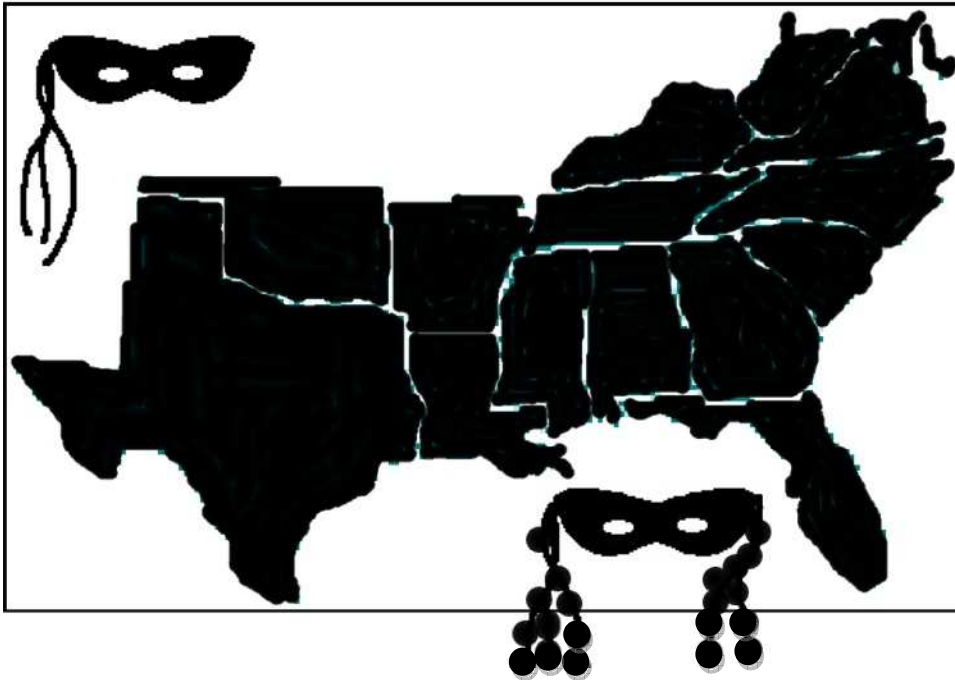


**GUMBO YAYA: A DISCUSSION ON THE RELATIONSHIP BETWEEN
FISHERIES RESEARCH AND MANAGEMENT**

Southern Division of the American Fisheries Society Spring Meeting



15-18 January 2009

Royal Sonesta Hotel

New Orleans, Louisiana

Hosted by the Louisiana Chapter of the American Fisheries Society

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Acknowledgements

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Schedule-at-a-glance

Thursday - January 15, 2009

Date/Time Event: Location

7:30 AM - 5:00 PM Registration: Foyer
8:00 AM - 5:00 PM Poster Set up: Evangeline B
1:00 PM - 5:00 PM Presentation Loading: Esplanade
1:00 PM - 5:00 PM Presentation Practice: Iberville
3:00 PM - 5:00 PM SDAFS EXCOM Officers: Gris Gris
5:30 PM - 8:30 PM SDAFS Leadership Meeting: South Ballroom

Technical Committee Meetings

8:00 AM - 5:00 PM Reservoir Committee: Teche/Belle Grove
8:00 AM - 5:00 PM Warmwater Streams Committee: Evangeline C
8:00 AM - 5:00 PM Pollution Committee: Royal Conti
8:00 AM - 12:00 PM Alligator Gar Committee: Regal Suite
8:00 AM - 2:30 PM Flint River Group: Gris Gris
12:30 PM - 5:00 PM Catfish Committee: Oak Alley/Madewood
1:00 PM - 5:00 PM Aquaculture Committee: Regal Suite
1:00 PM - 5:00 PM Nongame Aquatics Committee: Evangeline A
1:00 PM - 5:00 PM Trout Committee: Bourbon

Friday - January 16, 2009

Date/Time Event: Location

7:30 AM - 5:00 PM Registration: Foyer
7:30 AM - 5:00 PM Presentation Loading: Esplanade
7:30 AM - 5:00 PM Presentation Practice: Iberville
8:00 AM - 12:00 PM SDAFS EXCOM Meeting: South Ballroom
8:00 AM - 5:00 PM Poster Setup: Evangeline A and B
12:00 PM - 1:30 PM SDAFS Past President's Luncheon: Galatoire's
2:30 PM - 5:00 PM Poster Setup and Display: Evangeline Suite
5:00 PM - 6:30 PM SDAFS Business Meeting: South Ballroom
7:00 PM - 10:00 PM Student/Professional Social: Bienville Suite

Workshops

8:00 AM - 5:00 PM F.A.S.T. Workshop: Oak Alley/Madewood
8:00 AM - 5:00 PM Gar Ageing Workshop: Regal Suite
8:00 AM - 12:00 PM Student Affairs Workshop: Teche/Belle Grove
8:00 AM - 12:00 PM Flint River Group: Evangeline C
1:00 PM - 5:00 PM Pond Management Workshop: Teche/Belle Grove
1:00 PM - 5:00 PM Fish Health Workshop: Royal Conti
1:00 PM - 2:30 PM Asian Carp: Evangeline C

Saturday - January 17, 2009

7:30 AM - 5:00 PM Registration: Foyer
7:30 AM - 5:00 PM Presentation Loading: Esplanade
7:30 AM - 5:00 PM Presentation Practice: Iberville
8:00 AM - 10:00 PM Poster Session: Evangeline Suite

8:00 AM – 9:30 AM Plenary Session: Grand Ballroom

9:30 AM - 10:00 AM Break

10:00 AM - 4:20 PM Pontchartrain Basin Fisheries Symposium: Teche/Bell Grove

10:00 AM - 2:20 PM Atchafalaya River Basin Symposium: North Ballroom

10:00 AM - 5:00 PM Gar Symposium: Regal Ballroom

10:00 AM - 2:00 PM Adaptive Management Symposium: South Ballroom

10:00 AM - 2:20 PM Nuisance Plants Symposium: Royal Conti

10:00 AM - 1:40 PM Crayfish Symposium: Bienville

10:00 AM - 11:40 AM Contributed Session: Oak Alley/Madewood

11:40 AM - 1:00 PM Student/Mentor Lunch

1:00 PM - 2:40 PM Contributed Session: Oak/Alley Madewood

1:40 PM – 4:40 PM Aquaculture Symposium: Bienville

2:00 PM - 2:40 PM Contributed Session: South Ballroom

2:20 PM - 4:40 PM Large River Symposium: North Ballroom

2:40 PM - 3:00 PM Break

3:00 PM - 5:00 PM Contributed Session: South Ballroom

3:00 PM - 5:00 PM Contributed Session: Oak Alley/Madewood

3:00 PM - 5:00 PM Contributed Session: Royal Conti

4:20 PM - 5:00 PM Contributed Session: Teche/Bell Grove

5:30 PM - 6:30 PM LA AFS Chapter Meeting

7:00 PM - 10:00 PM Dinner/Social Grand Ballroom

Sunday - January 18, 2009

7:30 AM - 5:00 PM Registration: Foyer

7:30 AM - 5:00 PM Presentation Loading: Esplanade

7:30 AM - 5:00 PM Presentation Practice: Iberville

8:00 AM - 10:00 PM Poster Session: Evangeline Suite

8:00 AM - 9:40 AM Contributed Session: North Ballroom

8:00 AM - 9:40 AM Contributed Session: South Ballroom

8:00 AM - 9:40 AM Contributed Session: Regal

8:00 AM - 9:40 AM Contributed Session: Teche/Belle Grove

8:00 AM - 9:40 AM Contributed Session: Oak Alley/Madewood

8:00 AM - 11:20 AM Anadromous Fish Symposium: Royal Conti

8:00 AM – 9:40 AM Contributed Session: Bienville

9:40 AM - 10:00 AM Break

10:00 AM - 12:00 PM Poster Removal

10:00 AM - 12:00 PM Contributed Session: North Ballroom

10:00 AM - 12:00 PM Contributed Session: South Ballroom

10:00 AM - 12:00 PM Contributed Session: Regal

10:00 AM - 12:00 PM Contributed Session: Teche/Belle Grove

10:00 AM - 12:00 PM Contributed Session: Oak Alley/Madewood

10:00 AM - 12:00 PM Contributed Session: Bienville

11:20 AM - 12:00 PM Contributed Session: Royal Conti

Presentation Grid: Session titles indicated planned symposia or contributed papers. Shading indicates a student talk.

Saturday 1/17	Evangeline Suite	South Ballroom Session	South Ballroom Speakers	North Ballroom Session	North Ballroom Speakers
	BREAK	BREAK	BREAK	BREAK	BREAK
		Moderator	Symposium Coordinators	Moderator	Symposium Coordinators
10:00	POSTER	Adaptive Mangement Symposium	Peterson	Atchafalaya Symposium	Kelso and Kaller
10:20	POSTER	Adaptive Mangement Symposium	Galat and Cornish	Atchafalaya Symposium	Kaller et al.
10:40	POSTER	Adaptive Mangement Symposium	Smith, D.R. et al.	Atchafalaya Symposium	Constant et al.
11:00	POSTER	Adaptive Mangement Symposium	Jacobson and Galat	Atchafalaya Symposium	Allen and Constant
11:20	POSTER	Adaptive Mangement Symposium	Kennedy and Irwin	Atchafalaya Symposium	Harlan et al.
11:40	POSTER	Adaptive Mangement Symposium	Irwin and Kennedy	Atchafalaya Symposium	Perret et al.
12:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
		Moderator	Symposium Coordinators	Moderator	Symposium Coordinators
1:00	POSTER	Adaptive Mangement Symposium	Nibbelink et al.	Atchafalaya Symposium	Bonvillain et al.
1:20	POSTER	Adaptive Mangement Symposium	Tyre	Atchafalaya Symposium	Keim and Newman
1:40	POSTER	Adaptive Mangement Symposium	Discussion	Atchafalaya Symposium	Thomas et al.
2:00	POSTER	Coastal Ecology 1	Switzer and Keenan	Atchafalaya Symposium	Halloran et al.
2:20	POSTER	Coastal Ecology 1	Parsons et al.	Large River Symposium	Schramm
2:40	BREAK	BREAK	BREAK	BREAK	BREAK
		Moderator	Jonathan West	Moderator	Symposium Coordinators
3:00	POSTER	Stream Ecology 1	Kollaus and Bonner	Large River Symposium	Hartfield et al.
3:20	POSTER	Stream Ecology 1	Perkin and Bonner	Large River Symposium	Reed et al.
3:40	POSTER	Stream Ecology 1	Markos et al.	Large River Symposium	Corcoran et al.
4:00	POSTER	Stream Ecology 1	Ward et al.	Large River Symposium	Killgore et al.
4:20	POSTER	Stream Ecology 1	Morgan	Large River Symposium	Boysen et al.
4:40	POSTER	Stream Ecology 1	Lauretta et al.	Large River Symposium	Hernandez-Divers et al.
Sunday 1/18	Evangeline Suite	South Ballroom	South Ballroom	North Ballroom	North Ballroom
		Moderator	Noel Novelo	Moderator	Shauna Harris
8:00	POSTER	Coastal Ecology 3	Boswell et al.	Coastal Ecology 5	Belcher and Jennings
8:20	POSTER	Coastal Ecology 3	Black	Advances in Fisheries 1	Lorensen and Fisher
8:40	POSTER	Coastal Ecology 3	Shiple and Cowan	Advances in Fisheries 1	Bodine and Shoup
9:00	POSTER	Coastal Ecology 3	Littleton and Rakocinski	Advances in Fisheries 1	Hartman et al.
9:20	POSTER	Coastal Ecology 3	Brandt and Jackson	Advances in Fisheries 1	Casto-Yerti and Bettoli
9:40	BREAK		BREAK		BREAK
		Moderator	Brian Ward	Moderator	Melissa Fries
10:00	POSTER	Coastal Ecology 4	Topping and Szedlmayer	Rivers and Reservoirs	Smith, N.G. et al.
10:20	POSTER	Coastal Ecology 4	Rome et al.	Rivers and Reservoirs	Daugherty and Buckmeier
10:40	POSTER	Coastal Ecology 4	Kinsey et al.	Rivers and Reservoirs	Farrae and Peterson
11:00	POSTER	Coastal Ecology 4	Lindsey et al.	Rivers and Reservoirs	Rigsby et al.
11:20	POSTER	Coastal Ecology 4	Ellis	Rivers and Reservoirs	Peterson et al.
11:40	POSTER	Coastal Ecology 4	Mickle	Rivers and Reservoirs	Osborne and Rulifson
	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)
	Adams et al.	Day, J.L. et al.	Galvez et al.	Melancon	
	Alford et al.	Delabbio et al.	Goar and Irwin	Nicholson and Jordan	
	Bennett and Cotton	Eison and Barrass	Kemp and McInerny	Simonsen et al.	
	Beyer and Szedlmayer	Figiel	Kerns et al.	Spencer and Kaminski	
	Broussard et al.	Flowers and Pine	Kleber	Strickland and Cailteux	
	Carter et al.	Ford	Martin and Irwin	Thompson et al.	
	Dailey and Howard	Fries et al.	McInerny and Kemp	Williamson et al.	

Presentation Grid: Session titles indicated planned symposia or contributed papers. Shading indicates a student talk.

