs pupfish. The reservoir will be restocked to restore a productive sport fishery as well as create a new type of largemouth bass fishery by using a non-interbreeding combination of native *Micropterus salmoides salmoides* (for high catch rates) and triploid *M. s. floridanus* (for trophy potential). We will also develop a habitat management program designed to take advantage of fluctuating water levels. Sociological challenges of developing a consensus in a rural community will also be discussed.

## **Sport Fishing Index - A Method to Quantify Sport Fishing Quality**

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*Abstract.*—A team of biologists including representatives from TVA and Tennessee Valley state fishery resource agencies developed an index to quantify sport fishing quality for individual sport fish species. The objective of the Sport Fishing Index (SFI) is to provide fishermen with information to assist them in selecting locations which have the best potential for a successful fishing experience for the species they prefer, and give biologists a measure of the quality of that fishery. Comparison of both creel and population sampling results for a particular sport fish species with expectations of these parameters from a high quality fishery (reference conditions) allows determination of fishing quality. To date, indices have been developed for largemouth, smallmouth, and spotted bass and crappie. Each SFI relies on measurements on both quantity and quality aspects of angler success and fish population status. Comparison of index results among reservoirs and between years from Tennessee and Cumberland river reservoirs from 1990-1995 found differences in fishing quality for a particular species were measurable. Years when only creel results were available had higher annual variations. When both creel and population data were available, annual variations were generally minimal and considered to be a result of differences in year class strength.

## **Sand and Gravel Mining in Alluvial Systems**

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*Abstract.*—In-channel or near-channel mining of sand or gravel inevitably alters the sediment budget of an alluvial system, and may substantially alter channel hydraulics. These alterations can have variable effects on aquatic habitat depending on magnitude and frequency of mining disturbance, mining methods, particle-size characteristics of the sediment load, characteristics of riparian vegetation, and magnitude and frequency of hydrologic events following mining disturbance. In addition, temporal and spatial responses of alluvial systems can vary because of thresholds, feedbacks, lags, upstream or downstream transmission disturbances, and physiographic controls. Minimization of the detrimental effects of aggregate mining requires detailed predictive understanding of the complex response and recovery of a channel to mining disturbance. Decisions about how much, how frequently, and where to mine also require definition of a reference state — a minimally acceptable physical and biological condition of the channel. However, understanding of alluvial systems is rarely sufficient to predict responses quantitatively and confidently, and reference states are difficult to define. Still, a general understanding of fluvial processes can still provide some guidelines to minimize detrimental effects of mining. Improved understanding sufficient to evaluate physical, biological, and economic tradeoffs, however, will require well-documented case studies and field experiments.

## **The Consequences of Sand and Gravel Mining Within and Adjacent to River and Stream Channels in Mississippi and Louisiana**

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*Abstract.*—Sand and gravel mining within or adjacent to river and stream channels can initiate channel degradation and erosion. Instream mining (dredging) changes channel geometry and creates local inflection in stream gradient. Point bar mining (removal) increases gradient by effectively straightening the stream. Inappropriately sited flood plain mines may capture the river during flood events, causing a relocation and inflection of the thalweg. Such changes are accompanied by increased water velocity above the mined areas precipitating local channel scouring and erosion. Where mining activities are numerous and concentrated, an upstream progression of channel degradation and erosion occurs that is consistent with the process of headcutting. Mining has been identified as a causative factor in active headcuts on the Amite, Bogue Chitto, and Tangipahoa Rivers in Mississippi and Louisiana, and on the Buttahatchee and East Fork Tombigbee Rivers in Mississippi. Mining induced channel erosion destroys upstream private and public property, reduces recreational and fish and wildlife values, and has contributed to the extirpation and extinction of stream fauna. Geomorphic theory, as well as published field observations and evidence of the damaging effects of channel and riparian mining in alluvial systems is currently more than adequate to prohibit or severely regulate such practices.

## **Influence of Sand and Gravel Mining on Sediment Transport in the Brazos River, Texas**

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*Abstract.*—Sediment from the main channel of the lower Brazos River in Texas has been utilized extensively as a source of sand for construction of infrastructure in southeast Texas. Concern has arisen recently over the influence of this sediment removal on the transport of sediment to the Gulf of Mexico from the Brazos River, and ultimately, its influence on beach erosion in the Sargents Beach area of the Texas coast. The U.S. Geological Survey (USGS), in cooperation with the Texas Parks and Wildlife Department (TPWD) and the University of Texas Bureau of Economic Geology (BEG), is conducting an analysis of historical streamflow and sediment-transport data to estimate the effects of main-channel sand and gravel removal on sand delivery to the Gulf of Mexico. The effects of numerous upstream reservoirs and changes in land-use practices in the Brazos River basin will be accounted for in the analysis. The localized effects of a typical dredging operation will also be analyzed by measuring the flow field and sediment-transport characteristics upstream, through, and downstream of the dredging operation. The hydraulic effects of this operation will be shown with a series of velocity vector maps and comparisons of upstream, mid-reach, and downstream sediment measurements.

## **Effects of Instream Gravel Mining on Fishes Using Different Habitat Types in Four Alabama Streams**

SCOTT PEYTON

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*Abstract.*—The effects of instream mining on the fish assemblages of four streams in Alabama (Uphapee, Line, Cubahatchee, and Mulberry creeks) were assessed by sampling five pre-defined habitat types (shallow-fast, slow-instream cover, deep-fast, shallow-slow, shallow-coarse) at sites impacted by instream gravel mining (test sites), and at sites upstream from mining impacts (reference sites). Fish densities were similar between test and reference sites, except in shallow-fast habitat at Cubahatchee Creek, which had higher densities at the reference site and shallow-fast and deep-fast habitat at Line Creek which had higher densities at the test sites (t-test,  $P < 0.05$ ), due primarily to high numbers of largescale stonerollers. Comparisons of community similarity (Morisita's Index) at test and reference sites showed low similarity between fast flowing habitats in Uphapee, Line, and Cubahatchee creeks ( $I_m < 0.65$ ). Relative abundance of cyprinids increased, and relative abundance of percids decreased at test sites. Speckled darters, blackbanded darters, greenbreast darters, and rock darters occurred at higher densities at reference sites, and skygazer shiners, blacktail shiners, and speckled chubs occurred at higher densities at test sites.

## **Spatial and Temporal Variability in Gravel Availability, Current River, Missouri**

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*Abstract.*—Streams of the Ozark Plateaus are characterized by abundant unstable channel reaches with extensive unvegetated gravel bars. Gravel bars are used throughout the Ozarks as a source of construction aggregate. The controls on the spatial and temporal distribution of gravel bars in the Current River, Missouri, were studied to evaluate the potential effects of gravel mining on channel instability and the aquatic ecosystem. Historical evidence indicates that alluvial gravel has been released from storage in low-order bottomlands because of riparian disturbances, principally open-range grazing. Waves of gravel have moved downstream into zones of accumulation in third- to sixth-order channels. The spatial distribution of gravel bars along the Current River mainstem was used to indicate controls on gravel accumulation. Results indicate that gravel accumulation areas are related primarily to tributary junctions. The magnitude of gravel input at junctions relates mainly to tributary basin relief and bedrock geology. Downstream of tributary junctions, accumulations of gravel are controlled secondarily by valley physiography and downstream decay of the tributary input. Reaches of accumulation of land-use-derived gravel in Ozarks streams are discrete areas where gravel potentially may be mined from bars with minimal effect on the aquatic ecosystem.

## **Instream Sand and Gravel Mining and the Corps of Engineers Permit Program**

MARK KING

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*Abstract.*—The U.S. Army Corps of Engineers began regulating activities within the nations navigable waterways with the approval of the Rivers and Harbors Act in 1899. In 1972, the Corps, through the Environmental Protection Agency, was given the lead in administering Section 404 of the Clean Water Act. In the past, instream mining operators in the coastal and near-coastal counties of Texas received little resistance in receiving a Department of the Army permit. However, recent modifications of the definition of “discharge of dredged material” and availability of new biological and hydro-geomorphological information often presents a regulatory maze, rather than a regulatory process, to many mining operators.

## **Pits, Permits, and Populism: Resource Regulation in the Age of Miscommunication**

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*Abstract.*—The events of the past century and shifts in perceptions by governmental agencies and the public create a peculiar climate in which to try to manage public resources. The taking of sand and gravel from stream beds serves as an instructional example to industry, regulators, property owners and conservation interests on the appropriate roles of each in the process. Texas may be an illustrative microcosm of the development of issues and perceptive shifts that have occurred with increased resource impacts and population presence. The Texas Parks and Wildlife Department has regulated the “disturbance of taking” of streambed materials since 1911. Although regulations have not changed greatly, interpretations have evolved, and the focus and intensity of enforcement have waxed and waned. The greatest changes have occurred in the last 10 to 20 years, as the public has become sensitized to environmental impacts of human activities. The citizens of any given area are particularly prone to oppose any environmental impact that will occur in their immediate vicinity. Examples from recent Texas experiences in the regulatory area illustrate the mistakes made on all sides, and the lessons which could be learned to better manage public resources, including efficiencies which should be developed to allocate greatest effort to the most important problems.

## **Instream Sand and Gravel Mining in North Carolina: the View from a Fisheries Biologist**

STEPHANIE E. GOUDREAU

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*Abstract.*—Instream sand and gravel mining in North Carolina requires both state and federal permits in accordance with the Mining Act of 1971 and Clean Water Act of 1977. As a fisheries biologist within the Habitat Conservation Program of the North Carolina Wildlife Resources Commission, I routinely review all permit applications for sand and gravel operations in my region and provide comments to the North Carolina Division of Land Resources and U.S. Army Corps of Engineers. These regulatory agencies usually incorporate my comments as permit conditions in an effort to minimize potential impacts to fisheries resources resulting from these operations. Instream sand and gravel mining by any method is inherently offensive to a fisheries biologist because it disturbs substrate and stream banks. Fish and other aquatic organisms may be impacted directly by the resuspension of sediment and sand or indirectly when aquatic habitat is modified through loss of gravel and cobble bars and riparian vegetation. I am constantly challenged to provide sound recommendations using professional judgment and literature review rather than site-specific information.

## **The Politics of Gravel Mining: Now You See It, Now You Don't**

STEVE FILIPEK

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*Abstract.*—Instream gravel mining has been one of the traditional sources of gravel in the uplands of Arkansas. Increased demand for this product for road, parking lot, and house construction prompted a closer look at this use of Arkansas stream resources. Several studies conducted in 1990-1992 by the Arkansas Game and Fish Commission and others were the basis for a bill submitted to the Arkansas legislature by the Arkansas Department of Pollution Control and Ecology (ADCPE) in 1993. This bill would prohibit commercial instream gravel mining on Extraordinary Resource Waterbodies (ERW), about 24 streams and lakes designated as unique biological, physical, or recreational waterbodies. Although the bill was signed into law (Act 378 of 1993), the ADCPE, under pressure from gravel miners and politicians, placed a moratorium on the enforcement of the law for two years to give miners time to find new sources of gravel. In 1995, gravel miners and politicians discussed repealing the 1993 legislation. Several agencies together developed a video demonstrating the effects of gravel mining of streams. In 1995, a second bill was passed (Act 1345 of 1995) which prohibited gravel mining in ERW. The process of getting this legislation passed and the efforts by those opposed to gravel mining regulations are reviewed.

## **Sand and Gravel Mining: an Industry Overview**

DAVID KURZ

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*Abstract.*—The sand and gravel mining industry provides basic raw materials that touch everyone's daily lives. For thousands of years sand and gravel have been integral components of road and building construction. Today, demand for sand and gravel continues to increase. As someone who has been involved in the industry for many years, I have seen the industry grow and I have worked with a number of agencies and organizations to ensure that operations are conducted in a responsible manner. Contrary to what some might think, there are many areas where the industry, working in partnership with agencies, is already addressing environmental concerns. It is vitally important that we continue to work together.

## **Movement of Adult Red Drum in the Central South Atlantic Bight**

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*Abstract.*—Relocations of adult red drum marked with external tags or telemetered with ultrasonic transmitters were used to describe seasonal movements and habitat preferences within the central South Atlantic Bight. From 1989-1995, a total of 1,090 fish (702-1,080 mm) collected with hook and entanglement gear from Georgia's nearshore waters were marked with plastic dart tags and released at the capture site. Ultrasonic transmitters were internally implanted in 75 red drum. Six tagged red drum were recovered within 10 km of the release site after periods at large ranging from 190 to 1,091 days. One fish was recaptured after 86 days near Titusville, Florida, a distance of 168 miles south. A total of 50 telemetered red drum were relocated at least once. Adult red drum exhibit a pattern of seasonal movement spending the winter months offshore, moving to nearshore waters in the spring, entering the estuaries during the late summer, then moving back into the nearshore waters during the fall. Critical habitats include deeper reaches of tidal rivers, coastal inlets, and shoal/sandbar complexes. These findings indicate that some portion of the spawning biomass exhibits fidelity to specific areas supporting the idea that functional subgroups exist within the Atlantic Coast population.

## Utility of Trammel Nets for Sampling Subadult Red Drum in the Central South Atlantic Bight

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*Abstract.*—Harvest restrictions, temporal/spatial aspects of angling effort, and variable distribution of red drum all introduce bias in the fishery-dependent data used in age-structured assessments of Atlantic Coast red drum. Monofilament trammel nets were used to collect subadult red drum from St. Simons and Altamaha estuaries in coastal Georgia during 1994-1996. A total 1,482 fish were captured of which 1,269 were marked with external tags and released. The length composition of trammel net samples and fishery-dependent data from the Marine Recreational Fishery Statistics Survey were dissimilar. The 19% angler return rate for tagged subadult red drum <450 mm was significantly greater than that observed for larger fish (7%). These data indicate that larger subadults are more abundant and escapement to the spawning biomass may be greater than previously estimated. Consequently, trammel net data can be used with regional stock assessments to more accurately describe the status of Atlantic Coast red drum.

## Comparison of Red Drum Growth Models Among Texas Bays

ROBERT L. COLURA AND ROBERTA BUCKLEY

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*Abstract.*—Red drum *Sciaenops ocellatus* age and growth in Texas was investigated. Von Bertalanffy growth models fitted for each bay differed ( $P \leq 0.05$ ) among bays, with only two exceptions. However, the models predicted similar lengths at age and a single coast-wide von Bertalanffy growth model which includes mature fish from offshore is recommended for use in future management of Texas red drum. The within bay growth rate of Texas red drum is slower than growth rates reported for Florida and North Carolina red drum. This is possibly due to regional environmental differences.

## Potential Impact of a Red Tide Bloom on Spawning Activity and Larval Survival of Red Drum on the Central Texas Coast

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*Abstract.*—A red tide (composed of *Gymnodinium brevis*) bloom in the near-shore western Gulf of Mexico and adjacent estuaries in September 1996 resulted in the death of a significant number of red drum *Sciaenops ocellatus*. Over 12,000 mature red drum were estimated to have washed up on the beaches of Mustang, St. Jose, and Matagorda Islands. In addition to the removal of some portion of the spawning population, the red tide had the potential to produce significant larval mortality as well. The goal of this study was to use several measures of spawning activity and larval density to assess the impact of the red tide on red drum larval recruitment in the vicinity of the Aransas Pass, Texas. Preliminary observations suggest that sound production by spawning male red drum, and egg and larval densities in the tidal inlet and the seagrass nursery areas are similar to observations from the fall of 1994 and 1995. Red drum catches in bag seines from Texas Parks and Wildlife's Coastal Fisheries Monitoring program will also be compared with data from prior years to assess potential impact on YOY fish. These findings provide intriguing insights into the potential stock size and spawning behavior of red drum along the central Texas coast.



## Hook-Release Mortality of Red Drum *Sciaenops ocellatus* and Spotted Seatrout *Cynoscion nebulosus* from Common Angling Methods

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**Abstract.**—Post-hooking mortality of red drum and spotted seatrout is being assessed to determine overall mortality rates and differences due to fishing methods. Flow-through tank systems are employed for transportation and holding. Seatrout (1,512 captures) and red drum under 680 mm (743) were studied in Trial 1. Overall survival was 82.5% in seatrout and 97.3% in red drum. Highly significant differences ( $P < 0.001$ ) in seatrout survival occurred between methods: 97% (treble hook artificial lure; THA), 91% (single hook lure; SHA), 83% (treble hook with live bait; THB), and 74% (single hook, live bait; SHB). Significant variation ( $P = 0.058$ ) occurred between red drum method groups: 99% (SHA), 97% (THA), 96% (SHB), and 94% (THB). Trial 1 results demonstrate that popular assumptions of high post-release mortality and excessive mortality from use of treble hooks are incorrect. Survival of red drum smaller than the minimum size limit in Louisiana (406 mm; five fish bag) was similar to that of legal-sized fish (98 vs 96%). Seatrout under the 305 mm limit were more likely to live (87%) than were larger fish (81%,  $P = 0.010$ ). Since Louisiana anglers are granted a 25-fish bag limit on seatrout, most released fish are probably undersized. Relatively low mortality in these fish tends to support a minimum-size regulation. In Trial 2 hook-release mortality will be assessed for red drum over 686 mm (limit one) caught with standard and circle-style hooks. Preliminary results indicate negligible mortality from circle hooks, but about 15% mortality from conventional hooks.

## Red Drum and Spotted Seatrout Size Limits: They Work

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**Abstract.**—Red drum *Sciaenops ocellatus* and spotted seatrout *Cynoscion nebulosus* are important recreationally sought species in Texas. Size and bag limits are used to reduce mortality and optimize yield of these fishes. Three red drum (20-28 inches long) and 10 spotted seatrout (> 15 inches long) can be retained per day; one red drum > 28 inches can be kept per year with an attached trophy tag. If too many fish die of handling, then using size and bag restrictions may jeopardize management goals of allowing fish to spawn, reducing growth overfishing, providing adequate escapement, and providing for quality or trophy fisheries. The objectives of this study were that knowing the numbers of caught and released fish and subsequent mortality of released fish allows managers to evaluate the success of harvest regulations. The results included determining estimates of bycatch of Texas private sport-boat anglers during May-November 1993; these estimates of released fish ranged from 347,000 to 378,000 red drum and from 803,000 to 902,000 spotted seatrout. About two each of red drum and spotted seatrout were released for every one landed. Studies in Texas report hooking mortalities of 4-10% for both red drum and spotted seatrout. Conclusions indicate that even with relatively high numbers of released fish, the corresponding low hooking mortality indicates Texas size and bag limits are appropriate options to allow spotted seatrout to spawn at least once, reduce growth overfishing, provide adequate escapement of red drum, and provide a quality red drum and spotted seatrout sport fishery. Because of these findings, Texas Parks and Wildlife Department fishery managers will continue using size and bag limits to manage red drum and spotted seatrout.