Saturday 1/17	Regal Session	Regal Speakers	Teche/Bell Grove Session	Teche/Bell Grove Speakers	Oak Alley/Madewood Session	Oak Alley/Madewood Speakers
	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK
	Moderator	Symposium Coordinators	Moderator	Symposium Coordinators	Moderator	Brian Alford
10:00	Gar Symposium	Wayman et al.	Pontchartrain Basin Fisheries Symposium	Cashner and O'Connell	Black Bass	Fontaine et al.
10:20	Gar Symposium	Inebniitt et al.	Pontchartrain Basin Fisheries Symposium	Cashner and O'Connell	Black Bass	Goclowski and Sammons
10:40	Gar Symposium	Clay et al.	Pontchartrain Basin Fisheries Symposium	Cashner and O'Connell	Black Bass	Greenlee
11:00	Gar Symposium	McGrath	Pontchartrain Basin Fisheries Symposium	Lopez	Black Bass	Gwinn and Allen
11:20	Gar Symposium	McGrath	Pontchartrain Basin Fisheries Symposium	Lopez	Black Bass	Horne and Lochmann
11:40	Gar Symposium	Suchy et al.	Pontchartrain Basin Fisheries Symposium	Lopez	Black Bass	O'Rourke and Allen
12:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
	Moderator	Symposium Coordinators	Moderator	Symposium Coordinators	Moderator	Jan Dean
1:00	Gar Symposium	Widgeon et al.	Pontchartrain Basin Fisheries Symposium	Commagere et al.	Fisheries Management 1	Wilde
1:20	Gar Symposium	Smith, O.A. et al.	Pontchartrain Basin Fisheries Symposium	Lorenz	Fisheries Management 1	Barabe et al.
1:40	Gar Symposium	DiBenedetto et al.	Pontchartrain Basin Fisheries Symposium	Schieble et al.	Fisheries Management 1	Balkenbush et al.
2:00	Gar Symposium	Adams et al.	Pontchartrain Basin Fisheries Symposium	Ellinwood et al.	Fisheries Management 1	Whisenhunt
2:20	Gar Symposium	Irwin et al.	Pontchartrain Basin Fisheries Symposium	Eustis	Fisheries Management 1	Hunter et al.
2:40	BREAK	BREAK	BREAK	BREAK	BREAK	BREAK
	Moderator	Symposium Coordinators	Moderator	Symposium Coordinators	Moderator	Kirsten Simonsen
3:00	Gar Symposium	Buckemeier et al.	Pontchartrain Basin Fisheries Symposium	Brogan and O'Connell	Fisheries Management 2	Hutt and Neal
3:20	Gar Symposium	Brinkman and Fisher	Pontchartrain Basin Fisheries Symposium	Lyncker	Fisheries Management 2	Balsman and Shoup
3:40	Gar Symposium	Glass et al.	Pontchartrain Basin Fisheries Symposium	Lezina et al.	Fisheries Management 2	Schroeder and Williams
4:00	Gar Symposium	David et al.	Pontchartrain Basin Fisheries Symposium	Van Vrancken	Fisheries Management 2	Kuklinski and Boxrucker
4:20	Gar Symposium	LaFleur et al.	Coastal Ecology 2	Callihan and Cowan	Fisheries Management 2	Williams, J.S. et al.
4:40	Gar Symposium	Zelko and Eschevarria	Coastal Ecology 2	de Mutsert et al.	Fisheries Management 2	Scott, M.K. et al.
Sunday 1/18	Regal	Regal	Teche/Bell Grove	Teche/Bell Grove	Oak Alley/Madewood	Oak Alley/Madewood
	Moderator	Charles Brown	Moderator	Kelsey Adkisson	Moderator	Cynthia Fox
8:00	Population Biology	Open	Community Ecology	Beckman	Paddlefish	Gordon
8:20	Population Biology	Throneberry and Cook	Community Ecology	Will and Lochmann	Paddlefish	Crews et al.
8:40	Population Biology	Day et al.	Community Ecology	Reeves and Garrett	Paddlefish	Moore et al.
9:00	Population Biology	Fox et al.	Community Ecology	Groom and Gordon	Paddlefish	James and Gordon
9:20	Population Biology	Davis and Cook	Community Ecology	Ryles and Gagen	Paddlefish	Patterson and Fisher
9:40		BREAK		BREAK		BREAK
	Moderator	Peter Markos	Moderator	Craig Gothreaux	Moderator	Mike Kaller
10:00	Stream Ecology 2	Smith and Welsh	Fisheries Management 3	Dotson et al.	Fisheries Management 4	Rankin and Figiel
10:20	Stream Ecology 2	Welsh and Keplinger	Fisheries Management 3	Pine et al.	Fisheries Management 4	Janssen (SAS)
10:40	Stream Ecology 2	Driver and Adams	Fisheries Management 3	Haley et al.	Fisheries Management 4	Adkisson et al.
11:00	Stream Ecology 2	Camp et al.	Fisheries Management 3	Martin and Irwin	Fisheries Management 4	Weaver and Kwak
11:20	Stream Ecology 2	Gibbs and Cook	Fisheries Management 3	Zuber and Schaefer	Fisheries Management 4	Catalano and Allen
11:40	Stream Ecology 2	Sielheimer and Fisher	Fisheries Management 3	Johnston and Peterson	Fisheries Management 4	Brey et al.
	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)
	Adams et al.	Day, J.L. et al.	Galvez et	Melancon		
	Alford et al.	Delabbio et al.	Goar and Irwin	Nicholson and Jordan		
	Bennett and Cotton	Eison and Barrass	Kemp and McInerny	Simonsen et al.		
	Beyer and Szedlmayer	Figiel	Kerns et al.	Spencer and Kaminski		
	Broussard et al.	Flowers and Pine	Kleber	Strickland and Cailteux		
	Carter et al.	Ford	Martin and Irwin	Thompson et al.		
	Dailey and Howard	Fries et al.	McInerny and Kemp	Williamson et al.		

Presentation Grid: Session titles indicated planned symposia or contributed papers. Shading indicates a student talk.

Saturday 1/17	Royal Conti Session	Royal Conti Speakers	Royal Conti Session	Bienville Speakers
	BREAK Moderator	BREAK Symposium Coordinators	BREAK Moderator	BREAK Symposium Coordinators
	10:00 Nuisance Plants Symposium	Madsen et al.	Crayfish Symposium	Wagner and Kottmyer
	10:20 Nuisance Plants Symposium	Sanders and Whitehead	Crayfish Symposium	Huner and Konikoff
	10:30 Nuisance Plants Symposium	Maceina et al.	Crayfish Symposium	Westra et al.
	10:50 Nuisance Plants Symposium	Netherland et al.	Crayfish Symposium	Adams and Warren
	11:10 Nuisance Plants Symposium	Parys and Johnson	Crayfish Symposium	Kilian et al.
	11:30 Nuisance Plants Symposium	Matthews and Moses	Crayfish Symposium	Loughman et al.
	11:50 LUNCH Moderator	LUNCH Symposium Coordinators	LUNCH Moderator	LUNCH Symposium Coordinators
	1:00 Nuisance Plants Symposium	Walley and Sanders	Crayfish Symposium	Welch et al.
	1:20 Nuisance Plants Symposium	Webb and Dibble	Crayfish Symposium	Doucet et al.
	1:40 Nuisance Plants Symposium	Owens	Aquaculture Symposium	Lochmann and Ludwig
	2:00 Nuisance Plants Symposium	Theel and Dibble	Aquaculture Symposium	Lochmann and Ludwig
	2:20 Invasive and Native Species	Gilliland	Aquaculture Symposium	Fisher and Lochmann
	2:40 BREAK Moderator	BREAK Melissa Kaintz	BREAK Moderator	BREAK Symposium Coordinators
	3:00 Invasive and Native Species	Dunn et al.	Aquaculture Symposium	Mace and Neal
	3:20 Invasive and Native Species	Elder and Bennett	Aquaculture Symposium	Brown et al.
	3:40 Invasive and Native Species	Holt	Aquaculture Symposium	Ippolito and Supan
	4:00 Invasive and Native Species	Dick	Aquaculture Symposium	Hu et al.
	4:20 Invasive and Native Species	Carter et al.	Aquaculture Symposium	Novelo et al.
	4:40 Invasive and Native Species	Janssen (mapping)	Aquaculture Symposium	Harris et al.
Sunday 1/18	Royal Conti	Royal Conti	Bienville	Bienville
	Moderator	Symposium Coordinators	Moderator	John Supan
	8:00 Anadromous Fish Symposium	Wrege et al.	Contributed Aquaculture	Broach et al.
	8:20 Anadromous Fish Symposium	Ruth and Kirk	Contributed Aquaculture	Chambers et al.
	8:40 Anadromous Fish Symposium	Duncan et al.	Contributed Aquaculture	Kuenz et al.
	9:00 Anadromous Fish Symposium	Isely	Contributed Aquaculture	Cuevas-Urbe et al.
	9:20 Anadromous Fish Symposium	BREAK	Contributed Aquaculture	Ying Chen et al.
	9:40 Anadromous Fish Symposium Moderator	Peterson Symposium Coordinators	Moderator	BREAK Raphael Cuevas-Urbe
	10:00 Anadromous Fish Symposium	Spidel and Rulifson	Advances in Fisheries 2	Carmean and Jackson
	10:20 Anadromous Fish Symposium	Smith and Hightower	Advances in Fisheries 2	Ivasauskas and Bettoli
	10:40 Anadromous Fish Symposium	Mohan and Rulifson	Advances in Fisheries 2	Vincent and Balkenbush
	11:00 Anadromous Fish Symposium	Riley et al.	Advances in Fisheries 2	Rypel and Haag
	11:20 Anadromous Fish Symposium	Adelsberger et al.	Advances in Fisheries 2	Johnson, C.R. et al.
	11:40		Advances in Fisheries 2	Kitterman and Bettoli
	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)	Posters (Evangeline Suite)
	Adams et al.	Day, J.L. et al.	Galvez et	Melancon
	Alford et al.	Delabbio et al.	Goar and Irwin	Nicholson and Jordan
	Bennett and Cotton	Eison and Barrass	Kemp and McInerny	Simonsen et al.
	Beyer and Szedlmayer	Figiel	Kerns et al.	Spencer and Kaminski
	Broussard et al.	Flowers and Pine	Kleber	Strickland and Cailteux
	Carter et al.	Ford	Martin and Irwin	Thompson et al.
	Dailey and Howard	Fries et al.	McInerny and Kemp	Williamson et al.

Plenary Session

Biographical Sketch – Kerry St. Pé

Kerry St. Pé, for the past 11 years, has been the Executive Director of the Barataria-Terrebonne National Estuary Program, a nationally recognized effort dedicated to preserving and restoring the 4.2 million-acre area between the Mississippi and Atchafalaya Rivers in Southeast, Louisiana. He worked for 23 years as a field biologist and regional coordinator for the Louisiana Departments of Wildlife and Fisheries and Environmental Quality and served as Interim Administrator of the Louisiana Universities Marine Consortium (LUMCON) for 3 years. Kerry has conducted several major studies on the impacts of oilfield brine on Louisiana wetlands as well as studies of clam shell dredging in several Louisiana lakes. He serves on the Ocean Resource and Research Advisory Panel, a national advisory panel to the Secretary of the Navy and state and local advisory boards and is a frequent public speaker.

His wetland restoration work has been featured in the best selling book *Bayou Farewell, The Rich Life and Tragic Death of Louisiana's Cajun Coast* by Mike Tidwell and most recently in the PBS documentary, *Washing Away: Losing Louisiana*.

Kerry grew up in Port Sulphur, Louisiana during the '50s and '60s where the vast coastal marshes surrounding his home inspired him to become a marine biologist. He graduated from Nicholls State University in 1973.

Resurrection of the Bayou People, 2008 A.D.: Wetlands, Hurricanes, and Restoration

Kerry St. Pé, Barataria-Terrebonne National Estuary Program

The entire 4.2 million acre region between the Mississippi and Atchafalaya Rivers was established as the Barataria-Terrebonne National Estuary in 1990 by congressional action under Section 320 of the Clean Water Act. National Estuaries are areas of special national significance that are unusually threatened by multiple and complex environmental issues. The programs created under this act are charged with developing comprehensive plans that are firmly based upon science, using a consensus-driven approach with broad stakeholder involvement to restore the threatened region. Currently there are 28 National Estuary Programs (NEPs) in the United States.

The unique cultural mix and the incredible biological productivity of the Barataria-Terrebonne region are both products of the Mississippi River. The rich mix of flora and fauna, the oil and gas, and the very land that supports, protects, and sustains the region's communities and infrastructure are resultant of the actions of the deltaic processes of a river system that drains two-thirds of the United States. The culture of the region and its direct dependence on the productivity of the region has remained relatively undiluted largely because of the population's tendency to remain in the region for multi-generational time spans.

Due largely to regional and watershed-level human impacts to the hydrology of the Mississippi River and changes to the ecology of the delta, the Barataria-Terrebonne system is suffering from a level of wetland loss that is greater than any other in the world. In addition to the inevitable collapse of the fisheries in the region, the loss of coastal landscape features is threatening surface water sources as saline water intrudes from the Gulf of Mexico towards the north into drinking water supplies. Oil and gas pipelines and entire communities have become far more susceptible to damage from hurricane storm surges and even from lesser climatic events. Hurricanes Katrina and Rita in 2005 and Hurricanes Gustav and Ike in 2008 devastated most of south Louisiana and resulted in an elevated national awareness and interest in Louisiana's wetlands loss.

Restoration planning in Louisiana is not a new phenomenon. The comprehensive restoration plan developed by the Barataria-Terrebonne National Estuary Program was completed and approved by federal and state governments in 1996. The multiple stakeholder and broadly inclusive approach of the National Estuary Program resulted in an exceptionally high level of acceptance of the Comprehensive Conservation and Management Plan (CCMP). A broad level of agreement to the 51 restoration strategies

of the CCMP is an essential component to our ability to return to same level of acceptable risk experienced by the regionally prevalent bayou-dependant culture for generations.

One recently evaluated strategy that could successfully deliver sediments to areas that have changed from marshes to open water is one that would harvest sediments with dredges from the Mississippi and Atchafalaya River beds and then direct the resulting sediment slurry to areas of need. The delivery of riverbed-harvested sediments would result in a much-needed, quicker rebuilding of wetlands without the huge water volumes normally needed to transport sediments to considerable distance. Diversions of harvested sediment would result in a lower magnitude of salinity regime change and fewer conflicts among the user groups that rely on the current fresh, brackish and saline bands of marsh types. Smaller volumes of water diversions would be needed to sustain the rebuilt wetland systems.

Symposium Abstracts: Presenters noted by *. Students are in bold.

Pontchartrain Basin Fisheries: Recovery, Management, and Conservation.