## The Effects of Temperature on RNA/DNA Ratios in Larval Red Drum *Sciaenops ocellatus*

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**Abstract.**—Red drum larvae are subjected to a wide range of temperatures during transport from spawning to nursery areas. Cooler water temperatures can directly or indirectly reduce larval growth rate. We have observed that changes in larval growth, caused by diet, are reflected in RNA:DNA ratios. An experiment was designed to investigate whether temperature influenced changes in growth are reflected in RNA:DNA ratios. Eggs from captive red drum were hatched in 25.5°C degree seawater. Larvae were then transferred to 28°C or 23°C seawater. Standard lengths, nucleic acid concentrations (using the ethidium bromide fluorometric technique) and soluble protein concentrations were measured every other day. Growth rates from the warm treatment were significantly greater than those found in the cooler treatment. Per standard length, RNA, DNA and RNA:DNA was not significantly different between fish acclimated to 28°C or 23°C. These same results were seen in red drum larvae grown at 27°C and 22°C. Though there were differential growth rates between treatments, the same amount of RNA and DNA is produced per millimeter of fish. Temperature influenced changes in growth only effect the rate of growth and not amount of RNA or DNA per size.

## Black Drum Life History in Texas Bays with Emphasis on the Upper Laguna Madre

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*Abstract.*--Texas black drum *Pogonias cromis* reproductive biology and age and growth were investigated. Ageing was accomplished using measurements from the center of sectioned otoliths to otolith annuli and margins. Reproductive maturity was determined based on GSI values, presence and percentage of vitellogenic ova, and egg counts and measurements. Black drum from the upper Laguna Madre matured at a younger age and grew slower than black drum from the rest of the Texas coast. Fish from the upper Laguna Madre reached maturity at age 2, as compared to age 5 for fish from other Texas bays. Mean measured size at age for upper Laguna Madre fish was significantly smaller than size of fish from other bays, with a maximum differential of 109 mm at 4.3 years of age. Von Bertalanffy growth models for fish from the upper Laguna Madre and remaining bays were significantly different ( $P > 0.05$ ). Maturity at a younger age and the resulting commitment of energy available to fish in other bays for growth could be expected to induce the observed difference in growth. Reasons for early maturation are not as easily defined, however a difference in mortality rates between the two areas, either natural or due to fishing pressure, might cause juvenescence of black drum in the upper Laguna Madre.

## Allozyme Analysis of Population Structure in Black Drum *Pogonias cromis* Along the Texas Gulf Coast

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*Abstract.*--Protein electrophoresis was utilized to survey nuclear genetic variation and population structure of black drum from multiple bays along the Texas coast. Levels of genetic variability were found to be similar or slightly higher than those previously reported for Texas sciaenids. Black drum exhibited nonrandom distribution of alleles both within and between bays. Estimates of gene flow between bay systems indicated absolute population subdivision was limited. Genetic similarity between populations was relatively high but distance metrics indicated some genetic differentiation. The significance of such genetic variation and the potential management implications of these findings will be considered.

## Stock Assessment of Spotted Seatrout *Cynoscion nebulosus* in Texas Coastal Waters

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*Abstract.*--A sequential population analysis was performed to determine past and present conditions and trends of the spotted seatrout resource. An age-length key was used to assign ages by sex. Females grow faster and larger than males, with an  $L_{\infty}$  of 1,065 mm and 611 mm (41.9 inches and 24.1 inches) for females and males, respectively. Length at age is variable for both sexes. Spotted seatrout are weakly migratory, remaining in or near the same estuary during their adult life. Recreational landings of spotted seatrout were variable from May 1984-May 1996. Most (60%) of the harvest is taken by private boat anglers in bays and passes. Females comprised 70% of landings in 1995-1996. The female population almost doubled in size since 1984, while the male population almost tripled. Recruitment also increased for both sexes, as well as spawning biomass and number of older fish (age 5+). Unweighted transitional spawning potential ratios (SPR) for females have increased from 22% to 37% during 1984-94. Male SPR's have also increased from 49% to 65% during the same time. Both sexes are currently at or within biological reference points used for assessing exploited populations (20% static SPR,  $F_{max}$ ,  $F_{0.1}$ ,  $F_{20}$  and  $F_{30}$ ), indicating they are not overfished, and are not currently subject to overfishing. A Beverton-Holt spawner-recruit relationship indicates recruitment and spawning biomass has been increasing through time. Because of the increased spawning biomass, recovery from a severe winter freeze should occur more rapidly than in 1984. Population growth is expected to continue, although at a slower rate. Unweighted transitional SPR is converging with static %SPR. Monitoring of the fishery should continue, as fishing mortality may increase.

## Ontogenetic Trophic Patterns and Dietary Overlap of Larval and Juvenile Red Drum *Sciaenops ocellatus* and Atlantic Croaker *Micropogonias undulatus*

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**Abstract.**—Red drum *Sciaenops ocellatus* and Atlantic croaker *Micropogonias undulatus* spend most of their adult lives offshore and congregate near tidal passes to spawn. Pelagic larvae of both species are transported by oceanographic and tidal currents to nursery habitat in bays and estuaries. Larval and juvenile red drum and Atlantic croaker concurrently occupy seagrass beds in the fall and interactions may affect trophic dynamics. A study was undertaken to: 1) describe quantitatively the diet of larval and juvenile red drum and Atlantic croaker, 2) determine ontogenetic patterns in diet for the two species, and 3) determine dietary overlap of red drum and Atlantic croaker when they co-occur in seagrass beds. A total of 274 red drum (4.00 - 19.99 mm SL) and 205 Atlantic croaker (8.00 - 17.99 mm SL) guts were examined of which 8.4 % and 28.8 % were empty, respectively. The primary prey taxa consumed (% IRI) by both species were calanoid copepods, harpacticoid copepods, and mysid shrimp. More discrete ontogenetic trophic patterns were detected for red drum than for Atlantic croaker. Four of the five size classes (8.00 - 15.99) examined had high dietary overlap values (> 0.7).

## Response of Atlantic Croaker Fingerlings to Practical Diet Formulations with Varying Protein and Energy Contents

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**Abstract.**—Atlantic Croaker *Micropogon undulatus* belongs to the family Sciaenidae. This fish is abundant in the bay systems year-round and is heavily utilized as both a bait fish and as an excellent food fish. The development of culture techniques for this species would allow an alternative to the harvesting of wild stocks, diversity aquaculture and expand our understanding of this species. However, to successfully culture a new species, considerable information must be obtained on major life stages, environmental requirements and nutritional needs. In response to commercial request, this research sought to initiate the development of practical diet formulations for fingerling growout and to evaluate the response of this species to controlled culture conditions. Eggs were hatched and the larvae reared under controlled culture conditions similar to those used for red drum. After 78 days of culture fish were transferred to a research system and conditioned to the culture conditions. A series of eight practical diets were formulated to contain 45, 40, 35 and 30% protein with varying energy contents. Each test diet was offered to four replicate groups of fish (10 fish/tank) having a mean initial weight of 3.8 g. The fish were maintained in a semi-closed recirculating system over a 7 week growth trial. Temperature and salinity of the culture water was maintained at 28 C and 28 ppt. At the conclusion of the feeding trial, final weights of fish maintained on the test diets ranged from 19.2 g (410% weight gain) to 12.0 g (210 % weight gain) with 100% survival for all dietary treatments. Weight gain and estimated feed conversion efficiencies significantly increased with protein content of the diet. Weight gain of fish maintained on the 45% protein diet decreased, but not significantly, as the lipid content of the diet was increased from 8 to 12 or 16%. Estimated feed conversion efficiencies for fish maintained on the 45% protein diet with 8% lipid were significantly higher than that of fish maintained on the 45% protein diet containing 16% lipid. Based on the observed results, the Atlantic croaker adjusts well to controlled culture conditions and responds well to laboratory handling. The observed results would indicate that this fish grows best on a high protein diet with moderate lipid levels.

## Genetic Variation in the Atlantic Croaker *Micropogonias undulatus*: Temporal Perspectives

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**Abstract.**—Routine resource monitoring data suggest the Atlantic croaker *Micropogonias undulatus* is experiencing growth overfishing. In response to this observation Texas Parks and Wildlife Department is currently considering a variety of management interventions, including stocking. Data on genetic structure are necessary before such programs are instituted. Atlantic croaker have been sampled in each major bay on the Texas coast over a two year period. Electrophoretic analyses of these samples have provided information on within and between bay genetic variability, on temporal stability, and on genetic structure for this species in Texas waters. The implications of these data for management options are discussed.

## Effects of Parental Exposure to o,p'-DDT on the Behavior of Atlantic Croaker *Micropogonias undulatus* Larvae

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**Abstract.**—Mature Atlantic croaker *Micropogonias undulatus* were administered one of three doses of o,p'-DDT (0, 2.0, or 10.0  $\mu\text{g}$  100g BW<sup>-1</sup> d<sup>-1</sup>) in their diet. Their eggs and larvae were reared in "clean" water and the behavior of the larvae before and after presentation of an acoustic stimulus was recorded on video tape. Swimming speeds for individual larvae were calculated using computerized motion analysis equipment. Prior to complete yolk and oil absorption, the spontaneous swimming speeds of the DDT treated groups were significantly reduced ( $P < 0.0001$ ). After this time, no difference was seen between treatments. A reduction in spontaneous activity during the early larval period could reduce the ability of a larva to locate sufficient prey to survive the transition from endogenous to exogenous feeding. The proportion of larvae which responded to the acoustic stimulus was higher in the control group than the exposed groups following complete yolk and oil absorption ( $P < 0.01$ ). Burst swimming speeds of the larvae which responded to the stimulus were not different across treatment levels. A change in responsiveness due to parental exposure to DDT could increase the risk to predation and therefore decrease recruitment into the breeding population.