M. O'Connell, Coordinator

A history and overview of fishery research in the Pontchartrain Basin

Cashner, R.C. University of New Orleans (emeritus), and M.T. O'Connell, Pontchartrain Institute for Environmental Sciences, University of New Orleans*

The levee failures associated with hurricanes Katrina and Rita have spotlighted Pontchartrain Basin fisheries while scientists and managers attempt to assess local ecological and economical impacts. These current efforts are assisted by the fact that there is a long history of research on Pontchartrain fishes and fisheries that dates back half a century. After providing an overview of current and recent fishery research in the Basin, we will provide a history of the different research efforts that have been conducted since the 1950s. We have been fortunate enough over the years to discuss these historical data with some of the primary scientists whom actually conducted the research, including Dr. Royal Suttkus and the late Dr. Bruce Thompson. Insights provided by them, their data, and their field notes have allowed us to analyze fish assemblage change over the last half-century in Lake Pontchartrain. We were able to compare collection data from three gear types and monthly environmental data (salinity, temperature, and water clarity) from four periods: 1954, 1978, 1996-1998, and 1998-2000. Canonical correspondence analysis (CCA) revealed that assemblage instability was the most pronounced for fishes collected by trawls from demersal habitats. Atlantic croaker (*Micropogonias undulatus*) and spot (*Leiostomus xanthurus*) were more dominant in past demersal assemblages while the planktivorous bay anchovy (*Anchoa mitchilli*) has become more dominant in recent assemblages. By presenting these historical data along with some of the personal insights from those researchers who collected them, we hope to begin our symposium with a thorough and useful historical overview.

The environmental history of the Pontchartrain Basin and the multiple lines of defense strategy in south Louisiana

Lopez, J. A., Lake Pontchartrain Basin Foundation

In 1718, Europeans settled New Orleans and began develop infrastructure and exploit the natural resources of the Pontchartrain Basin, dominated by estuarine wetlands. Assessment of three centuries of environmental impacts suggests five periods of activities leading to significant degradation. This includes conversion of natural ridges to agriculture, severing of the Mississippi River from deltaic wetlands, commercial logging of all forests, dredging and armoring of wetlands, and surface water pollution. All of these have influenced indigenous fish and their habitats, and therefore, create framework to understand the current condition of fish throughout the basin. An additional direct or indirect result of these impacts is a high rate of loss of coastal habitats, which reduces the natural coastal buffer to storm-driven storm surge that may threaten coastal communities. With increasing frequency of higher intensity hurricanes and a weakened flood protection system, the coast of Louisiana is in crisis as demonstrated by Hurricane Katrina in 2005. The Multiple Lines of Defense Strategy is a proposal to orchestrate coastal restoration and flood protection in harmony to sustain Coastal Louisiana's natural resources and heritage. The strategy utilizes natural and manmade defenses while applying regional wetland habitat goals to maintain estuarine functions.

Implications of future climate change and restoration policy for Gulf Coast fisheries: A pilot project

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Climate change threatens fishery resources, particularly in coastal Louisiana. Potential risks include altered hydrologic regimes, wetland loss from climate-induced sea level rise, and altered migratory corridors. We initiated a pilot study to evaluate the implications of climate change and restoration policy on coastal fisheries in southeastern and south-central Louisiana. Using a quantitative model, we evaluated possible ecosystem outcomes under specific restoration and hurricane protection strategies and assumed future climatic and ecosystem conditions. We applied Robust Decision-Making (RDM) methodologies to our model results to better understand the key risks and vulnerabilities of wetlands and three commercially important species: brown shrimp, white shrimp, and Gulf menhaden. Proposed restoration actions such as river diversions resulted in increased wetland area but also altered the salinity regime. Lower salinities caused by larger diversions exacerbated the decline in brown shrimp habitat, while the rate of habitat decline for white shrimp was reduced. For juvenile menhaden, a balance between the size of the diversion and habitat suitability was evident indicating sensitivity to salinity changes. Key vulnerabilities related to wetland loss included severe climate changes, increased subsidence rates, and increased land loss resulting from relative sea level rise. Results from this pilot study are largely driven by the nature of the model and the habitat suitability index (HSI) used for each species and should not be the basis for directing management actions. However, the RDM approach used for analyzing model results is a useful tool for coastal planning as it allows for the testing of multiple uncertainties and assumptions.

Measuring the impact of an invasive cichlid in New Orleans

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The Rio Grande cichlid (*Herichthys cyanoguttatus*) was introduced to the Greater New Orleans Metropolitan Area (GNOMA) approximately 20 years ago. It has since spread to nearly every possible urban canal and has been caught in considerable numbers outside of the GNOMA as well. To understand the impact of this species, surveys were conducted before and after Hurricane Katrina, as well as before and after the cichlid's arrival at City Park located within Orleans Parish. Competition experiments were also performed. Cichlid growth was measured with native species or with different salinities. Direct competition behavioral trials were also performed, determining the strategies employed by both native bluegill and invasive species during interspecific contests. Findings indicate that this invasive species is well established, aggressive, salinity tolerant, and is expanding its range.

Hypoxia in Chandeleur Sound and a preliminary assessment of a primary nursery habitat for lemon sharks (*Negaprion brevirostris*) at the Chandeleur Islands, Louisiana.

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In early June 2008, a longline survey conducted by NOAA – National Marine Fisheries Service indicated that possible hypoxic conditions were establishing in Chandeleur Sound, Louisiana. A subsequent survey conducted by researchers from the Nekton Research Laboratory (NRL) at the University of New Orleans found similar conditions near two of the NOAA sites as well as at five other sites in Chandeleur Sound. We hope to revisit these sites in 2009 to better determine if a “dead-zone” is establishing in proximity to the Chandeleur Islands. A decline in water quality in this area may threaten a primary nursery habitat for lemon sharks (*Negaprion brevirostris*). In 2008 we collected, tagged, and released 34 neonate (n=21, 594-697 mm total length) and juvenile (n=13, 710-1150 mm total length) lemon sharks from the nearshore waters surrounding the Chandeleur Islands in an effort to delineate primary nursery grounds for that species. Formerly, there were no records of *N. brevirostris* utilizing the Chandeleurs as pupping grounds or of the species establishing nursery areas north of 27.5° latitude in the Gulf of Mexico. We will further investigate this unique nursery at the Chandeleur Islands by fitting neonate and adult lemon sharks with real-time satellite tracking tags to establish the home range, site fidelity, and relative abundance of this species in these habitats. These data will be useful in assessing the significance of habitat loss at the Chandeleur Islands themselves.

Response of barrier island fish assemblages to impacts from multiple hurricanes: assessing resilience of Chandeleur Island fish assemblages to hurricanes Ivan (2004) and Katrina (2005).

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Hurricanes can temporarily disrupt seasonal patterns of fish assemblage change or result in permanent changes in fish assemblages. I studied the effects of hurricanes Ivan (landfall 16 Sept 2004) and Katrina (landfall 29 August 2008) on fish assemblages collected from three habitat types at the Chandeleur Islands, Louisiana. I also wanted to examine the possible influence that storm-generated wash-over channels may have on the composition of local fish assemblages. In addition, I compared recent survey data to historical data collected at the Chandeleur Islands in the early 1970s during a period of recovery from Hurricane Camille. Nearshore fish assemblages changed the most after both hurricanes but changes in species composition were primarily due to increases in overall abundance and diversity. In comparison, demersal fish assemblages decreased in overall abundance following the hurricane impacts. During July 2007 there was no significant difference (ANOSIM; $R = -0.072$; $p = 0.763$) between fish assemblages collected with gillnets in channel and deep intertidal seagrass habitats, although significant differences among wash-over channels did exist. Loss of habitat and the increased intensity and frequency of recent storms may explain why current fish assemblages at the Chandeleur Islands are less diverse (as measured by taxonomic distinctness) than assemblages collected during 1969-1971.

The effect of shrimping season on the diet of Lake Pontchartrain catfishes: gut content analysis of gafftopsail catfish (*Bagre marinus*) and hardhead catfish (*Ariopsis felis*).

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In the Lake Pontchartrain Estuary, commercial fishing impacts many non-target species that are regularly collected as bycatch. Some species, though, may benefit from consuming carcasses discarded from fishing vessels. Commercial fishing activity may be a source of high-quality food for some opportunistic foragers such as the gafftopsail (*Bagre marinus*) and hardhead catfishes (*Ariopsis felis*). To test the possibility that these catfishes exploit discarded bycatch, I examined gut contents of specimens collected near shrimping activity during and between the 2007 and 2008 shrimping seasons (July-October of 2007 and May-October 2008). Fishes were collected with 250 m gillnets using both soak and strike methods. While this method collected multiple species, the catch was dominated by the two catfish species. Specimens were transported on ice to the laboratory where they were weighed and measured. Total weight and total volume of the contents were measured along with the weight and volume of those contents that could be identified and separated. Fishes found in the guts were identified by length and by vertebrae. Based on examining the gut contents of 130 *A. felis* and 350 *B. marinus*, I found an increase in percent occurrence of fishes in catfish diets towards areas of shrimping and an increase in percent occurrence of fishes in catfish diets during the shrimping season. Preliminary model testing confirms the effects of shrimping season and geographic location are more important than other effects in determining the fish content of the diets of these ecologically important species.

Red drum (*Sciaenops ocellatus*) habitat use in an urban system; behavior of reintroduced fish in Bayou St. John, New Orleans.

Brogan, S.J., and M.T. O'Connell, Pontchartrain Institute for Environmental Sciences, University of New Orleans*

Red drum (*Sciaenops ocellatus*) habitat use in an urban system; behavior of reintroduced fish in Bayou St. John, New Orleans. Sunny J. Brogan. University of New Orleans, Department of Earth and Environmental Sciences, New Orleans, Louisiana 70148. sunnybrogan@yahoo.com. Bayou St. John is an environmentally degraded, urban water-body located within New Orleans. Once a natural system connected to Lake Pontchartrain, the Bayou is now disconnected from the Lake by flood-control

structures which impede the movement of aquatic species and water between the two systems. I used ultrasonic telemetry to track 26 adult red drum (*Sciaenops ocellatus*) reintroduced into this urban system. My goals were to determine if these fish could survive these degraded conditions and to assess their habitat use. Tagged red drum did survive in the Bayou and upon locating a tagged individual fish, I measured dissolved oxygen, salinity, and water temperature to assess their habitat use and to determine if their distribution was related to water quality conditions, habitat, or availability of potential food items. All tagged red drum avoided the southern portion of Bayou St. John and moved rapidly to the northern portion which is closer to Lake Pontchartrain. This habitat choice appears unrelated to measured water quality conditions. To better discern the reason for this habitat choice, a second set of tagged red drum will be tracked in winter 2008 using ultrasonic telemetry with internal transmitters and automatic receivers placed in appropriate habitats.

Blue crab migratory routes into Lake Pontchartrain.

*Lyncker, L. A. * HDR Engineering, Inc,*

I conducted a 12-month study that combined field and remote sensing techniques to assess the spatiotemporal distribution of early life stage blue crabs (*Callinectes sapidus*) throughout Lake Pontchartrain and the environmental conditions that likely influenced recruitment and settlement dynamics within the system. Field data indicated there were two considerable *C. sapidus* recruitment and settlement events during 2006. The largest event occurred in May and June and the smaller in September and October. The majority of *C. sapidus* were collected in the eastern region of Lake Pontchartrain. Remote sensing along with wind and tidal data indicated there were two different sets of environmental conditions influencing each recruitment event. Different wind and tidal patterns within each recruitment event likely induced transport of early life stage *C. sapidus* into Lake Pontchartrain via two separate migration corridors. The MODerate-resolution Imaging Spectroradiometer (MODIS) 250 m data revealed a clear-water plume that emerged from the Inner Harbor Navigational Canal (IHNC) into Lake Pontchartrain during May and likely transported *C. sapidus* into the system, whereas *C. sapidus* were likely transported into Lake Pontchartrain via the natural passes into the eastern region during the second event. My results show that *C. sapidus* use an artificial corridor as an avenue of transport between lower and upper estuarine habitat.

Pontchartrain Basin fishery-independent data and the 2008 Bonnet Carré Spillway opening: a comparison of historic and post-opening surveys with comment on Basin-wide freshwater inputs.

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The Mississippi River floods of 2008 and resultant opening of the Bonnet Carre' Spillway dramatically increased the freshwater input into Lake Pontchartrain and the entire Pontchartrain Basin. In a collaborative effort to assess the response of estuarine fishes and invertebrates to this inflow of fresh water, biologists with the Louisiana Department of Wildlife and Fisheries and the University of New Orleans combined efforts to sample the Pontchartrain Basin using trawls from April to July, 2008. This is the first time that such a large-scale ecological analysis of fishes has been attempted after a Spillway opening and the first time that historic fishery-independent Basin-wide data were available for comparative purposes. Analysis of Similarity indices highlighted fish assemblage differences between years with the greatest monthly differences noted in stations immediately adjacent to freshwater inputs, and well-after spillway opening. We interpret these results as representing a localized shift in suitable habitats as well as a delayed response by the fishes as the amount of river water in the Basin increased over time. Our results suggest that the significant changes in estuarine fish assemblages we observed may be avoided if planned releases of river water allow for more efficient mixing of water in the estuary and are balanced with natural inputs.

Effects of Hurricane Katrina on freshwater fish assemblages of a small tributary of Lake Pontchartrain, Louisiana

Van Vrancken, J.M. Pontchartrain Institute for Environmental Sciences, University of New Orleans

Extreme winds and large saltwater storm surges associated with tropical cyclones can have severe effects on small stream communities. In 2005, the impact of Hurricane Katrina on Southeast Louisiana presented a unique opportunity to explore the effects of a catastrophic storm on a small bayou. Bayou Lacombe is a small (46.1 km), primarily freshwater bayou that drains into the northeastern portions of Lake Pontchartrain. During the summer of 2005, I conducted monthly electrofishing samples along six reaches of the Bayou. In order to standardize all samples, all fish collection efforts were conducted using the same techniques (boat electrofishing downstream and backpack electrofishing upstream) and at the same GPS locations between the summers of 2005 and 2006. Significant differences were found in salinity ($p < 0.001$) between pre- and post-Katrina downstream samples. Although the upstream samples were not affected by Hurricane Katrina's storm surge, significant differences were found between pre- and post-Katrina dissolved oxygen ($p < 0.001$) readings due to the formation and decomposition of debris dams. Using analysis of similarity (ANOSIM), I tested for differences in fish assemblages before and after Hurricane Katrina between respective sites. ANOSIM results showed that there was no significant change among downstream fish assemblages between sampling periods. However, ANOSIM results did show significant changes among upstream fish assemblages ($R\text{-value} = 1.000$, $p = 0.029$) between sampling periods. During the fall of 2006, the Federal Emergency Management Agency cleared all debris out of the upstream portions of Bayou Lacombe resulting in further fish assemblage changes.

Atchafalaya River Basin Symposium **M.D. Kaller, D.A. Rutherford, and W.E. Kelso, coordinators**

Ecosystem management in the Atchafalaya River Basin: Arranging deck chairs on the Titanic?

*Kelso, W. E. *, and M.D. Kaller, School of Renewable Natural Resources, Louisiana State University Agricultural Center*

Biological and ecological functions in the Atchafalaya River Basin (ARB) are closely tied to the annual flood pulse in the Atchafalaya River. Although constrained by guide levees over most of its length, the ARB retains many characteristics of a natural floodplain ecosystem, providing a complex mosaic of aquatic and semi-aquatic habitats that support a significant diversity of terrestrial and aquatic vertebrates and invertebrates. However, the ARB currently faces several daunting problems that threaten not only its biotic integrity, but also the fundamental ecological processes that historically contributed to its productivity and biodiversity. Closure of several Atchafalaya River distributaries and re-distribution of sediment from the Mississippi River to the Atchafalaya River have reduced the amount and spatial extent of water inflows to the floodplain during the flood pulse, while simultaneously increasing sediment deposition and the loss of aquatic habitats. Floodplain water circulation during the flood pulse has been impaired by spoil banks associated with an extensive network of excavated canals, which has contributed to spatially extensive and temporally persistent hypoxia as floodwaters inundate and subsequently recede from the floodplain. In addition, the aquatic macrophyte community is now dominated by exotic water hyacinth, hydrilla, common salvinia, and most recently, giant salvinia, which has severely impacted water flow and dissolved oxygen conditions from early summer to late fall. Together, these disturbances not only threaten the ecology of the ARB, but also restoration and management efforts by federal and state agencies aimed at improving ecosystem function and biotic integrity in this southern deepwater swamp.

To breathe or not to breath, that is the question: dissolved oxygen in the Atchafalaya River Basin

Kaller, M.D., W.E. Kelso, B.T. Halloran, and D. A. Rutherford, School of Renewable Natural Resources, Louisiana State University Agricultural Center*

In the Atchafalaya River basin (ARB), the spring flood pulse inundates remote, floodplain swamps, which rapidly become depleted in dissolved oxygen (DO). As floodwaters fall, warm (>20 C), hypoxic (<2mg/l DO) water exits the floodplain and mixes with better oxygenated waters in natural and manmade channels, often resulting in spatially extensive low DO conditions. These seasonal changes in oxygen availability may cause sublethal stress or acute lethal impacts to fishes and invertebrates depending on areal extent and timing of falling river stages. Consequently, DO is often an indicator of “ecosystem health” in the ARB and is a potentially important measure of water management project success. Using an eight year dataset of biweekly water quality monitoring, we investigated the factors that influence surface and bottom DO levels and stratification at local, management unit, and ARB-wide scales. Despite massive hydrologic modification, expected factors, including temperature, flooding, water velocity, and depth, influenced surface and bottom DO levels and stratification. Surprisingly, DO levels appeared to follow an increasing gradient from northwest to southeast, which was similar to historic flow patterns. Additionally, bottom DO levels in some parts of the ARB were higher than surface levels at moderate river stages, likely reflecting inputs of cooler, high-DO water from the Atchafalaya River and Intracoastal Waterway. Our analyses suggest that increasing water velocity will probably have the greatest impact on increasing DO levels and reducing stratification. We caution, however, that simply increasing flows may not be a holistic solution without consideration of sediment loads and exotic macrophytes.

Integrating remote sensing information and in-situ physicochemical monitoring to evaluate changes in aquatic habitat quality in the Atchafalaya Basin, La.: Buffalo Cove Water Management Project case study

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The Atchafalaya Basin Floodway System (ABFS) is approximately 830,000 acres of floodway that is operated by the U. S. Army Corps of Engineers (USACE) to protect residents, commerce, and physical infrastructure of South Louisiana. It also provides ecosystem services to one of the largest river floodplains in the United States. Its function is integral in sustaining growth in coastal estuaries as well as nurturing the flora and fauna within its protective levees, but its geophysical features and hydrology have changed continuously over the last century, which makes it difficult to account for how the various successive stages of environmental alteration have influenced floodplain function and ecology. One such function, water quality, was the target of improvement in a UCASE project that removed an earthen barrier along the Atchafalaya River to increase water flow to stagnant floodplain area in the Buffalo Cove Water Management Unit. The primary objective of this study was to measure the difference in water quality in specific areas targeted by the project. We measured water quality parameters before and after construction, and our results quantify the spatial extent, magnitude, and duration of water quality changes that are attributable to the water diversion project constructed in 2007. Our study also evaluates the benefits of expanding environmental and ecological assessments of this area beyond the local scale to design and evaluate conservation projects, and emphasizes integration of landscape changes with functional relationships. This paper highlights the use of new remote sensing products that are being developed from Landsat imagery to assist with analysis of in-situ physicochemistry as part of project evaluation. In addition, we give describe the use of these products to guide future project design.

Assessment of inundation extent and quality in the Atchafalaya Basin Floodway System 1983-2008 using Landsat Imagery.

Allen, Y.C., U. S. Geological Survey, National Wetlands Research Center, Coastal Restoration Field Station, and G.C. Constant, U. S. Fish and Wildlife Service, Baton Rouge Field Office

Within the Atchafalaya Basin Floodway System (ABFS), there is a complex structure of lakes, rivers, canals, and spoil banks formed by both natural and engineered processes. The distribution and quality of water within each water management unit (WMU) is primarily driven by water level and condition of the main river channels flowing through the ABFS. Diverse interior morphology within each WMU however can result in very different patterns of water distribution among the WMUs. River level gages have been established at many well-traveled locations throughout the basin but very little synoptic information has been available at more remote locations in the basin. The amount, quality, duration, and flow rate of water in large part define the availability and quality of habitats for flora and fauna living in the basin. It is therefore critical to gain a better understanding of the dynamics of water distribution patterns at basin-wide and WMU scales. We classified 33 Landsat TM 5 and 7 (TM) images into categories of land, open turbid water, open black water, turbid water in flooded lands and black water in flooded lands. Each image was captured during leaf-off conditions to optimize delineation of ground conditions. Turbid water distribution was compared to concurrent ground truth sampling to validate the classification. This series of classified imagery can be used to evaluate the distribution of land, water and turbid water through time and also to predict the impact of various flooding scenarios. A historical record of turbid water distribution could also allow managers to identify open water areas that have consistently received high levels of sediment. Such areas may be candidates for conversion to land due to sediment accretion.

Short-term impacts of Hurricane Gustav on water quality in the East Grand Lake Region of the Atchafalaya River Basin

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Hurricanes Gustav and Ike presented a rare opportunity to observe the immediate impacts of storm surge inundation on water quality within a Louisiana freshwater wetland system. A cooperative effort involving the Louisiana Department of Natural Resources, U. S. Fish and Wildlife Service, U. S. Army Corps of Engineers, U. S. Geological Survey, Louisiana State University School of Renewable Natural Resources, Louisiana Department of Wildlife and Fisheries and the Louisiana Department of Environmental Quality led to a unique look at how a hurricane strength storm surge affects dissolved oxygen and other water quality parameters throughout a large, freshwater wetland system. These agencies collectively observed prolonged periods of hypoxia throughout the sample area as well as high fish mortality and low phytoplankton densities directly following the inundation event. This collaborative effort provided invaluable data on the short-term impacts of a large storm surge within the Atchafalaya River Basin and provided critical base-line information on management and response protocols that may lessen the negative impacts of these types of events in the future.

Effects of Hurricanes Katrina and Rita on sportfish abundance in the southeastern Atchafalaya River Basin, Louisiana

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The Atchafalaya River Basin (ARB) is a 5,000 km² river-floodplain system in southcentral Louisiana that is made up of a complex mosaic of natural bayous, lakes, excavated canals, and extensive hardwood swamps. The Basin annually produces commercially-viable harvests of alligators, finfish, crayfish, and furbearers, and supports one of the most popular fisheries in the state for anglers pursuing bass *Micropterus* spp., sunfishes *Lepomis* spp., crappie *Pomoxis* spp., and catfishes *Ictalurus* spp. Hurricanes Katrina and Rita made landfall in August and September 2005, resulting in tremendous changes in habitat and water quality across the southern portion of the state. The impact of the storm and the associated flooding on organisms inhabiting the Basin was unknown, although potential effects on the abundance of popular sportfishes was of particular concern to Basin anglers as well as the Louisiana Department of Wildlife and Fisheries. A long-term fish and water quality monitoring program throughout the Atchafalaya Basin provided us with sufficient electrofishing data to analyze sportfish abundance two years before and after the hurricanes, specifically within the Bayou Sorrel, Murphy Lake, and Bayou Postillion areas of the southeastern ARB. We used multivariate analysis of variance with Tukey-Kramer adjusted least-squares means to assess the effects of the hurricanes on sportfish catch per unit effort (CPUE). Results suggested that location within the basin influenced the effect of the hurricanes on sportfish abundance ($F_{8, 514} = 35.15$ $P < .0001$), and that overall CPUE decreased following the hurricane ($P < 0.0001$). More specifically, sunfishes in Bayou Postillion ($P = 0.0019$), bass and sunfishes (both $P < 0.0001$) in Murphy Lake, and sunfishes ($P < 0.0001$) in Bayou Sorrel all exhibited higher CPUE before the hurricanes hit in August 2005. We believe our CPUE data is reflective of ARB sportfish abundance, and our analyses suggest that these populations, particularly sunfishes, declined significantly following the hurricanes.

Biotic and abiotic Influences on wild *Procambarus clarkii* populations in the Atchafalaya River Basin

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Crayfish harvested from the Atchafalaya River basin (ARB) represent almost 100% of Louisiana wild crayfish landings. Currently, the absence of a management plan coupled with limited studies and

declining commercial harvests necessitates an increased understanding of the environmental factors that structure ARB crayfish populations. While crayfish populations in the ARB are known to be influenced by the magnitude of the flood pulse, other abiotic and biotic variables can have significant impacts. Our study examined the influence of physicochemical parameters, macrophyte composition, and heavy metal concentration on ARB crayfish population characteristics. Crayfish were sampled weekly throughout the ARB with pillow design traps (1.22 m height, 0.772 cm galvanized wire mesh). Five traps per site were baited with 150 g commercial crayfish bait and allowed to fish for 24 hours. Habitat and physicochemical data were collected at every sample date. Carapace length, species, sex, and form were determined for all captured crayfish. Only red swamp crayfish *Procambarus clarkii* were used in analysis. Crayfish abundance was analyzed with a mixed Poisson model comparing abundance to metals and macrophytes, which were organized on PCA prior to analysis. Crayfish abundance showed a strong negative relationship with the principle component characterized by alligator weed and water hyacinth ($P < 0.0001$). Crayfish carapace length was also analyzed using a mixed model and showed a positive relationship with dissolved oxygen ($P = 0.0045$) and negative relationships with turbidity ($P = 0.0114$) and iron ($P = 0.0041$). While there was not a significant difference between habitats, dead-end canals were characterized by the largest and most abundant crayfish.

Subsurface hydrological connections between a backswamp and channel in the Atchafalaya Basin

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Water chemistry in backswamp lakes and channels depends greatly on the rate of water exchange with larger bodies of water. The morphology of the Atchafalaya Basin presents a difficult management challenge because its formation by deltaic aggradation has created a network of natural levees along channels that severely limits surface exchange of water with most backswamps. Understanding subsurface exchange through natural levees is therefore important for modeling water quality. We used measured subsurface hydrological responses in shallow wells to natural and artificially imposed hydraulic gradients in a section of natural levee in the Atchafalaya Basin and used natural and active tracers to measure flow velocity. Spatial variability in response across the well field (30 m x 20 m) implies a network of preferential flowpaths connects the backswamp to the adjacent channel, perhaps through large pores such as root channels and animal burrows. The rapid responses of chemical tracers in some wells indicates flow velocities sufficient to move water through the natural levee at timescales of hours to days when backswamps are impounded. Despite the limited spatial extent of this study, results suggest subsurface flow may be sufficient to affect water quality, although the scale and magnitude of the effect are not uncertain.

Invasive aquatic species in the Atchafalaya Basin: the Asian carps.

Thomas R.G, Kaller, M.D., School of Renewable Natural Resources, Louisiana State University Agricultural Center, and J.B. Alford, Louisiana Department of Wildlife and Fisheries

Invasion of Atchafalaya Basin waters by four species of Asian carps would seem to portend major ecological changes similar to ecosystem destabilizations noted in the Midwest. Grass carp *Ctenopharyngodon idella* populations appeared to rapidly increase through the 1970's eventually stabilizing at current levels. Beginning in the early 1980s, commercial fishermen noted increasing populations of bighead carp *Hypophthalmichthys nobilis* and silver carp *Hypophthalmichthys molitrix* (together, the bigheaded carps). However, fishery-independent sampling by Louisiana Department of Wildlife and Fisheries personnel has produced only incidental catches of the big-headed carps. Populations of these species appear to be increasing at a much slower rate than that occurring in large Midwestern rivers, possibly due to intermittent seasonal availability and limited suitability of backwater habitat for juvenile fish. Additionally, many Atchafalaya Basin water temperatures may exceed thermal preferences for grass and bighead carps. In 2002, harvester reports of sporadic captures of "different-looking" grass carp suggested the possible presence of black carp *Mylopharyngodon piceus*. Eight diploid specimens of black carp have since been collected from sites connected to the Basin, indicating

the presence of a reproducing population that may threaten molluscan species-of-concern. Although statewide reported commercial landings of grass and bigheaded carps have been as high as 80,000 lbs/yr, limited market demand has caused many captures to be discarded, and this figure may be under representative of fish populations.

Windshield or bug? Examining the synchronous occurrence of ichthyoplankton and zooplankton in a temperate floodplain system.