## Development of Anti-Predator Behavior in Three Species of Sciaenids

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**Abstract.**—Red drum, spotted seatrout, and Atlantic croaker larvae all utilize an inshore nursery habitat, but the extent of this usage depends on the species. Responses of these sciaenids to a model predator were examined throughout the larval period to determine whether the sensory systems important for evading predators are related to species-specific habitat usage. Red drum, croaker, and seatrout all had high responsiveness under control conditions. When larvae were approached in darkness, red drum and seatrout had higher responsiveness than did croaker. When larvae were able to see, but the lateral line was not functional, red drum and seatrout had generally decreasing responsiveness, while croaker had generally increasing responsiveness. Similar trends were seen in the distance at which larvae responded to the stimulus. Seatrout and red drum responded at a larger distance from the stimulus in the dark than did croaker. Croaker responded at a larger distance than the other species when the lateral line was not functional. Differences in behavioral development appear to be related to patterns of habitat usage of these three species. These findings suggest that the microhabitat characteristics for optimal predator evasion, and thus survival, may be different for these three species.

## Comparative Reproductive Biologies of Red Drum, Black Drum, and Spotted Seatrout from the Northern Gulf of Mexico

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**Abstract.**—Although red drum *Sciaenops ocellatus*, black drum *Pogonias cromis*, and spotted seatrout *Cynoscion nebulosus* share many aspects of their reproductive biologies, each exhibits unique characteristics which presumably allow them to maximize survival of progeny. Their spawning seasons vary in duration from two to four to six months, respectively, and show minimal overlap. Mean spawning season gonosomatic indices (GSI) of male black drum and spotted seatrout are one-third those of the females, but male and female GSI of red drum are equivalent. Further, male red drum GSI are two to three times those of black drum and spotted seatrout males. This may indicate that male red drum participate in more frequent spawning events during their shorter spawning season or reflect a greater propensity for spawning in large schools. Female spotted seatrout achieve 50% maturity at age 1 whereas the much longer lived red drum and black drum reach 50% maturity at age 4 and 5. All three species are group synchronous, multiple batch spawners and batch fecundities are positively correlated with fork length, eviscerated body weight and ovary-free body weight in each. Spawning frequencies are comparable among the species with individual spawning events occurring on average at four day intervals over the entire spawning season.

# Growth and Yield-Per-Recruit Modeling of Spot *Leiostomus xanthurus* in the Chesapeake Bay

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*Abstract.*—Spot are an important component of the Virginia commercial catch. Little management directed information exists that is specific to Chesapeake Bay spot. The objectives of this research were to model spot growth, estimate spot mortality rates and model spot yield-per-recruit under likely mortality and growth scenarios and interpret the results in the context of Sciaenid life history. Spot observed lengths at age were highly variable. The von Bertalanffy growth model was a good fit to both male and female spot. No difference between sexes was found and a von Bertalanffy model was fit to combined sex data. Total annual instantaneous mortality ( $Z$ ) estimated from maximum age ranged from 1.5 to 2.3. Yield-per-recruit modeling indicates that under conservative scenarios, spot harvest levels in the Chesapeake Bay are below maximum potential harvest levels.

## Cryopreservation of Sperm from Marine Sciaenid Fishes

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*Abstract.*—Pressure on sciaenid stocks in the Gulf of Mexico has created interest in commercial aquaculture and captive propagation. Cryopreservation of sperm can be used to reduce the number of males needed in hatchery operations, produce crossbreeding or hybridization, preserve genetic resources of endangered stocks, and accelerate genetic research. Sperm were collected from black drum *Pogonias cromis*, spotted seatrout *Cynoscion nebulosus*, and red drum *Sciaenops ocellatus* during spawning seasons by removing and slicing the testis to release sperm. Hanks' balanced salt solution (200 mOsm/kg) was added as an extender. Sperm were frozen in 0.5-ml straws at three freezing rates (-2.5°C/min to -45°C/min). Methanol, glycerol, dimethyl acetamide, and dimethyl sulphoxide (DMSO) were evaluated as cryoprotectants at two concentrations (5% and 10%) for black drum and spotted seatrout sperm, while only 10% DMSO was evaluated for red drum. Ten percent DMSO yielded significantly higher post-thaw sperm motility than did the other cryoprotectants tested. Red drum sperm were thawed at different temperatures in a water bath or on a bench top. Sperm thawed in a water bath (10°C to 60°C) had significantly higher post-thaw motility ( $P = 0.0138$ ) than did sperm thawed on the bench top (21°C). Cryopreservation of sciaenid sperm appears possible, but utilization of these techniques in hatcheries and aquaculture has not become established.

# Mechanisms of Chemical Interference with Reproductive Endocrine Function in Sciaenid Fishes

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**Abstract.**--Teleost reproduction is primarily controlled by hormones secreted by the hypothalamus-pituitary-gonadal (HPG) axis. Chemicals can potentially act at numerous sites on the HPG axis and by a variety of mechanisms to alter hormone secretion, action or metabolism and disrupt reproductive function. Some mechanisms of endocrine disruption which have been identified in Atlantic croaker *Micropogonias undulatus* are discussed. Evidence is presented that Kepone (chlordecone) can exert estrogenic effects at the liver to stimulate vitellogenesis in vitro by binding to the hepatic estrogen receptor. Other in vitro studies show that cadmium can act directly at the pituitary and at the ovary to stimulate hormone secretion. These results indicate that the stimulatory effect of cadmium on gonadal steroidogenesis is mediated by activation of the adenylate cyclase second messenger system. Finally, we show that the impairment of reproductive function in male croaker after chronic exposure to lead in vitro is associated with a lack of pituitary response to stimulation by luteinizing-hormone releasing hormone (LHRH). Interestingly, the decline in gonadotropin secretion was accompanied by decreases in the hypothalamic content of serotonin, a neurotransmitter which has been shown to augment the gonadotropic response to LHRH in this species. Taken together, these results suggest that lead impairs reproductive function by disrupting the serotonergic system in the hypothalamus that regulates gonadotropin secretion. It is concluded that chemicals can act via a variety of mechanisms to disrupt reproductive endocrine function in teleosts.

## Utilization of Subtropical Seagrass Meadows by Newly Settled Sciaenids

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**Abstract.**--Spatial and temporal patterns in recruitment and nursery habitat use were examined for sciaenids utilizing seagrass meadows in the Aransas Estuary, Texas. A total of 5,443 sciaenid larvae and early juveniles were identified from biweekly epibenthic sled collections taken from August 1994 to August 1995. Five species were abundant in seagrass meadows during the post-settlement phase: Atlantic croaker *Micropogonias undulatus*, red drum *Sciaenops ocellatus*, silver perch *Bairdiella chrysoura*, spot *Leiostomus xanthurus*, and spotted seatrout *Cynoscion nebulosus*. Recruitment among the five sciaenids was partitioned temporally, potentially minimizing competition for resources in nursery habitats. Length-frequency distributions indicated that individuals from inshore spawners (red drum, silver perch, spotted seatrout) recruit to seagrass meadows at smaller sizes than individuals spawned offshore (Atlantic croaker, spot). In addition, recruits from inshore spawners appeared to 'settle and stay' in nursery habitats, while residency by offshore spawned individuals was limited in duration. Density of new recruits was highly variable within and among species. During peak recruitment, mean and maximum densities among species ranged from 0.1 - 0.8 m<sup>-2</sup> and 0.7 - 23.8 m<sup>-2</sup>, respectively. Density and mean size of sciaenids differed significantly between habitats (*Halodule wrightii*, *Thalassia testudinum*) and among sites within the estuary.

## Bias in Least-Square and Maximum Likelihood Estimators of Mortality Rates for Steady-State Populations

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**Abstract.**--When age-frequency data are insufficient for fisheries scientists to estimate year- or age-specific mortality, they often pool those data to provide a single estimate of mortality for all fully recruited age groups. The accuracy of a pooled estimate depends largely on whether or not the sampled population is in a steady state, i.e., a state in which the rates of recruitment and mortality are relatively constant. Although both the maximum likelihood (ML) and least square (LS) estimators can provide very accurate estimates of mortality for exact steady-state age frequencies, the effect of random variation within the age frequency has not been investigated. In this study, I evaluated the effect of sample size and mortality rate on the accuracy and precision of Chapman-Robson maximum likelihood estimators and the least squares "catch curve" estimator. Using simulation modeling, the LS estimator is negatively biased, especially when small, random samples are drawn from a steady-state population whereas the ML estimators are not. If the sample age-structure is truncated using some minimum abundance criterion, bias in the LS estimator is reduced. Application of the two estimation techniques to preliminary age composition data for adult red drum *Sciaenops ocellatus* from the eastern Gulf of Mexico appear to confirm the findings of the simulations.

## **Comparison of Swimming Performance of Electrofished and Kick-Seined Orangebelly Darters**

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*Abstract.*—Orangebelly darters were collected from the Ouachita River by electrofishing. Due to the obvious number of mortalities from this collection method subsequent collections from riffles were made using a short burst of electricity as opposed to continuous current. Other specimens were collected by physically disturbing substrate and collecting fish in a seine. Fish were held for thirty days in aquaria and determined to be in good health by ocular inspection with no noticeable signs of physical damage or disease. Fish were placed in an ichthyonotometer to assess velocities at which they could no longer maintain their positions in a clear PVC pipe. Flow levels at which fish could not maintain position were compared for the two groups. Electrofished specimens failed at lower velocities than kick-seined fishes ( $PROB>T=0.05$ ) suggesting that mechanical injury may have occurred to either skeletal, muscular or nervous tissue. No attempt was made to determine physiological damage. This experiment does provide evidence to stimulate further research on long term physiological effects of electrofishing on small fishes.

## **Swimming Speed Performance of the Bigeye Shiner and Longear Sunfish from the Ouachita River Drainage**

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*Abstract.*—An inexpensive ichthyonotometer was used to assess swimming endurance of longear sunfish and bigeye shiners at various flow velocities for varying length of times. Percent success of fishes that could endure such flows was recorded. Longear sunfish could successfully traverse low flows less than 19 cm/sec for up to 14 minute intervals. However success swindled rapidly for increased flows with no fish being able to swim or maintain position for over ten minutes at 33 cm/sec. Bigeye shiners could negotiate against currents of up to 33 cm/sec while success rapidly failed at velocities of 39 cm/sec at times exceeding four minutes with no fish being able to maintain position for any time period at 53 cm/sec velocities. Presumably body shape may have a great deal to do with endurance at higher velocities.



## Swimming Performance of Larval and Juvenile Robust Redhorse: Implications for Recruitment in the Oconee River, Georgia

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**Abstract.**--Robust redhorse *Moxostoma robustum* occur only in an 85-km stretch of the Oconee River, Georgia, located downstream from a hydropower dam. The available data suggest that the population consists mostly of older individuals, and recruitment in recent years has been negligible. Our goal was to test the hypothesis that larval and juvenile robust redhorse can tolerate current velocities that occur in the Oconee River during hydropower generation. Specifically, we measured swimming performance for three 2-mm size classes (mean, 13.1, 16.2, and 20.4 mm TL) of robust redhorse, and compared swimming speeds to actual current velocities measured in the river. We used probit analysis to calculate median failure velocities (i.e., water velocity at which 50% of fish fail to swim for one hour) and confidence intervals for each size-class. Our results indicate a general improvement of swimming performance with length. For example, failure velocities were 6.9, 10.6, and 11.7 cm/s for 13.1-, 16.2-, and 20.4-mm fish, respectively. These swimming speeds are among the highest recorded for larval and juvenile fishes. Therefore, robust redhorse rearing habitats probably were not limited by current velocity in the Oconee River since areas with velocities less than 7 cm/s were available during varying flow conditions.

## Swimming Performance of the Threatened Leopard Darter *Percina pantherina* in Relation to Stream Barriers

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**Abstract.**--The leopard darter is a threatened species endemic to five streams in southeastern Oklahoma and southwestern Arkansas. Migrating individuals would have to cross road culverts, so we used swimming performance as a measure of their ability to cross these barriers. Performance was evaluated in a flow-through apparatus at current velocities of 0, 5, 12, and 25 cm/s. Eight leopard darters were tested at each velocity, and their activity in terms of swimming burst length and duration was measured. Using a nested ANOVA, we found that burst length, duration, and speed (body lengths/second) were significantly different between velocities with the greatest activity at 25 cm/s. Current velocities measured at road culverts in the Mountain Fork and Glover Rivers ranged from 0 cm/s to over 2 m/s with a mean of about 70 cm/s. Our findings indicate that leopard darter swimming activity increases significantly at moderately high velocities (i.e., 25 cm/s); however, it seems improbable that leopard darters could sustain swimming or maintain their position on the bottom at extremely high velocities (i.e., > 1 m/s) that can occur in stream culverts.

## Assessment of a Tennessee Trophy Trout Fishery

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**Abstract.**--The Clinch River below Norris Dam in east Tennessee supports a trophy trout fishery and is stocked annually with about 30,000 harvestable and 150,000 fingerling rainbow trout and brown trout. Between August 1995 and August 1996, seven different cohorts of fingerling and harvestable rainbow trout and brown trout were microtagged and stocked ( $N_{TOTAL} = 46,000$ ) over a 20 km reach of the river. Growth and survival of tagged trout were investigated by electrofishing 12 fixed transects each month and conducting a roving creel survey. Habitat was surveyed and mapped utilizing a modified version of the Basinwide Visual Estimation Technique. Fingerling rainbow trout and brown trout stocked in February-March 1996 grew well and were commonly collected through October 1996. The catch of tagged trout stocked late in the fishing season (June and August) approached zero substantially faster (40 - 80 days post-stocking) than the catch of tagged trout stocked in April (170 days). The rates of decline for each cohort of harvestable trout varied directly with the amount of fishing pressure the tailwater received. Trout abundance and average size varied among reaches of the river and were affected by differences in habitat and fishing pressure in different reaches of the river.

## Shifts in Diel Movement by Brown Trout Over Four Consecutive Seasons in the Chattooga River Watershed, South Carolina

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**Abstract.**—Diel movements of brown trout were investigated using radio telemetry in the Chattooga River watershed. 24 wild brown trout were captured using electrofishing and hook and line. 18 trout were located in the main branch of the river and 6 trout were located in the East Fork creek. Radio transmitters were surgically implanted in the abdominal cavity and the trout were released at the point of capture. Trout were located once every hour for a continuous 24-hour period to constitute one diel track. Temperature and macrohabitat were recorded for each identified location of the trout. Diel tracks were collected during the winter (10 tracks), spring (14 tracks), summer (11 tracks), and fall (12 tracks). Total distance moved and diel range were obtained for each diel track. Differences in movement between river trout and creek trout were also examined. ANOVA was used to determine the effects of location, season, time of day, and macrohabitat on diel movement.

## A Comparison of Allometry in Striped Bass *Morone saxatilis* Larvae Fed Two Different Nutritional Regimes

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**Abstract.**—Morphometric landmarks, homologous between biological forms, can be the basis for an unbiased measure of allometry within a biological group, as well as, for discrimination between groups. Landmark locations can be archived with computer imaging equipment, and may allow for discrimination between species during larval stages based on relative changes in landmark location. Our objective was to utilize a landmark-based morphometric technique to analyze between-group differences in allometry of larval striped bass. We selected nine homologous landmarks found along the outline of the mid-sagittal plane of larval specimens between 5 mm and 10 mm SL. These a priori landmarks were utilized to compare larvae fed a diet consisting of *Artemia* nauplii either with or without 0-3 fatty acid supplementation. Principle component analysis indicated limited group shape differences between the two feeding groups. However, changes in within-group allometry over time indicated that variability in shape indices may be related to nutritional quality at this life stage. The impact of preservation technique on this type of analyses is discussed. This is a preliminary study for a planned comparison of differences in allometry between three species from the genus *Morone*.

## Larval Striped Bass Growth and Vulnerability to Predation in Relation to Zooplankton Variability

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**Abstract.**—Striped bass inhabiting Lake Marion, South Carolina, spawn in rivers which feed into this reservoir and their buoyant eggs and early larval stages are subject to hydrodynamic transport downstream. Cohorts of larvae could experience a riverine or lentic environment depending on stream flow and temperature, which affect transport and developmental rates of larvae. Our past research has shown that zooplankton abundance and composition vary along this riverine to lentic gradient and that larval foraging success is higher under the conditions found in the more lentic habitats. The objective of this study was to examine larval striped bass growth and responsiveness to predator attack under a range of foraging conditions similar to those found in Lake Marion. Striped bass larvae were raised from age 4 to 14 d at three prey levels: Low - representing riverine conditions; Medium - representing mean prey levels in lentic habitats; and High - representing peak densities in lentic habitats. Larval growth was highest in the High and Medium treatments, and negligible in the Low density treatments. We also video taped behavioral experiments where larvae from the three prey treatments were attacked with a model predator. Larval responsiveness to predator attacks was related to the prey treatments, but was not a simple function of larval size.

## Respiratory Response of Striped Bass to Feeding

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*Abstract.*—Feeding elicited metabolic response, often expressed as oxygen consumption, is a well documented phenomenon. However, response quantification for fish commonly raised in small ponds and tanks is lacking for many species. Oxygen consumption rates were determined for 300 - 500 gram striped bass *Morone saxatilis* fed a commercially prepared, high protein diet. Gross respiratory response was investigated utilizing a mass respiration chamber at standard culture temperature and salinity (24°C, 5ppt). Oxygen consumption increased 50% over starved, baseline values, for a duration of 24 to 48 hours. Magnitude and duration of the response appears to be linked with the quantity of food ingested. Quantification of the feeding response affords the opportunity for more accurate decisions on when to feed pond reared fish and when supplemental aeration is necessary to maintain mass oxygen balance. In addition, response duration suggests that a two day starvation period is sufficient for transportation of striped bass at optimal metabolic conditions.

## Evaluation of Harvest Restrictions on White Bass Populations and Fisheries in Texas Reservoirs

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*Abstract.*—White bass *Morone chrysops* are an important sport fish in Texas. During the early and mid 1980's, white bass harvest was not regulated in Texas, in part because fisheries managers felt that the species' high fecundity and rapid growth precluded stocks from being adversely impacted by anglers. However, during this same period, angler effort directed towards white bass increased sharply, and managers were unsure of how population structures would respond to high exploitation levels. Therefore, white bass harvest restrictions were implemented in 1988, due to concern about potential overharvest of adults stocks. In this study, we monitored the population structures and fisheries at 7 Texas reservoirs following imposition of 254-mm minimum-length and 25-fish daily-bag limits. We will present the results of pre- (1984-1988) and post-regulation (1989-1993) comparisons of population abundances, size and age structures, and angler catch and harvest. Outcomes will be discussed in the context of white bass management strategies.