**Halloran, B. T., Rutherford, D. A., Kaller, M. D., and W.E. Kelso, School of Renewable Natural resource Building, Louisiana State University Agricultural Center*

In temperate floodplain ecosystems, springtime flood pulses reset microbial, nutrient, and invertebrate cycles as well as providing diverse new microhabitats for spawning fishes in areas adjacent to the mainstem. Although there was been considerable emphasis on quantifying the abundance and composition of larval taxa during both inundation and drawdown, few studies have documented the annual level of overlap (the match/mismatch hypothesis) between ichthyoplankton and zooplankton as young fishes switch from endogenous to exogenous foraging.

To better understand the forces that shape larval survivorship, we compared the distribution of larval fishes in relation to the zooplankton community over a two-year period to determine if both seasonally co-occurred. Data from this study suggests that perhaps the most advantageous reproductive strategy hinges upon a protracted spawning cycle with larvae that appear to withstand a wide degree of variation in physicochemistry regardless of the scale of inundation. Further, extended seasonal reproduction may also ensure that young fishes encounter abundant, yet variable, zooplankton communities. This could enhance a "match" of predator (ichthyoplankton) with prey (zooplankton) as floodwaters recede; especially during the summer (May-August) months. Consequently, if fishes hedge on the optimal combination of flooding, stable post-flood water quality, and food densities, year classes might consistently fail to recruit. The optimal spawning strategy appears to require reproductive flexibility, both in the timing and duration, and perhaps the ability to continuously reproduce even as the floodplain becomes increasingly disconnected. A reliance on a strict physicochemical threshold (i.e., temperature regime) and/or environmental parameter (i.e., hours of daylight) may "backfire" due, in part, to the patchy distribution of zooplankters. Consequently, in some years recruits may thrive (or be the windshield) as opposed to years where the lack of concordance between predator and prey produces limited survivorship (results in the bug).

Gar Symposium

A.M. Ferrara and R. Campbell, coordinators

Chemical de-adhesion of alligator gar eggs.

Wayman, W.R., Clemmensen, S. U.S. Fish and Wildlife Service, Warm Springs Fish Technology Center, and R. Campbell, U.S. Fish and Wildlife Service, Private John Allen National Fish Hatchery

Alligator gar eggs are extremely adhesive. The current de-adhesion method (Fuller's earth) has been inadequate for rolling eggs in McDonald hatching jars. Often the eggs need to be rolled at excessive flows, causing reduced hatch rates. The study evaluated 3 chemical de-adhesion methods that have been reported for other species. Alcalase enzyme was used at 16, 32, and 48 AU/L. Tannic acid was used at 0.5, 1.0, and 1.5 g/L. Sodium sulfite was used at 15, 30, and 45 g/L. Each treatment was applied for 5 min and then rinsed off, except Fuller's earth solution which was applied for 30 min and then rinsed. The percentage of eggs that stuck to the bowls was estimated to determine the amount of de-adhesion. Tannic acid at all concentrations and alcalase at the 16 AU/L concentration had similar de-adhesion results as did Fuller's earth. However, within 24 hr all eggs treated with alcalase died. After 48 hours, eggs were counted and percent fertilization was estimated. There were no differences among eggs treated with tannic acid or those treated with Fuller's earth. Eggs treated with sodium sulfite had some fertilized eggs, but due to adhesion to the jars, fertilization rates were not estimated. After all eggs had hatched, embryos were counted. Eggs treated with 1500 mg/L tannic acid had significantly higher hatch rates than did eggs treated with sodium sulfite. Overall, the 1500 mg/L tannic acid treatment had similar or higher de-adhesion, fertilization and hatch rates than did all other treatment levels.

Relationship between hydrology and reproductive success of alligator gar, *Atractosteus spatula*, in the Fourche LaFave River, Arkansas.

Inebnit III, T.E., Adams, S.R. University of Central Arkansas, Department of Biology, and L.C. Lewis, U.S. Fish & Wildlife Service, Arkansas Field Office*

We studied spatial and temporal aspects of alligator gar (*Atractosteus spatula*) reproduction in the Fourche LaFave River system, a tributary of the Arkansas River. During spring and early summer of 2007 and 2008, we determined the timing and location of alligator gar spawning events from collections of larvae and two direct observations of spawning. Spawning occurred primarily in tributaries and generally corresponded with an increase in river stage due to flooding from the Arkansas River when water temperatures ranged from 22°C to 27°C. Reproductive success in 2007 was relatively high with five spawn events contributing to over 1000 observed alligator gar larvae/early juveniles (<70 mm) in June and over 100 juveniles (70 -1200 mm) observed in fall 2007 through early winter 2008. In 2007, river levels were below flood stage preceding the spawning season and then increased to a high magnitude, long duration flood event during and after reproduction, providing abundant spawning and nursery habitat. However, in 2008 a high magnitude, long duration flood event preceded the spawning season and river levels gradually decreased to below flood stage during and after reproduction. Spawning and recruitment success in 2008 was relatively low with only one spawn event (direct observation) and no larvae or juveniles observed. Our data suggest that timing of flood events and increase in water temperature not only cue spawning behavior in alligator gar but are also a determining factor in recruitment of young alligator gar in the Fourche LaFave River.

Culture of juvenile alligator gar *Atractosteus spatula* in recirculating systems

Clay, T.A., Suchy, M.D., Ferrara, A.M., and Q.C. Fontenot, Bayosphere Research Lab, Department of Biological Sciences, Nicholls State University

Juvenile alligator gar *Atractosteus spatula* were exposed for 21 days to four trials: (1) fluctuating ambient temperatures (28.7 ± 1.5 C) and fed 4% body weight split equally among three daily feedings; (2) controlled average temperature (27.5 ± 0.5 C) and fed 4% body weight split equally among three daily feedings; (3) fluctuating temperatures (28.4 ± 2.6 C) and fed 4% body weight split between two daily feedings; (4) feed amounts of 8, 4, 2, or 1% body weight per day split equally among three daily feedings. All gar were fed 2.4mm Aquamax extruded floating pellets (45% protein/16% lipid). Fish were stocked at 0.5 fish/l in 95 liter circular tanks with 60 liters of water at 4 ppt in either individual or four tank recirculating systems. Total biomass was not different ($\alpha=0.05$) between the ambient and fluctuating temperatures or between different feeding frequencies. Fish fed 8% body weight (36.8 g) were larger than fish fed lower amounts. Survival was not different among any treatments, though there was a general increase in survival in higher feed tanks. Condition was not significantly different among temperature and feeding frequency trials. Gar fed 4% feed had the highest condition (0.40) and lowest feed conversion rates (2.15). Increasing feed amounts resulted in significantly increased total-ammonia-N and decreased DO levels, with gar fed 8% feed experiencing total ammonia-N (9.31 ± 8.9 mg/l) and DO (3.1 ± 1.6 mg/l). The results of this study suggest juvenile alligator gar should be three times a day at 4% body weight.

Sexually dimorphic growth and fecundity of longnose gar

McGrath, P.E. *Virginia Institute of Marine Science*

Longnose gar (*Lepisosteus osseus*, $n=232$) were caught in the tidal rivers of Virginia to examine for differences in growth rates between males and females. This data was then compared to the relationship between fecundity and age in males and females to further explore the dynamics of mature longnose gar. A von Bertalanffy growth curve was fit to back-calculated sizes at ages of longnose gar and found males to have a growth rate parameter (k) of 0.1529 and maximum length (L_{∞}) of 917.5 mm, while females had a significantly smaller k of 0.1099 and significantly larger L_{∞} of 1213.4 mm. The faster growth rate in male longnose gar may be due to the earlier maturation of males. Male longnose gar grow quickly to ensure they reach the largest possible size before beginning to devote most of their energy to reproduction. The significantly larger maximum size of females correlates to the significantly higher slope of the fecundity vs. age regression. The ability of female longnose gar to grow older and larger enables them to have a higher fecundity. This is an important attribute due to the large size and number of eggs produced by the female every year.

Longnose gar, an apex predator within Chesapeake Bay's tributaries (Virginia)

McGrath, P.E. *Virginia Institute of Marine Science*

Longnose gar (*Lepisosteus osseus*) is a common predator residing in all of the major rivers extending from fresh to mesohaline waters in Chesapeake Bay (Virginia). It is one of the dominant piscivores in important marine and anadromous fishes' nursery zones. Longnose gar ($n=639$) were opportunistically collected in the tidal stretches of eight rivers in Virginia to examine diet preferences, age/growth, and reproductive output. This presentation will focus on the diet preferences of 315 longnose gar with items present in their stomachs. Mean percent abundance (M%N) and weight (M%W) were used to determine value of the consumed prey items. White perch was the most important prey item (24.4 M%N and 25.3 M%W) followed by Atlantic menhaden (19.1 M%N and 20.2 M%W) and Atlantic croaker (11.4 M%N and 11.0 M%W). Juvenile fishes utilizing the estuary as a nursery were a large component of the diet. Salinity was a major factor in determining the diet composition. Menhaden, Atlantic croaker, and spot were the most important prey species in mesohaline water, while white perch and fundulids were the most important prey species in oligohaline and fresh-waters. Longnose gar appear to be apex predators in the upper tributaries of Chesapeake Bay and their potential impact on local game fish populations and important forage fishes warrants further study of their life history.

Effects of salinity on growth and plasma osmolality of juvenile alligator gar *Atractosteus spatula*

Suchy*, M.D., Clay, T.A., Ferrara, A.M., and Q.C. Fontenot Bayosphere Research Lab, Department of Biological Sciences, Nicholls State University

Juvenile alligator *Atractosteus spatula* were exposed to various salinities to determine the effects on growth and plasma osmolality. After acclimated to treatment salinity levels (0, 4, 8, or 12 ppt), fish were stocked at 5 fish/L in 60 L recirculating systems (28.1±2.1 °C) and reared for 31 d in a greenhouse. Fish were fed floating feed (45% protein/16% lipid) daily either 10% body weight (19-33 days after hatch (DAH)) or 5% body weight (34-51 DAH). Growth was greater ($\alpha=0.05$) at 4 and 8 than 0 and 12 ppt. To determine the ability of juvenile alligator gar to maintain plasma osmolality (mOsm), we exposed fish to salinities ranging from 0 to 37 ppt with or without an acclimation period. Plasma osmolality was measured for three un-acclimated fish (maintained at 0 ppt) after 24 hr exposure to either 0, 4, 8, 12, 16, 20, 24, 28, or 32 ppt. Compared to the 0 ppt treatment (305±9.8), plasma osmolality levels were elevated for the 16 ppt (337±17.0) and higher treatments with one mortality at 28 ppt and two at 32 ppt. No mortalities occurred during the acclimation trial where salinity was increased from 0 to 37 by 1 ppt per day. Plasma osmolality levels were elevated by the end of the study (37 ppt: 372.3). Un-acclimated fish had higher plasma osmolality levels at 8 ppt (acclimated; 304±1.3: un-acclimated; 313±3.1) and greater salinities. Alligator gar are euryhaline and grow faster at 4 and 8 than 0 and 12 ppt.

Seasonal diets of spotted gar in a coastal Louisiana estuary

Widgeon, T., Pitre, L., Ferrara, A.M., and Q.C. Fontenot, Bayosphere Research Lab, Department of Biological Sciences, Nicholls State University

Spotted gar, *Lepisosteus oculatus*, are dominant top level predators and were used to analyze seasonal trophic dynamics within the upper Barataria Estuary, Louisiana. A total of 401 fish were collected using monofilament gill nets deployed at sunset for one hour. Dissolved oxygen (DO; mg/L), specific conductance ((micro)s/cm) and temperature (°C) were measured 0.3 m below the water surface each time a net was deployed. Net catch and mean (±SD) water quality per season were as follows; Spring (N=85; DO=2.6±0.6; temp=25.3±0.9; specific conductance 274±56), Summer (N=115; DO=1.6±0.6; temp=28.7±1.3; specific conductance 132±9), Fall (N=75; DO=1.7±1.7; temp=22.4±3.8; specific conductance 458±286) and Winter (N=126; DO=2.5±1.2; temp=13.3±4.4; specific conductance 152±32). Fish were more abundant in spotted gar diets in fall than spring, and were intermediate for winter and summer. Shrimp were more abundant in the summer than fall, and were intermediate in winter and spring. Crawfish were most abundant in the winter, followed by summer, and were least abundant in spring and fall. Amphibians were more abundant in summer than fall and winter, and were intermediate in spring. Insects were more abundant in spring than fall and winter and were intermediate in summer. Results of this study suggest that seasonal variations in spotted gar diet correspond to natural migrations and process's of estuarine species and may be affected by the systems hydrology.

Reproductive characterization of spotted gar *Lepisosteus oculatus* in the upper Barataria Estuary, Louisiana

Smith, O.A., Ferrera, A.M., Fontenot, Q.C. and G.J. LaFleur, Jr., Bayosphere Research Laboratory, Department of Biological Sciences, Nicholls State University

Gonad histology is useful for the classification of reproductive phases, which can be used to characterize the reproductive phases of fish populations. The goal of this study was to characterize spotted gar reproduction in the upper Barataria Estuary, Louisiana, using standard histological techniques, gonadosomatic index (GSI), fecundity, and age at maturity. From 5 October 2006 to 26 September 2007, spotted gar were collected from the upper Barataria Estuary. Histological samples were used to classify individuals into reproductive phases (immature, developing, spawning capable/actively spawning, regressing, and regenerating) based on gonad development. Based on histological and macroscopic analyses, males (N = 94) may be capable of spawning year round. However, spawning did not occur

year round. Females exhibited determinate fecundity and group-synchronous oocyte development. GSI peaked in the spring and decreased through the summer for males (N = 215) and females (N = 253). Based on histological analyses and GSI, spawning occurred from March through May. Mean total fecundity was 6,493±4,225 eggs per fish (N = 192; mean TL = 579 ± 44 mm); however, the majority of females did not release all of their late vitellogenic eggs during spawning. Males matured by age 1 and 344 mm TL and females by age 2 and 410 mm TL. Classification of reproductive phases will aid in the assessment of reproductive potential by incorporating rates of incomplete spawning and egg atresia.