## Population Characteristics of Striped Bass, White Bass, and their Hybrids in Cherokee and Norris Reservoirs, Tennessee

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*Abstract.*—The concern of natural hybridization between striped bass *Morone saxatilis* and white bass *Morone chrysops* occurring at Norris and Cherokee reservoirs resulted in an investigation of these two important sportfish. Anglers and biologists have both noted the presence of *Morone* spp. physically resembling the hybrid (Cherokee bass). Standard biochemical genetic techniques, fatty acid composition analysis, and an evaluation of parasite infection rates of the nematode *Eustrongylides* were used to determine if natural hybridization was occurring. We found no evidence of hybridization in Norris Reservoir. Individuals resembling Cherokee bass were found to be striped bass. The possibility that hatchery reared fish were the result of backcrossing of  $F_x$  individuals is still being investigated. Hybrid *Morone* were found in Cherokee Reservoir. Their presence was attributed to either natural hybridization or escapement from an adjacent hatchery. The percent lipid of striped bass, white bass or Cherokee bass was not significantly different and no reservoir effects were determined. Infection rates of the nematode showed no preference between striped bass or Cherokee bass.

# The Effects of Salinity on Growth, Mortality, and Nutritional Condition of Juvenile Striped Bass

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*Abstract.*—Juvenile stages of striped bass *Morone saxatilis* depend on estuarine productivity for rapid growth and the habitat diversity of estuaries for protection from predation. Suitability of estuaries as nursery areas may be influenced by water temperature and salinity. Two age groups of juvenile striped bass were reared in the laboratory at three different salinities (0, 5, 10 ppt.) And two temperatures (25, 28 °C) to test the effects on growth rate, mortality, liver somatic index (LSI), and lipid concentration. At 25°C, mean specific growth was significantly greater in salinities of 5 and 10 ppt. At 28°C, salinity did not affect growth for either age group. Survival exceeded 98% survival at all temperature and salinity combinations. Lipid concentration increased with age, but LSI and lipid concentration did not differ with salinity. Unpublished data collected by the Georgia Cooperative Fish and Wildlife Research Unit show the fresh/saltwater interface is important in determining the location of juvenile striped bass in the Savannah and Ogeechee rivers. They are more abundant on the freshwater side of the interface. Since growth was only affected by higher salinity at 25°C and salinity had no significant effects on any of the condition indices, factors other than salinity are probably contributing to the spatial distribution of juveniles.

## The Salinity Preference of Striped Bass *Morone saxatilis*

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*Abstract.*—The importance of estuaries as nursery habitats for striped bass has been well documented. However, the classification and delineation of rearing microhabitats for larvae and juveniles has been a difficult task. The highly variable physicochemical nature of estuaries in conjunction with the euryhaline behavior of striped bass have allowed fishery managers to only speculate what portions of an estuary are vital for successful recruitment. The intent of my research was to test the hypothesis that juvenile striped bass prefer water of relatively low salinity when offered a range of salinities that may be proximal to the brackish/freshwater interface within estuaries. Specifically, four salinity concentrations were tested: 0, 5, 10, and 15 ppt. Gradients containing water of these concentrations were established within modified Stellionate salinity gradient devices. Individual fish were placed into a device and filmed over four hours to determine preference or avoidance of particular salinities. Fish acclimated at both 0 and 15 ppt were tested to determine if acclimation state affects preference. To test for ontogenetic shifts in preference, test fish ranged in size from approximately 35-125 mm. A total of 50 fish were tested for each acclimation state. Data analyses and thesis preparation are currently underway. Anticipated completion of final results is January 1997.

## The Toxicity of Acid Mixing Zones to Juvenile Bluegill

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*Abstract.*—Acid mixing zones occur at the confluence of waters of different pH and are often visible by plumes of metal precipitates in the water column and attached to the substratum. Metals (e.g., Al, Fe, Mn) soluble in the low pH stream become insoluble as rapid pH elevation occurs in the mixing zone. Mixing zone toxicity to juvenile bluegill *Lepomis macrochirus* was evaluated by measuring mortality rates in instream cages during six hour tests. Mortality rates in the mixing zone were much higher than those placed in the acid or neutral stream or downstream below the effects of mixing. A mixing channel was assembled in the field allowing the toxicity of mixed water to be compared after various mixing times (0-2.5 min). Water immediately after mixing was significantly more toxic than after 2.5 minutes when it reached caged fish at the terminus of the channel. The suspected mechanism of mortality, Al precipitation and polymerization on fish gills, was supported by water quality analysis and Al speciation. Reactive Al species were present at higher levels early in the mixing process and had precipitated into unreactive Al species before reaching bottom cages.

## **Preliminary Evaluation of Pigment Distribution of Macrophage Aggregates in Response to Arsenic and Dieldrin**

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*Abstract.*--Biomarkers are often used to assess environmental degradation and effects on fish populations. Macrophage aggregate size, number, and pigment distribution are potential biomarkers for fish health and environmental degradation. Pigment distribution of macrophage aggregates may be representative of exposure to certain types of contaminants. In a laboratory study, fish were fed 0, 50, 200 and 800 (ppm) arsenic and 0, 0.01, 0.10, 1.0, 10.0 and 25.0 (ppm) dieldrin in their diet. Liver, spleen and head kidney were removed from each fish for macrophage aggregate analysis. A preliminary evaluation of these tissues found that there were significant dose-dependent increases in pigment distribution of macrophage aggregates. These findings may be comparable to field studies in detecting contaminants in fish populations.

## **Toxicity Effects of Sludge on the Survival and Reproduction of *Ceriodaphnia dubia***

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*Abstract.*--Toxicity testing with aquatic biota has become an accepted practice for determining the potential toxicity of waste water and other effluents that may be discharged to the Nation's water resources. Similarly, runoff reaching playas and lakes from agricultural lands treated with sludge, can also be tested to evaluate its effect on the flora and fauna. These tests can be indirectly used to identify the toxic effects of effluent and runoff on the survival and reproduction of fish populations. However, organisms that are selected for toxicity tests should be easily cultured, have a short life cycle, and be representative of local populations. The fresh water invertebrate currently used in toxicity tests is a micro crustacean, *Ceriodaphnia dubia*. Two separate batches of bioassay experiments were performed at Texas Tech University, utilizing soil samples treated with sludge and sludge samples from a municipal waste water treatment plant. Results of the toxicity test with soil samples indicated that the No-Observed-Effect-Concentration and the Lowest-Observed-Effect-Concentration for survival were, respectively, 80% and 100% concentrations ( $P < 0.05$ ) for soil samples treated with 16 tons/acre of sludge. For soil samples treated with 0 and 8 tons/acre of sludge, the survival rates of *Ceriodaphnia dubia* were not significantly ( $P < 0.05$ ) affected at any concentration. Reproduction was suppressed by 25% when *Ceriodaphnia* were exposed to 10.9% concentration of soil treated with sludge at 16 tons/acre. A 50% suppression of reproduction occurred when *Ceriodaphnia* were exposed to 50% concentration of soil treated with sludge at 16 tons/acre. With a sludge application rate of 8 tons/acre, the reproduction was suppressed significantly ( $P < 0.05$ ) by 25%, at a treatment concentration of 60%. Neither 25% nor the 50% Inhibition Concentrations were significantly ( $P < 0.05$ ) affected in the treatment involving the sludge application rate of 0 tons/acre. It is inferred from this experiment that, runoff from soil treated with 16 tons/acre seems to have an effect on the reproduction and survival of cladocerans. Experiments utilizing both wet and dry sludge samples from a waste water treatment facility indicated that, the No-Observed-Effect-Concentration and the Lowest-Observed-Effect-Concentration for survival were respectively, 80% and 100% concentrations of the sludge. Reproduction data indicated that the 25%-Inhibition Concentration was 40.3% for the wet sludge and 19.2% for the dry sludge, whereas the 50%-Inhibition Concentration on reproduction was 54.2% for the wet and 92.5% for the dry sludge. This indicated, that the inhibition of reproduction by the wet sludge was caused by the anaerobic conditions of the sludge, whereas in the dry sludge it may have been caused by dissolved metals present in the sludge.

## **Effects of Copper Contamination on Recruitment of *Posthodiplostomum minimum* (Trematoda) by Bluegill *Lepomis macrochirus***

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*Abstract.*—A laboratory study was conducted to investigate the effect of copper contamination on recruitment of the endoparasitic *Posthodiplostomum minimum* (white grub) by bluegill *Lepomis macrochirus*. White grubs as encysted metacercariae have been reported from a number of fish species and are commonly found in the viscera of bluegill and other centrarchids. The life-cycle of this strigeid trematode was established in the laboratory using chicks as experimental definitive hosts and physid snails as first intermediate host. Upon completion of development in snails, juveniles emerged as free-swimming cercariae which then served as a source of infection for bluegill. The 96-hr LC50 of copper (a common algicide) for bluegill was determined to be 1.08 ppm (nominal concentration) under laboratory conditions. Sublethal copper concentrations used in parasite exposure experiments were 5, 10, and 20% of the LC50 value. Uninfected fish were exposed to sublethal concentrations of copper for two weeks, prior to exposure to cercariae. Percent mortality and parasite intensity was determined for fish in each concentration and compared to that of controls not exposed to copper. The potential for use of white grubs as bioindicators of pollution was assessed.

## **"Something's Fishy" in Texas: A 4-H Aquatic Science School Enrichment Program for Elementary Students**

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*Abstract.*—An increasing number of youth have limited knowledge and understanding of the biological and sociological processes impacting our aquatic resources. As a result, a 4-H school enrichment pilot program entitled "Something's Fishy" focusing on fisheries resources, aquatic science, water quality and water conservation was conducted. The objectives of this study were to test the efficacy of a mobile, multi-media teaching module and measure the attitudes and knowledge of fourth graders regarding the conservation and management of aquatic resources. The experiential module consisted of a free-standing display, videos, lesson plans, water quality test kits and an interactive computer program. A total of 499 fourth graders from three campuses participated in the pilot program during the 1995-96 school year. All participants were pre-tested with a ten question survey, then post-tested to measure program impact at the end of the module's two week stay on each campus. Students scored an average of 52% on the pre-test and 78% on the post-test. There were no significant differences in pre- or post-test scores between male and female students or between students of different ethnicities. Program expansion using this multi-media teaching approach should increase awareness and knowledge of aquatic resources among elementary students.

## **Preliminary Results of Substrate Effect on Crawfish Egg and Juvenile Production in Artificial Burrows**

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*Abstract.*—The effects of two substrate types on water quality, adult female mortality, egg mortality, and hatching success were studied for two species of crawfish. Sexually mature females of *Procambarus clarkii* (Girard) and *P. zonangulus* Hobbs and Hobbs were placed in artificial burrows containing water only, silt and water, or clay and water. There was little difference in female mortality among the treatments. After 32 days in the burrows egg mortality was significantly lower for both species in the silt treatment. Burrows with clay did not significantly alter egg mortality. Of females laying eggs, egg mortality decreased from 78% in water to 17% in silt for *P. zonangulus* and 19% to 0% for *P. clarkii*. More *P. clarkii* females hatched juveniles than did *P. zonangulus* during the same period.

## SEAMAP - A Classic Cooperative Program

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*Abstract.*--The Southeast Area Monitoring and Assessment Program (SEAMAP) is a cooperative state/federal program for collecting, managing, and disseminating fishery-independent data in the southeastern United States. Fishery-independent data collected by SEAMAP scientists provide essential information on abundance and distribution of marine fish and invertebrates, and environmental changes that are used by fisheries managers, academic researchers, and the commercial and recreational fishing industries. SEAMAP consists of three regional components: SEAMAP-Gulf of Mexico; SEAMAP-South Atlantic; and SEAMAP-Caribbean. The purpose of this presentation is to give a brief description of the state, regional and federal fisheries agencies and organizations that participate in each component and provide a summary of the program achievements and data that are available in the SEAMAP Information System. The overall approach of SEAMAP emphasizes the collection of fishery-independent data to fill specific short and long-term management needs. Data are collected from research vessels following scientifically-designed long-term survey plans. The SEAMAP database provides information allowing managers and scientists to monitor and assess the condition of species or species groups under state, interstate, federal, and international management. SEAMAP data sets are particularly useful in fisheries stock assessments because of their quality and time series. Specific examples of fisheries for which SEAMAP data are now being used to support management decisions include red snapper and shrimp in the Gulf of Mexico; Spanish mackerel, rock shrimp, and weakfish in the South Atlantic; and red hind in the Caribbean. The SEAMAP Information System provides an integrated and decentralized data system allowing users easy access to 14 years of SEAMAP data. The on-line database currently contains 332 cruises with a total of 2.2 million records. Data may be obtained from the SEAMAP Data Manager by specific request, or from SEAMAP participants, published reports, or most recently, through the Internet. There is still great potential for increased use of ongoing SEAMAP data collection for fisheries management, especially as the SEAMAP resource survey databases continue to grow into longer time-series of fishery-independent data.

## Atmospheric Cold Fronts and Coastal Ocean-Estuarine Physical Forcing as a Brown Shrimp *Penaeus aztecus* Recruitment Enhancement Mechanism

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*Abstract.*--We conducted a field test of a recruitment enhancement hypothesis for postlarval brown shrimp *Penaeus aztecus* in a Louisiana estuary. The postulated mechanism involves the influence of tidal and wind-forced currents generated by atmospheric cold fronts on postlarval shrimp. Shrimp are hypothesized to use changes in water temperature and salinity associated with cold fronts to elicit either a passive or behavioral response in combination with a diel activity cycle. We are investigating the linkage between observed transport under astronomically-driven flows ("normal tides") and meteorologically-driven flows. Near surface and near bottom plankton collections were taken 8 times each day for a 90-day period from 1 Feb.-30 Apr. 1994, in Oyster Bayou, a tidal pass connecting the Gulf of Mexico with Fourleague Bay, Louisiana. February samples indicate an interaction between postlarval brown shrimp abundance and atmospheric cold front passages. We are presently determining the temporal, vertical, diel and tidal abundance of brown shrimp as they relate to water flux for the remaining two months.



# Potential Aquatic Ecological Impacts from Interbasin Water Transfers: Southeast, West-Central, and South-Central Texas

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*Abstract.*—An evaluation of potential aquatic ecological impacts from proposed interbasin water transfers in the Southeast, West-Central, and South-Central Texas was conducted utilizing historic and current data. Potential ecological impacts from the introduction of native and exotic aquatic organisms and operational activities associated with interbasin water transfers on aquatic ecosystems, including threatened/endangered species, were qualitatively assessed. Native aquatic species (e.g., microbes, algae, benthic invertebrates, amphibians, reptiles, and fish) and exotic organisms (e.g., aquatic macrophytes, mollusks, and fish including pathogens) could potentially be affected by the operational/transfer activities or cause adverse ecological impacts in the donor, conduit, and/or recipient basins in the study areas. Several general engineering and environmental recommendations/mitigations are proposed for the open and closed interbasin water transfers.

## Anadromous Fish Passage and Restoration in Virginia

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*Abstract.*—Anadromous fishes, such as American shad *Alosa sapidissima*, are important to Virginia for both commercial and recreational use. Unfortunate stock declines may be partly attributed to numerous dams that have blocked access to historical spawning grounds in the Chesapeake Bay drainage since the 1700's, and increased commercial harvest during the 1970's. Restoration efforts consist of three areas; 1) fish passage, 2) stocking "new" waters, and 3) commercial harvest restriction. Virginia's Fish Passage Program is supported by matching grants from the EPA/NOAA for coordination, design and construction of fishways. USFWS engineers provide technical support for passage projects. Since 1989, six fishways were completed on Bay tributaries in Virginia reopening 47.3 miles of spawning habitat. Current projects include Boshers Dam (137.4 miles) on the James River and Ruffins Dam (8 miles) on Massaponax Creek. Future projects include Embrey Dam (82.3 miles) on the Rappahannock River. Relative abundance assessments (electrofishing) of spawning runs are made each spring at several locations. Restocking efforts are concentrated above Boshers Dam on the James River in anticipation of fishway construction. In 1996, approximately 4,800 pre-spawn blueback herring *A. aestivalis* from the Chickahominy River and 5.5 million American shad fry from the King and Queen State Hatchery were stocked in the James River above Boshers Dam. Spawning success of herring and shad fry survival were documented by electrofishing and pushnetting above Boshers Dam during summer and fall. Average CPUE for shad juveniles was 31.5/hr for pushnet samples and 6.2/hr for electrofishing. Average CPUE for herring juveniles was 0.4/hr for electrofishing. Shad juveniles collected above Boshers Dam displayed the oxytetracycline mark received on their otoliths while in the hatchery.

## Retention of Coded Wire and Internal Anchor Tags in Juvenile Snook *Centropomus undecimalis*

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*Abstract.*—We evaluated the retention of coded wire tags and two types of internal anchor tags and tagging-related mortality in hatchery-reared juvenile snook *Centropomus undecimalis*. Retention of coded wire tags was evaluated in snook 60 - 115 mm SL for 60 d posttagging, and retention of internal anchor tags with disk- and T-style anchors was evaluated in snook 110 - 180 mm SL for 30 d posttagging. An average of 93.8% of the coded wire tags were retained for 60 d. Initial fish size significantly affected coded wire tag retention rates; retention rates were 95-100% in fish >70 mm SL and 87-92% in fish <70 mm SL. Coded wire tag retention rates decreased during the first 30 d of the experiment but not thereafter. The retention rate of both types of internal anchor tags was >99% after 30 d. Initial fish size did not affect retention of internal anchor tags. Disk-style anchors were more likely to be encapsulated in the peritoneum and attached to the inside of the body, which may enhance retention of this tag type. For all types of tags and fish sizes tested, tagging did not significantly affect snook survival.

## Growth and Mortality of Alevin Channel Catfish in the Oconee River, Georgia

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**Abstract.**--We estimated instantaneous growth and mortality of alevin channel catfish *Ictalurus punctatus* from the Oconee River, Georgia. The Oconee is a regulated river characterized by highly-variable, unpredictable flows. Our objective was to estimate alevin growth and mortality in this regulated system. We modeled growth and mortality with exponential equations and estimated these parameters with regression techniques. Instantaneous growth was 0.0062 (SE = 0.0008) and instantaneous mortality was 0.0731 (SE = 0.0104). Published estimates of instantaneous growth and mortality are lacking for young-of-the-year (YOY) ictalurids. Our growth model predicted that YOY catfish would be 25 mm by mid-September. This size is much smaller than that (i.e., 60 mm) reported for similarly-aged alevins in other systems. Our results suggest that flow regulation may affect YOY fish population dynamics, but the mechanisms for such actions are unknown. Nonetheless, we attribute the low growth and mortality of YOY catfish in the Oconee River to the regulated flows in the system. Further, we hypothesize that the highly-variable, unpredictable flows that accompany hydropower generation may 1) increase energy demands for alevins and leave less energy available for growth, and 2) increase turbidity and thereby reduce alevin vulnerability to predators, which then results in low alevin mortality.