Life History characteristics of Alligator gar (*Atractosteus spatula*) in South Louisiana

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Alligator gar (*Atractosteus spatula*) is one of four gar species native to Louisiana and is currently harvested both commercially and recreationally. However; no size, bag, license limits, or equipment limits have been implemented on this specie. Unfortunately, due to sport and commercial fishing pressure along with habitat loss and alteration alligator gar suffer from population decline and historic range contraction. Alligator gar life history data and stomach content samples were collected 1 April 2007 - 1 May 2008 from the Bayou Dularge and surrounding areas, Terrebonne Parish, in south central coastal Louisiana. Sampling rendered 329 alligator gar over 23 trips. Females (n=125) and males (n=202) had an average mean length of 1160 mm and mean weight of 9.8 kg. Female mean length was 1247 mm and mean weight was 12.4 kg while male mean length was 1106 mm and mean weight was 8.2 kg. Preliminary analysis of stomach contents reveal diets dominated by striped mullet (*Mugil cephalus*). Alligator gar age will be determined from otoliths and scales and results will be discussed in presentation along with other final findings.

Food habits of sympatric spotted (*Lepisosteus platostomus*) and shortnose (*Lepisosteus platostomus*) gar during flooding of an Arkansas River tributary

Adams, S.R., Benton, J., Inebnit, T.E., and **R.H. Walker***, University of Central Arkansas

Gars are generally thought to be avid predators, predominantly feeding on fishes, and to a lesser extent, invertebrates. Though southern river systems typically contain multiple gar species, few studies have examined feeding characteristics of sympatric populations. Further, little information exists on food resources of shortnose gar *Lepisosteus platostomus*. We report results of an examination of diet in shortnose gar and spotted gar *Lepisosteus oculatus* from the Fourche LaFave River in Arkansas. Stomachs were dissected and examined from 74 adult spotted gar (46 - 81 cm TL) and 91 adult shortnose gar (49 - 76 cm TL) collected during May to July 2007, corresponding to back-flooding from the Arkansas River. Forty-seven (64%) spotted gar and 54 (59%) shortnose gar contained identifiable prey items. Considering frequency of occurrence, important food resources of spotted gar were fish (74%), crayfish (26%), aquatic insects (11%), and terrestrial insects (9%). Similarly, fish (59%) was the most commonly occurring food item in shortnose gar, but they consumed aquatic (24%) and terrestrial (35%) insects more frequently than spotted gar. Additionally, shortnose gar utilized amphibians (17%) as prey. Our analyses suggest similar-sized, sympatric spotted gar and shortnose gar had different feeding habits where shortnose gar utilized a wider variety of prey, including both aquatic and terrestrial food resources.

Alligator gar conservation in the southeast United States: development of a decision tool for evaluating effects of management on population viability

Irwin, E., USGS Alabama Cooperative Fish and Wildlife Research Unit, Auburn University, Ferrara, A., Nichols State University, Sakaris, P.C., Southern Polytechnic University, Kennedy, K., USGS Alabama Cooperative Fish and Wildlife Research Unit, and R. Campbell, U.S. Fish Wildlife Service

Alligator gar are charismatic megafauna yet are imperiled throughout their range in the United States. Reasons for imperilment include habitat loss or lack of connectivity of critical habitats, and over harvest. Most states either have active plans for conservation and restoration of populations or interest in planning; however, few quantitative data exist for the species. Conservation planning includes culture and stocking by the U.S. Fish and Wildlife Service and State partners along with assessment of stockings and population and habitat evaluation. We present a Bayesian Belief Network (BBN) that constitutes a decision support tool to evaluate how conservation plans potentially affect alligator population stability. Available data and expert opinion were used to populate the conditional probability tables in the BBN. The BBN also incorporates uncertainties relative to data gaps and assists with decision making related to best management actions in a broad spatial context and in the face of changing climate. Results of the model varied depending on specific population structure and management objectives of the different agencies. Structured decision making will assist managers in evaluating probabilities of success associated with different management and conservation plans and can be updated routinely as new data are collected.

Management of alligator gar in Texas

Buckmeier, D.L., Daugherty, D.J., Schlechte, W.J. and N.G. Smith, Texas Parks and Wildlife Department, Heart of the Hills Fisheries Science Center

Historically, Texas alligator gar *Atractosteus spatula* have received little attention from anglers or biologists. Past research focused on diet because of concerns that alligator gar might be negatively affecting sport fisheries through predation.. Recently, the popularity of alligator gar fisheries has increased substantially, and anglers from around the world now travel to Texas for the opportunity to catch fish approaching 300 pounds. While most states have seen dramatic declines in size structure and abundance of alligator gar, Texas is fortunate to have populations that are capable of producing fish of this size. Biologists and anglers are concerned that habitat loss and increased exploitation may cause alligator gar populations in Texas to decline, as they have in other states. The Texas Parks and Wildlife Department is presently reviewing management options for this species. The goals of management are 1) to identify and protect critical habitats and 2) to implement harvest regulations that sustain the current trophy fishery. Several research studies have been initiated to estimate size structure, growth, mortality, seasonal movements and habitat use of alligator gar. Additional efforts will use existing data from other states to model alligator gar populations and evaluate regulation options to produce sustainable trophy fisheries.

Life history and management of alligator gar in the Red River, Oklahoma-Texas.

Brinkman, E.L. and W.L Fisher, USGS Oklahoma Cooperative Fish and Wildlife Research Unit and Department of Natural Resource Ecology and Management, Oklahoma State University

Alligator gar populations are declining in the southeastern United States and Mexico resulting in efforts by state and federal agencies to actively manage populations. We assessed the life history of the alligator gar population in the Red River drainage of Oklahoma. Catch rates for larger alligator gar were highest using multi-filament trammel nets during cold water periods, whereas mini-fyke nets were effective for collecting young alligator gar in warm water periods. Alligator gar exhibited logistic growth devoting early growth to increasing length and later growth towards increasing mass. Movements and home-range were examined using ultrasonic telemetry. Home range area of six individuals ranged from 4.93 to 17.13 km² during a nine month period. Linear home range of these individuals ranged from 5.77 to 49.72 km. Ages of 64 alligator gar ranged from 0 to 28 years at date of capture. Age data indicated that successful spawning occurred in 2006 and 2007, and spawning in Lake Texoma was documented in spring 2007. Age determination of alligator gar, using scale sections proved to be imprecise and biased towards overestimation of age in adults. The alligator gar population in Lake Texoma and the Red River above the reservoir, was represented by a range of age and length classes. Future stability of Red River alligator gar populations will be dependent on availability of shallow, flooded herbaceous vegetation and proper management of exploitation.

Home range and critical habitat of the Threatened Spotted Gar (*Lepisosteus oculatus*) in Rondeau Bay, Southwestern Ontario, Canada.

Glass, W., Corkum, L. University of Windsor, and N. Mandrak, Department of Fisheries and Oceans

Spotted Gar, a species designated as Threatened in Canada under the federal Species at Risk Act, were collected at several sites in Rondeau Bay, a shallow coastal wetland of Lake Erie, in May and June of 2007. External radio transmitters were surgically attached to 37 specimens before they were released. These individuals were tracked throughout the summer of 2007 and into the fall. Locations were marked with a hand-held GPS unit and water chemistry data was collected. Macrophyte samples were also taken where present. Tracking resulted in 212 discrete locations. Of these sites, 192 (91%) had macrophytes present. General movement patterns showed individuals near shore in the spring, moving offshore as the summer progressed, often taking up residence in offshore weedbed areas.

Ecology, biogeography, and conservation of the spotted gar (*Lepisosteus oculatus*) in Michigan, USA

David, S., University of Michigan, School of Natural Resources & Environment, Kik IV, R. Wiley, M., University of Michigan, School of Natural Resources & Environment, Rutherford, E., Michigan Department of Natural Resources, National Oceanic and Atmospheric Administration, Diana, J., University of Michigan, School of Natural Resources & Environment, and B. O'Connor, University of Michigan, Department of Ecology & Evolutionary Biology

The spotted gar (*Lepisosteus oculatus*) is one of seven extant members of the family Lepisosteidae and ranges from the southern Great Lakes region to the Gulf Coast. The spotted gar has a disjoint distribution and is more common in the Mississippi River basin than the Great Lakes region. The Great Lakes basin population of spotted gars is poorly studied and distribution not well known. We hypothesized that spotted gars in the Great Lakes region exhibited different life history patterns than the southern US population. We further hypothesized that distribution of spotted gars in the Great Lakes basin was limited by access and availability of habitat as opposed to temperature and length of growing season. We used historic distribution data from the Michigan Department of Natural Resources (MDNR) and University of Michigan Museum of Zoology (UMMZ) to select inland lakes for assessment of present spotted gar distribution, habitat preference, reproduction, and associated fish communities from May to September 2008. We used DC electrofishing to sample adult spotted gars from various habitat types in 25 inland lakes and 5 river systems, as well as seining and dip-netting to collect young-of-the-year juveniles to examine multiple stages of development. Adult gars (N=118) were tagged with 3-digit metal fin clips and released for mark-recapture estimation of populations. A subsample of juveniles (N=10) from collection sites was vouchered every 1-2 weeks after hatching, with another subsample (N=7) maintained in aquaria to observe growth and development within the first year. A subsample of adult gars (N=30) was vouchered for analysis of diet, age, sex, and fecundity. Results indicated spotted gars prefer secluded, highly vegetated habitat. Congregation of gars for spawning took place primarily in late May and June with average temperature 24°C. Mean size range of adults was 50-59cm (N=54). Spotted gars were components of fish communities comprised of 44 other species. Two other species of concern, starhead topminnow (*Fundulus dispar*) and creek chubsucker (*Erimyzon oblongus*), were often found in association with spotted gar, suggesting similar habitat preference.

Preliminary Evidence that gar oocyte toxin affects crustacean neuromuscular junction by inhibiting post-synaptic potentials

LaFluer, Jr., G.L., Broussard, N. Ferrara, A., Ponnath, A. Dept of Biological Sciences, Nicholls State University, and H. Farris, LSUHSC Neuroscience Center

The toxicity of gar eggs was first reported over 150 years ago, yet the molecular entity responsible for this toxicity has not yet been isolated. Previous work in our lab suggests that gar roe is an effective neurotoxin in three infraorders of decapods: *Astacidea*, *Brachyura*, and *Caridea*. Other work in the lab has tested the toxicity on molluscs, insects, other fishes, and frogs, and we have found that there is no

significant effect on these other animal models. To characterize the active component of the extract and its mechanism of action on crustaceans, the toxin was applied to the neuromuscular junction in crawfish tail while simultaneously recording pre- and post-synaptic potentials. Separation of the extract into fractions with cutoff values of 3, 10, 30, and 50 kDa suggests the primary neurotoxic activity results from the 3 kDa fraction. Whereas spontaneous activity in the presynaptic motor neurons is unaffected, application of the 3 kDa fraction alters post-synaptic muscle potentials. To test whether a Ca^{++} conductance mediates this effect, we are currently measuring the activity of gar toxin applied with nimodipine, an antagonist of L-type Ca^{++} channels. Such a mechanism would be similar to that of ciguatoxin, also shown to modify Ca^{++} conductance. Whether the toxin is actually synthesized by the gar itself, or by an environmentally-associated microbe, as with tetrodotoxin and ciguatoxin remains to be elucidated. This work was supported by the NIH COBRE program in collaboration with LSU Neuroscience Center.

Alligator gar (*Atractosteus spatula*) intensive culture trials at Warm Springs National Fish Hatchery, Warm Springs, Georgia

Zelko, J. and C. Echevarria, Warm Springs National Fish Hatchery, U.S. Fish & Wildlife Service

Alligator gar (*Atractosteus spatula*) is one of the largest freshwater fishes and is native to North America (formerly ranged in public waters of 13 states). As a top level predator, the species has a unique ecological role within river systems and tributaries. Warm Springs NFH began development of appropriate culture techniques for rearing the early life stages of gar for stocking purposes in 2006. The protocols were refined in 2008 and addressed the issue of culturing fry by alternative methods to determine the best culture practices for this life stage. These trials are part of collaborative efforts in Tennessee and Alabama to restore and enhance populations of alligator gar within selected river basins. Fry received in early May – early June were reared intensively utilizing several small circular (25-gallon) and oval (50-gallon) tanks set-up in our holding house. The tanks maximized surface area for eating, while minimizing surface disturbances. Grading of fish was performed frequently to minimize density and predation. Fish were eventually moved into larger circular tanks (150-gallon) and then either transferred to other rearing facilities or held for continued grow-out in a 20-foot raceway. Fish were stocked once they reached 8-10 inches in size. Fry were fed live feed (*Artemia* sp.) for the first 13-21 days of culture dependent on the size of the fish and then weaned onto Silver-Cup pellets for the remainder of the culture period. Fish were fed by manually during the day and with automatic feeders overnight.

Adaptive Management Symposium

E. Irwin, coordinator

Structured decision-making and adaptive management in fisheries

Peterson, J. T. USGS Georgia Cooperative Fish and Wildlife Unit, Warnell School of Forestry and Natural Resources, University of Georgia.

Natural resource managers often are faced with difficult decisions on how to satisfy socio-economic needs of the public while maintaining or restoring properly functioning ecological systems. Such decisions are fraught with complexity and uncertainty associated with the response of ecological system to management actions and the existence of multiple, often competing, management objectives. Structured decision-making (SDM) provides a means to formalize these complexities into an explicit framework consisting of objectives, management actions, system dynamics, and outcomes and provides managers a means to make better decisions with respect to resource objectives. In certain instances, management decisions are made sequentially in time or space. These sequential decisions provide an opportunity to reduce uncertainty about the system's likely response to management, provided the system is being monitored. Adaptive resource management (ARM) is a special case of SDM that incorporates information in the form of monitoring data for reducing uncertainty and learning about system dynamics. ARM is first and foremost management and does not require experimentation. Rather, ARM provides managers a way to make optimal decisions, given the current level of uncertainty about system response, and in anticipation that learning will improve decision making through time. Under SDM and ARM, resource goals and objectives are always paramount. The essentials of SDM and ARM are clear, compelling, and critically needed in natural resource management.

Challenges to applying adaptive management to large-scale ecosystem restoration: the Upper Mississippi Navigation and Ecosystem Sustainability Program (NESP)

Galat, D.L.. Missouri Cooperative Fish and Wildlife Research Unit, University of Missouri, and M.A. Cornish, U.S. Army Corps of Engineers, Rock Island District

Over \$1 billion are allocated annually to restoring rivers in the U.S. The Navigation and Ecosystem Sustainability Program (NESP), authorized in 2007, will direct \$3.28 billion over 15 years for the dual purposes of improving navigation efficiency and environmental sustainability within the Upper Mississippi River System (UMRS). Decisions to address the complex assortment of ecological restoration needs within the UMRS will be conducted through a long-term commitment to adaptive management. Components of adaptive management developed during the planning phase include a general conceptual model, an overarching vision, goals and objectives, performance criteria, indicators, monitoring programs, and environmental report cards. Challenges include implementing a system-wide perspective in a project dominated culture and incorporating a function-process approach along with traditional composition-structure outcomes. Improving upriver passage of migratory fishes through navigation dams is a major objective of NESP and is used to demonstrate opportunities for adaptive learning. Hypothesized benefits and costs of fish passage were evaluated, alternative fish passage designs compared relative to migratory fish swimming performance, and priority sites and designs identified. A nature-like fishway at Dam 22 was selected and is designed for adaptive experimentation. It can be modified post-construction to assess effects of different widths and flow patterns on ability to pass fish. Designing and implementing pre-and post monitoring programs to address effectiveness (e.g., is there a detectable population level response within the upriver reach?) as well as performance (e.g., is there a significant increase in the number of fish passing through Dam 22 following construction?) is one challenge discussed.

Adaptive management of horseshoe crabs and red knots in Delaware Bay: Could it be home at last?

Smith, D.R., USGS Leetown Science Center, Nichols, J.D., and C.P McGowan, USGS Patuxent Wildlife Center.

Management of Delaware Bay horseshoe crabs and migrant shorebirds has followed traditional species-specific assessments with only qualitative linkages between them. During that time the management process has been marked by dispute and ad hoc decision making. Recently, a group of managers and researchers embarked on a journey to develop and implement an adaptive management framework that explicitly accounts for the linkages and uncertainties in the species' associations. The decision is now structured as a harvest problem with conservation constraints defined by red knot population size or departure weight. Models are being developed to quantitatively link the multiple species and predict consequences of harvest actions under aleatory and epistemic uncertainty. Optimal harvest actions are being identified through stochastic dynamic programming. This is an ongoing project and so far, so good. In this talk, we highlight the successes and challenges encountered, as well as the challenges that lie ahead.

Concepts, design, and implementation of a naturalized flow regime on the Lower Missouri River

Jacobson, R.B., USGS Columbia Environmental Research Center, and D.L Galat, USGS Missouri Cooperative Fish and Wildlife Research Unit

In an initial step toward adaptive management of the Lower Missouri River (LMOR), managers, stakeholders, and scientists met during summer 2005 to design a more naturalized flow regime. The objective was to support reproduction and survival of threatened and endangered species, with emphasis on the endangered pallid sturgeon (*Scaphirhynchus albus*), while minimizing negative effects to existing social and economic benefits. Specific hydrograph requirements for pallid sturgeon reproduction are unknown, hence much of the design and evaluation process was based on environmental flow components (EFCs) of the natural flow regime (NFR). The design process incorporated a primary stage in which stakeholders developed conceptual hydrographs based on general ecological and social-economic understanding. The second stage accounted for hydroclimatic variation by coding the conceptual hydrographs into reservoir release rules, adding constraints for flooding and storage needs, and modeling the rules through 100 years of hydroclimatic simulation. The output flow regimes were evaluated for ecological benefits based on how closely they resembled EFCs in the NFR. Flow regimes also were assessed for social-economic cost indicators related to flooding and reservoir storage. This experience underscored the lack of confidence stakeholders place in existing scientific understanding. Stakeholders desired proof of ecological benefits commensurate with their certainty of economic losses. Although the effort failed to reach consensus, the process was successful in pilot-testing a design approach; it defined a starting point for management; it focused science on key gaps; and it demonstrated the potential for future collaborative decision making as part of adaptive management.

The next step: Evaluating and applying adaptive management monitoring data for the Tallapoosa River below R.L. Harris Dam

Kennedy, K.D.M., and E. Irwin, USGS Alabama Cooperative Fish and Wildlife Research Unit, Auburn University

The negative ecological consequences of altered flow regimes are well-documented. However, effective management aimed at reversing or mitigating these consequences is hindered by lack of knowledge of specific flow requirements for native fauna, as well as the conflicting goals and values inherent to multiple-use resources. Since 2005, the regulated Tallapoosa River below R.L. Harris Dam has been the site of an adaptive management project established to help make management decisions that optimize the values of resource stakeholders while gaining knowledge about faunal response to manipulated flows. A decision model based on acquired empirical data and expert opinion was developed to assist stakeholders in making an initial change in flow regime. Since the original management action was put into place, we have monitored the fish community below Harris Dam to detect any changes in community

structure. We present the results from four years of monitoring data (2005-2008) from which we calculated occupancy rates and extinction and colonization probabilities of all detected species. Results were used to construct a new decision model in which the faunal component was based on changes in occupancy of those species that 1) are of most importance to stakeholders and 2) are most sensitive to changes in the flow regime. This model will be used for the next iteration in the adaptive management process.

Stakeholder involvement: a primary need for successful adaptive management.

Irwin, E. and K.D.M. Kennedy, USGS Alabama Cooperative Fish and Wildlife Research Unit, Auburn University.

Adaptive management is different from other types of management in that it includes all stakeholders (versus policy makers only) in the process, uses resource optimization techniques to evaluate competing objectives, and recognizes and attempts to reduce uncertainty inherent in natural resource systems. Management actions are negotiated by stakeholders, monitored results compared to predictions of how the system should respond, and management strategies adjusted in a “monitor-compare-adjust” iterative routine. Many adaptive management projects fail because of the lack of stakeholder identification, engagement and continued involvement. Primary reasons for this vary but are usually related to stakeholders either not having ownership (or representation) in decision processes or disenfranchisement of stakeholders after adaptive management begins. We present an example, whereby, stakeholders participate fully in adaptive management of a southeastern regulated river. Structure decision analysis was used to define management objectives and stakeholder values and optimization used to determine initial flow prescriptions. The process was transparent, and the visual nature of the modeling software (Netica) allowed stakeholders to see how their interests and values were represented in the decision process. The development of a stakeholder governance structure and communication mechanism has been critical to the success of the project.

A structured decision-making approach to improving recovery planning for a federally threatened minnow, *Phoxinus phoxinus*.

Nibbelink, N.P. University of Georgia, McAbee, K. U.S. Fish and Wildlife Service, Mattingly, H.T., and T. Johnson, Tennessee Tech University*

High uncertainty and limited historic data hinder management of many imperiled species, leaving recovery planning largely to expert opinion. Therefore, many recovery plans lack measurable quantitative goals. While expert opinion is a practical place to begin, effective recovery planning must incorporate up-to-date ecological knowledge. Decision analysis provides a means to formalize relationships between variables, sources of uncertainty and management outcomes in quantitative models. We used a Bayesian belief network (BBN) to develop a structured decision model for blackside dace with the intent of improving recovery management. Serving as facilitators, we assembled a team of blackside dace experts to construct, refine and evaluate the decision model. First an influence diagram was constructed, graphically describing the “ecological causal web” believed to influence blackside dace populations. The influence diagram was then parameterized with conditional probabilities linking each parameter. Parameters selected are quantifiable under standard sampling efforts in the region of interest, vastly improving the likelihood of future use. The model was tested and refined based on sensitivity analyses and agreement with expert opinion. Model outcomes were also evaluated relative to various land management scenarios in specific regions. The model revealed important ecological relationships not yet well-understood; forced experts to quantify and clearly communicate known system components; and showed likely trends in blackside dace populations based on both current and alternate management scenarios. Furthermore, as a BBN, the model can be updated in the future with new ecological data, land use decisions, and population responses, thereby continually allowing new information to improve recovery management.

Accommodating fish and folk on big rivers: guaranteeing minimum performance creates win-win situations

Tyre, D., School of Natural Resources, University of Nebraska-Lincoln,

The classic paradigm in natural resources management, and indeed, in all economics, is the maximisation of a performance criterion. The most egregious example of this is MSY, but the paradigm is deeply entrenched. An alternative paradigm seeks to guarantee some minimum level of performance under the widest range of possibilities - this is variously known as "robust control" or "information gap" methods. Robust control is able to deal with situations characterised by "unbounded uncertainty" - uncertainty so extreme that we cannot calculate a probability distribution for it. In addition, because it deals with a minimum performance level, it is easier to deal with tradeoffs between conflicting objectives. My coauthors and I constructed an artificial example comparing management of flow from a large reservoir system for two competing purposes - flood control and fish spawning. By focusing on guaranteeing minimum performance for both flood control and fish population growth, it is possible to find decision sets that are "win-win" situations - minimum performance is met for both fish and folk.

Nuisance Plant Symposium

K. Butler and R. Walley, coordinators

Littoral zone survey of the Ross Barnett Reservoir (MS) for invasive species management

Madsen, J.D., Wersal, R.M., and M.L. Tagert, Mississippi State University*

Three non-native aquatic plant species that have caused major problems throughout the United States are waterhyacinth (*Eichhornia crassipes*), alligatorweed (*Alternanthera philoxeroides*), and hydrilla (*Hydrilla verticillata*). In Mississippi, these three species are found in the Ross Barnett Reservoir. Waterhyacinth and alligatorweed have been under intensive management for almost a decade, primarily through the use of herbicides. Hydrilla was first observed in the Reservoir in 2005 and has since been the target of aggressive management through the use of the systemic herbicide fluridone, combined with spot treatments with contact herbicides. We have conducted surveys of the littoral zone to monitor the occurrence of plant species from 2005 through 2007. In 2007, the dominant species was the native plant American lotus (*Nelumbo lutea*) with a percent frequency of occurrence of 21.1%. Hydrilla had a frequency of occurrence of 1.4%. The frequency of occurrence for both waterhyacinth and alligatorweed decreased significantly ($p < 0.01$) from 2005 to 2007. The frequency of occurrence for waterhyacinth in 2005 was 4.9% and declined to 2.9% and 1.2% in 2006 and 2007, respectively. The occurrence of alligatorweed was reduced from 21.1% in 2005 to 4.0% in 2007, approximately an 80% reduction. Furthermore, the removal of waterhyacinth and alligatorweed from some areas of the Reservoir has not impacted the overall species richness (mean number species per point) over the past three years. Additionally, hydrilla has been effectively removed from five areas of the Reservoir totaling more than 161 acres.

Controlling giant salvinia with herbicides - A ten year perspective from Louisiana.

Sanders, D.E., and A.K. Whitehead, LSU Agcenter, Bob R. Jones-Idlewild Research Station,

Giant salvinia, *Salvinia molesta*, was first reported in Louisiana in 1998 in Toledo Bend Reservoir. From initial infestations estimated at less than 500 acres in 1999 the weed has increased to cover an estimated 70,000 acres in 2008. During the past decade the authors have screened 18 potential herbicides. Herbicides selected for screening included those already labelled for aquatic use, proposed for aquatic use or labelled or proposed in the related area of rice weed control. Due to the exponential growth rate of giant salvinia herbicide treatments providing less than 90% control at 30 days after treatment were considered ineffective. In mesocosm trials the herbicides diquat, glyphosate, glufosinate ammonium, fluridone, penoxsulam and flumioxazin provided greater than 90% control after 30 days when applied at the maximum rate tested. However, in field trials no single application of any herbicide tested provided greater than 90% control after 90 days.

Impacts of Aquathol K applications on largemouth bass spawning behavior and production of young largemouth bass

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We evaluated the direct application of Aquathol K (endothall) on nesting largemouth bass (*Micropterus salmoides*) and examined the impacts on the subsequent reproductive success of these fish in small ponds in Alabama. Aquathol K was applied at the approved rate of 3 ppm in three 0.1 hectare ponds in March 2005, 2006, and 2007 as largemouth bass initiated spawning and spawning activity was monitored over 14 days. Water was applied in a similar fashion to three other 0.1 hectare ponds. For all three years; Aquathol K did not impact largemouth bass nesting activity or spawning behavior and nest fidelity was similar to ponds treated with water. In 2005, concentrations of Aquathol K declined three to six fold in the

ponds during the observed spawning period, but was still persistent in the water during spawning. Abundance and size of young largemouth bass produced after spawning varied among years, but within a particular year, were similar among ponds treated with Aquathol K and control ponds. Approved application rates of Aquathol K did not adversely impact largemouth bass spawning or subsequent production of young fish.

Historical and recent perspectives on the large-scale Herbicide management of Hydrilla in Florida

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Hydrilla (*Hydrilla verticillata*) is a submersed invasive plant introduced to Florida in the late 1950's. Herbicide management began in the 1960's with the contact herbicides copper, diquat, and endothall. Despite continuing management efforts, hydrilla spread rapidly throughout the state during the 1970s and 80's. In 1986, the bleaching herbicide fluridone was registered, and an active research and operations program was adopted using fluridone to control the spread of hydrilla. Extended exposures to low concentrations of fluridone proved key to cost-effective hydrilla control. By the early 1990's, fluridone became the herbicide of choice for large-scale selective control. In 2001, fluridone resistant hydrilla (FRH) was documented in numerous Florida lakes. Attempts at increasing fluridone use rates to control FRH were thwarted by increased herbicide resistance, increased non-target plant injury, and enhanced degradation of fluridone. In 2004, numerous hurricanes resulted in extreme disturbance and prolonged periods of high dark water that inhibited hydrilla growth. During this period of reduced hydrilla, two multi-agency workshops were held in December 2004 and 2005 to address issues related to hydrilla and strategies for management. Both large and small-scale management has shifted principally to the contact herbicide endothall. State personnel maintain aggressive detection and response programs in lakes with limited hydrilla infestations. For established infestations, research suggested a significant change in endothall use patterns with significant changes in both treatment timing and scale of application. In addition to discussing recent endothall results, operational treatments using two new acetolactate synthase inhibitors will be discussed.

Introduction and establishment of *Cyrtobagous salviniae* Calder and Sands to control *Salvinia minima* Baker in Louisiana.