## Differential Electrofishing Catch Rates of Two Species of Black Bass Due to Seasonal and Size-Related Changes in Habitat Preference

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**Abstract.**--Largemouth bass *Micropterus salmoides* and spotted bass *M. punctulatus* were sampled in the spring and fall over five years from Normandy Reservoir, Tennessee, to assess spatial and temporal differences in abundance. Bass were collected each season from 40 transects using a DC electrofishing boat equipped with boom-mounted electrodes. Sampling was stratified among the following habitats: riprap, rubble, gravel, mixed substrate, and coves. A randomized block design ANOVA was used to partition variation by habitat and year. Catch rates of largemouth bass were highest in riprap habitats and lowest in gravel habitats in both seasons ( $P=0.0001$ ). Gravel habitats yielded more small largemouth bass in both seasons ( $P=0.0001$ ). In contrast, spring catch rates of spotted bass varied unpredictably among years and habitats. Fall catch rates of spotted bass were highest in rubble habitats and lowest in cove and mixed habitats ( $P=0.0001$ ). Cove and gravel habitats consistently contained smaller spotted bass in both seasons. Managers designing electrofishing surveys to obtain a random sample of black bass should be aware that catch rates from electrofishing surveys vary according to specific habitat preferences of both sizes and species of black bass.

## Protection and Enhancement of Paddlefish Stocks in North America: Creation of a Multi-State and Multi-Agency Database

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*Abstract.*—Paddlefish *Polyodon spathula* have been an important resource of the North American fisheries industry since the late 1800's. With improved capture efficiencies, increasing demands for paddlefish, and alterations of critical spawning habitats, paddlefish populations have declined in many locales and been extirpated in several areas. To protect and enhance paddlefish stocks in North America, a large-scale, multi-state, cooperative fishery management effort was initiated in 1995 by the Mississippi Interstate Cooperative Resource Agency. Since 1995, 22 participating states have coded-wire tagged over 3,000 adult wild paddlefish to assess their abundance and migration patterns within the Mississippi River basin. In 1995 alone, over 200,000 hatchery-reared paddlefish juveniles were tagged and released to enhance wild paddlefish stocks throughout the Mississippi River basin and in several large rivers in Texas. Information on the capture, tagging, release, and recapture of wild paddlefish, as well as the tagging, release and recapture of hatchery fish is being incorporated into a GIS-database. Annual sampling by participating agencies is providing insight into the exploitation and long-range movements of paddlefish. The contribution, if any, of hatchery-reared fish to wild stocks will be apparent in several years when stocked fish recruit to commercial and recreational fisheries throughout the basin.

## Efficiency and Economy of Alternative Methods for Marking Hatchery Released Fish

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*Abstract.*—We evaluated efficiency and economy of oxytetracycline (OTC) immersion, coded-wire tags (CWT), and internal anchor tags for marking juvenile striped bass *Morone saxatilis* stocked in an estuarine enhancement program. Anchor tags require no investment in major equipment, are easily retrieved and decoded, and do not require sacrificing the recaptured fish. However, labor and material costs for applying tags are high, long-term tag retention is relatively poor (20% at age-3), and fish must be cultured to relatively large sizes. For CWT, application requires relatively expensive equipment, moderate labor and material costs, and fish typically exceeding 50mm in length. However, retention exceeds 90% for age-1 and older fish, and decoding requires little time and a microscope. Marking with OTC requires relatively little time and cost, however, retrieval of OTC information is expensive because of labor and equipment costs. OTC has relatively poor rates of mark retention (80% for age-1 and older) and detection 75%. The use of CWT and OTC requires sacrificing the recaptured fish. Results of this study identify trade-offs that should be considered when choosing marking methods to be used in a stock enhancement program.

## Seasonal Colonization Dynamics of the Zebra Mussel *Dreissena polymorpha* in the Lower Atchafalaya Basin, Louisiana

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*Abstract.*—Previous studies on the zebra mussel *Dreissena polymorpha* have examined tolerance limits of dissolved oxygen and temperatures that can be used in controlling this exotic pest. We wanted to determine if colonization of the zebra mussel in the Atchafalaya Basin would be deterred by the natural seasonal phenomenon of increased temperatures and decreased oxygen saturation. The Atchafalaya Basin is a large river-floodplain in Louisiana that represents the current most southern distribution of *D. polymorpha* in North America. During 1995-96, adult mussels were counted monthly on colonization samplers placed in riverine and floodplain habitats. We found a seasonal colonization dynamic with mussels settling in fall when minimum daily temperatures dropped below 31°C. By midwinter mussels colonized floodplain habitats as far as 10 km from the main stem river. In August, adult mussels experienced mortality as minimum daily temperatures rose above 29°C in the floodplain and above 31°C in riverine sites. Low dissolved oxygen levels and high temperatures in the floodplain prevented establishment of zebra mussel populations; however, small populations remained in riverine sites even during unfavorable summer conditions. Seasonal colonization of zebra mussels in the Atchafalaya Basin has implications for predicting zebra mussel distribution in warmwater systems.

## The Effects of Hypoxia on Aggressive Behavior in Male Sunfish

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**Abstract.**—Large areas of sunfish spawning habitat become hypoxic (dissolved oxygen concentrations < 2.0 mg/l) during the late spring and early summer months in the Atchafalaya Basin. In order to effectively guard nesting territories, male sunfish must exhibit aggressive behavior towards perceived intruders. In aquaria, we performed tests with intruder models and food items to determine if the behavior of males of two sunfish species (bluegill *Lepomis macrochirus* and spotted sunfish *L. punctatus*) differed when inhabiting low and high dissolved oxygen concentrations. Behavioral reaction time to a food item (worm) under hypoxic conditions increased in both bluegill and spotted sunfish. When presented with fish-model intruders, bluegill became more passive, less alert, and less aggressive under hypoxic conditions; while spotted sunfish became slightly less passive, more alert, and less aggressive. Hypoxia causes male bluegill to respond more passively when challenged, but spotted sunfish remain alert when inhabiting hypoxic habitats.

## Effects of a Variable Crest Weir on Fishes and Commercially-Important Crustaceans in the Brazoria National Wildlife Refuge, Texas

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STEWART JACKS

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**Abstract.**—In 1969, a variable-crest weir was constructed on the Brazoria National Wildlife Refuge (BNWR), Texas. The function of the weir is to retain water in the marsh during winter low tides to maintain vegetation and critical bird habitat. However, fishes are negatively impacted by the impedance of the weir on egress and ingress to crucial nursery habitats. Two study sites, one managed and one unmanaged, located on Salt Lake in the BNWR were selected to determine the effects of the weir on fish movements. Light traps and bag seines were utilized twice a month from July 1995 to July 1996 to sample larval and juveniles fishes and commercially-important crustaceans. A total of 51,717 individuals were collected representing 31 families and 52 species. The dominant organisms collected were *Brevoortia patronus* with 13,780 individuals and *Penaeus setiferus* with 12,980 individuals. Water quality measurements were also taken at both sites. Results from this study will be used to provide management strategies for coastal National Wildlife Refuges in Texas.

## Distribution and Abundance of Paddlefish in the Lower Neches River, Texas

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**Abstract.**—During 1996, we studied the distribution and abundance of paddlefish *Polyodon spathula* in the Lower Neches River, Texas, to help assess potential affects of temporary saltwater barriers on paddlefish populations. These barriers are installed on the Neches River about once every 10 years and are used to prevent saltwater from the Gulf of Mexico from moving upstream into water intake structures operated by the Lower Neches Valley Authority. Based on gill net catches and ultrasonic telemetry results for 51 tagged fish, paddlefish are localized in occurrence and avoid salinities greater than 0.5 ppt. Gill net catch rates, < 0.04 per hour, suggest the paddlefish population in the Lower Neches River is small.

## Historic Changes in Fish Assemblages of the Canadian River, Texas

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*Abstract.*—Fish assemblages of the Canadian River historically were relatively uniform in composition across the Texas Panhandle and were dominated by plains minnow *Hybognathus placitus* and Arkansas River shiner *Notropis girardi*. These two species comprised  $\geq 90\%$  of fishes collected from the Canadian River in 1954-1955. Construction of two reservoirs in the mid-1960s, Ute Reservoir in New Mexico and Lake Meredith in Texas, changed hydraulic conditions in the Canadian River. Downstream from Lake Meredith, flows have been reduced approximately 88% compared with historic flows. Since the 1950s, the relative abundance of plains minnow and Arkansas River shiner have decreased with both species comprising  $< 1\%$  of fishes collected in 1996. The relative abundance of red shiner *Cyprinella lutrensis* and sand shiner *Notropis stramineus* have increased with both species comprising 45% of fishes collected in 1996. Upstream from Lake Meredith, flows have been reduced by about 50% from historic levels. The relative abundance of plains minnow has decreased from 65% of fishes collected in the 1950s to 32% in 1996, the relative abundance of Arkansas River shiner has remained at about 24%, and speckled chub *Macrhybopsis aestivalis* has increased in relative abundance from  $< 1\%$  to 24% of fishes collected during the 1990s.

## Development of a Morphological Index of Nutrition Status of Young Largemouth Bass

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*Abstract.*—Food deprivation in larval and post-larval fishes has long been thought to be a cause of year class failure. Methods to detect starvation in larval fishes have been applied to several marine species, but very few freshwater species. We developed an index of nutritional status for post-larval largemouth bass *Micropterus salmoides* based on morphological changes during food deprivation. Bass were either fed or unfed. A truss network, along with additional measurements of standard length and body depth at the anal vent, was applied to 163 largemouth bass, 8-13 mm. A size-free discriminant function analysis was used to distinguish between fed and unfed largemouth bass. Mean discriminant scores for fed and unfed fish were significantly different ( $P < 0.01$ ). Three characters, anchored at the insertion point of the pelvic fin and the body depth at the anal vent, were most capable in discriminating between fed and unfed bass. Fed fish had significantly higher ( $P < 0.01$ ) ratios of the four measurements to standard length. Any of these ratios allows nutritional status of larval largemouth bass to be quickly and easily determined.