Parys, K.A. and S. Johnson, Louisiana State University AgCenter*

Cyrtobagous salviniae Calder and Sands (Coleoptera: Curculionidae) has been released in the United States and 13 other countries for biological control of both *Salvinia minima* Baker and *Salvinia molesta* Mitchell, invasive freshwater aquatic ferns that displace native vegetation. *S. minima* is widely established in Louisiana and multiple introductions of *C. salviniae* from southern Florida failed to establish over several field seasons and were assumed to not be temperately adapted. A population of *C. salviniae* was identified in northern Florida and used to make introductions in the summer of 2007. During the spring of 2008, *C. salviniae* was successfully recovered from two locations in Louisiana.

Triploid grass carp movement across spillways during high water events in two central Louisiana lakes

Mathews, R. L. and R.D. Moses, Louisiana Department of Wildlife & Fisheries,*

Numerous lakes in central Louisiana are severely infested with *Hydrilla verticillata*. Previous studies show Hydrilla is one of the preferred species of vegetation eaten by triploid grass carp (*Ctenopharyngodon idella*). Studies also show TGC are prone to extensive movement during periods of high water. If it was determined TGC would not move from these lakes during high water events they could be utilized in an integrated management plan to control hydrilla. This study was designed to determine if triploid grass carp (TGC) would move from bottomland lakes with large watersheds during periods of high water. The two study areas were cypress/tupelo covered impoundments with spillways that are periodically

overtopped by water during periods of heavy rainfall. Coded transmitter tagged TGC were initially stocked into the study areas in April, 2005. Saline Lake, located in Winn and Natchitoches Parishes, received 52 tagged carp and Iatt Lake, located in Grant Parish, received 40. Advanced Telemetry Systems, Inc. receiver/datalogger units were placed in strategic downstream locations to record the passage of tagged carp in the event of movement out of the lakes. Maximum transmitter battery life was 552 days. There were no flood events during the active transmitter period following the initial stocking so a second stocking of tagged carp occurred in March, 2007. Saline Lake received 28 additional tagged carp and Iatt Lake received 24. At the completion of the study no TGC were found to have moved from the lakes. However, there were no significant high water events during the active transmitter periods.

Large scale rearing and release of the giant salvinia weevil (*Cyrtobagous salviniae*) in Louisiana

Walley, R.C. Louisiana Department of Wildlife and Fisheries, and D.E. Sanders, LSU AgCenter*

The Louisiana Department of Wildlife and Fisheries (LDWF) Inland Fisheries Division, and Louisiana State University Agricultural Center have been working in cooperation to mass produce the salvinia weevil (*Cyrtobagous salviniae*) to serve as a biological control agent for giant salvinia (*Salvinia molesta*) in Louisiana. In June of 2007, six acres of an aquaculture facility owned by the Golden Ranch Corp in Gheens, Louisiana were flooded and stocked with giant salvinia from a nearby canal. On July 15, 2007 giant salvinia had covered the surface area of the pond with an estimated biomass of 750,000 pounds green weight. The pond was periodically fertilized and water quality parameters were also monitored. Once salvinia was established in the pond, weevils obtained from the Army Corp of Engineers were stocked on August 15, 2007. On September 1, 2007, initial samples from the pond were collected and Berlese funneled to remove adult weevils for population analysis. On June 5 and 20, 2008 additional weevils were collected from Toledo Bend Reservoir and stocked into the pond. After the additional weevils were stocked, samples were continuously collected and analyzed to determine population density. Once a high enough population was achieved, weevil infested plant material was harvested and released in water bodies infested with giant salvinia. To harvest infested salvinia from the pond, a mechanical transfer unit was constructed from a modified forage elevator. Initial releases were delayed due to hurricanes Gustav and Ike. Since September 29, 2008, LDWF has made releases in more than twelve water bodies.

Indirect effect of plant removal on Bluegill *Lepomis macrochirus* diet and feeding selectivity

Webb, K.M., and E. Dibble, Department of Wildlife and Fisheries, Mississippi State University,*

Structural habitat provided by submersed aquatic plants mediates prey availability and foraging efficiency of fish. We evaluate the effect of changes in vegetated habitat resulting from plant management on prey selectivity of bluegill sunfish *Lepomis macrochirus*. Two Minnesota lakes were treated with an herbicide application of endothall and 2-4 D to control Eurasian watermilfoil and Curley leaf pondweed and compared among two similar reference lakes with no plant control. Prior to the herbicide applications in June and September (2003) and in 2004 (post-treatment), fish and macroinvertebrates were collected using dip nets and boat-mounted electrofishing, respectively. Macroinvertebrates were enumerated and identified to taxonomic order, and fish stomachs were removed and examined for prey content. Prey availability and diet was determined and selectivity calculated using Manly's alpha. Fish in treatment lakes preferred dipterans, where in reference lakes, trichopterans were preferred. During the month of September each lake had 1-2 preferred items that differed significantly between 2003 and 2004 (alpha &le 0.05). Removal of plants appear to facilitate a shift in the preferred food item with decreases in Diptera (p = .0225) and increases in Acari (p = .0071) in treatment lakes. Decrease in selection of dipterans may be due to population fluctuation in availability and association of the larvae with plants. The increase selection of Acari may have resulted due to increased visual acuity of bluegill.

Effects of temperature, pH and conductivity on giant salvinia (*Salvinia molesta*) growth

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Giant salvinia (*Salvinia molesta*), an invasive, free-floating fern native to Brazil, is invading the US. In order to predict its ultimate distribution and to identify environmental factors that may affect the susceptibility of aquatic ecosystems to invasion, a series of studies were conducted to determine the effects of low temperatures, pH and conductivity on the growth of giant salvinia. Results from acute low temperature exposure in a controlled study demonstrated that formation of ice results in a decrease in percent survival of giant salvinia. All giant salvinia plants exposed to air temperatures of -16°C (48hr) were killed while those exposed to -3°C (48hr) survived due to incomplete ice formation in the surface water of the container. Additionally, growth of giant salvinia under different pH regimes was examined. Giant salvinia grew to completely cover a research pond over a 15-week period when pH was less than 7.5. Growth was reduced in a second pond maintained at higher pH (greater than 8 units). Tank studies found that significantly greater giant salvinia biomass was produced at lower pH and that water chemistry of tanks changed when completely covered by the resultant mat. Conductivity studies (2 pH regimes) found that under low pH (7 units or less) except for the highest conductivity (4350 and 10000 μmhos) treatments averaged between 60-90 % surface coverage in all treatment containers. This study likewise found that giant salvinia produced significantly greater biomass (approximately 6-fold) when grown at low pH (less than 7 units) than plants grown at higher pH but the plants were also impacted by increasing conductivity. Results suggest that the distribution of giant salvinia in the U.S. will be limited on the northern end by freezing surface waters and that the most susceptible sites are those having low pH (<7.5) and conductivity (<4000). However, once giant salvinia becomes established it is capable of spreading into less favorable conditions and even modifying those conditions to promote its growth.

A 5-yr evaluation of largemouth bass-bluegill populations following a selective herbicide application

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Macrophytes provide important habitat structure for fish and macroinvertebrate communities. An intermediate level of aquatic plant density and complexity are optimal for fish foraging and growth. Excessive plant growth, often characterized by an exotic plant invasion, increase optimal levels of aquatic structure thus altering predator-prey interactions. A four-lake experiment was conducted in Minnesota (June 2003-September 2007) to determine the effect of a selective herbicide application on the aquatic community. Low doses of endothall (1mg/L ai) combined with 2,4-D (0.5mg/L ai) were applied to Bush and Zumbra lakes to selectively remove Eurasian watermilfoil (*Myriophyllum spicatum*) and curly-leaf pondweed (*Potamogeton crispus*). Auburn and Pierson Lake served as reference lakes, receiving no treatment. Our data documented significant loss of Eurasian watermilfoil and curly-leaf pondweed, where no significant treatment effect was observed for the abundance or richness of the fish community. Largemouth bass (*Micropterus salmoides*) mean length was significantly greater in treatment lakes, where there was no difference in mean weight or condition between lakes. No treatment effect was observed for bluegill (*Lepomis macrochirus*) mean length, weight, or condition. Therefore, we conclude there were no immediate or long-term (5 years) negative effects observed from nuisance aquatic vegetation removal on largemouth bass or bluegill populations following an herbicide application.

Crayfish Symposium

S. Welch, coordinator

Status and distribution of the gapped ringed crayfish, *Orconectes neglectus chaenodactylus*, in Arkansas

Wagner, B.K., Arkansas Game & Fish Commission, Taylor, C.A., Illinois Natural History Survey, and M.D. Kottmyer, The Nature Conservancy

Orconectes neglectus chaenodactylus, the gapped ringed crayfish, is an uncommon and poorly-known stream-dwelling crayfish that is endemic to the central White River basin of Arkansas and Missouri. This study surveyed a semi-random selection of stream sites in the Arkansas portion of this range in order to characterize the crayfish communities and evaluate the status of *O. n. chaenodactylus* in Arkansas. Collections of a total of 1,811 individual crayfish specimens were made at 82 sites, including 497 *O. n. chaenodactylus* from 21 sites. *O. punctimanus* was the crayfish species most commonly associated with *O. n. chaenodactylus*, occurring at 71% of sites occupied by *O. n. chaenodactylus*. *O. n. chaenodactylus* was found in streams not significantly different from the median characteristics of streams sampled in the study. It is our opinion that *O. n. chaenodactylus* is of moderate concern due to its limited distribution in Arkansas, and should be considered uncommon.

Development of a management plan for wild-caught crawfish in Louisiana

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From 182,000 to 23,000,000 kg of wild crawfish are commercially harvested annually in Louisiana. Most come from the Atchafalaya Basin in the south-central part of the state. An unknown quantity of crawfish is caught each year by recreational fishermen but has, in the past, sometimes reached levels over a million kg in seasonally flooded wetlands. The erratic nature of harvests led to the rapid development of crawfish aquaculture and has stabilized supplies at levels around 50 million kg annually. Unlike other fisheries, no management plan has been developed for wild-caught crawfish. The Louisiana Crawfish Promotion and Research Board has provided funds to develop such a plan. The controlling factor for wild commercial crawfish populations, *Procambarus clarkii* and *P. zonangulus*, is the seasonal availability of waters in wetlands during the late fall - late spring period followed by a dry period. This wet-dry cycle in the Atchafalaya Basin is controlled by the annual flooding cycle of the Mississippi River. Crawfish production is directly correlated to the magnitude of the spring flood. Widespread misunderstandings of basic Atchafalaya Basin crawfish biology have resulted in misguided regulations on trap mesh size and demands for seasons to protect brood crawfish. Further complications involve social and legal issues over access to crawfish on seasonally flooded private lands and contentions that pipeline and oil and gas development have adversely impacted water quality and crawfish production. Actions directed towards reducing habitat destruction are adversely impacted by rapid deposition of sediment. Anoxia favors the amphibious crawfish by controlling predaceous fishes.

Economic valuation of benefits provided by crawfish pond habitat

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Over 260,000 ha of land in rice and crawfish production in Louisiana provide nesting, wintering and breeding habitat for 100 species of waterbirds. These working wetlands have become critical waterbird habitat, partially compensating for the loss of 600,000 ha of adjacent coastal wetlands. Despite steady yields, area devoted to rice farming has been declining in Louisiana because of low prices and high input costs as well as damage associated with recent hurricanes (saltwater intrusion and debris deposition,

among others). Meanwhile, the area in crawfish production has stabilized and has helped to keep many rice operations in business, despite economic problems (low prices and increasing costs) and competing crawfish products imported from China. The long-run economic situation facing Louisiana's rice industry is pessimistic. Without additional financial assistance, as much as 35% of these working wetlands and associated waterbird habitat may be lost. The level of support available under Conservation Provisions of recent Farm Bills is \$250-500 per hectare. On the other hand, producers incur economic costs of \$500-750 per hectare for providing environmental benefits from these working wetlands. Researchers have estimated values of the environmental services associated with these working wetlands to be \$750-1000 per hectare. Thus, there is evidence that the value of environmental benefits exceed the costs of providing them. If producers receive conservation payments offsetting expenses for maintaining seasonal working wetlands, such a conservation program may stem this potential habitat loss and help provide the environmental benefits society values.

The Mississippi Crayfish Database and Website as conservation tools – educational, management, and research applications

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We created a spatially explicit database of crayfish collection records from five data sources and created a website to access the database and other crayfish information. The database and related website content provides a tool for education, management, and research related to Mississippi crayfishes. Although Mississippi has about 63 described, and several undescribed, crayfish species, most Mississippians assume there are fewer than five crayfish species in the state; thus, education is a critical first step toward conservation. The next step is to provide land and wildlife managers, planners, and researchers with tools to better address crayfish conservation. Finally, with so many species and so little information about most of them, single-species management approaches are unlikely to provide effective conservation for the crayfish fauna. Therefore, we used multivariate analyses to delineate crayfish faunal groups and explored relationships between faunal group distributions and hydrologic and geographic distances and ecoregions. We will touch on potential hotspots for crayfish conservation in the state and how these relate to priority conservation areas identified by The Nature Conservancy for fishes and mussels.

Management of non-native crayfishes in Maryland

Kilian, J.V, Klauda, R.J., and S. Widman, Maryland Department of Natural Resources,*

Since 2006 the Maryland Department of Natural Resources (MDNR) has conducted a statewide assessment of the status and distribution of crayfishes. As a result of this effort, it has become clear that invasive crayfish species are a significant threat to Maryland's native crayfishes and to the integrity of Maryland streams and rivers. Four non-native invasive crayfishes are now established in the state. These introductions have primarily occurred as a result of the transfer and release of live crayfishes used as bait by anglers and from outdoor aquaculture. In recognition of the threat posed by invasive crayfishes, MDNR has pursued regulatory action to limit the sale and use of live crayfishes. In Fall 2008, MDNR conducted a mail survey of 10,000 freshwater anglers to assess the use of live crayfishes as bait. MDNR also conducted a telephone survey of 125 bait and tackle shops to assess the commercial sale of live crayfishes in the state. These surveys were necessary to determine the recreational and economic impact of additional regulation. We will present the results of these surveys and discuss the actions that MDNR is taking to control the introduction and spread of non-native crayfishes in Maryland.

Crayfish of West Virginia's Potomac River Basins: conservation and natural history

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West Virginia's portion of the Potomac River system consists of the North and South Branch of the Potomac, Cacapon, Potomac Drains, and Shenandoah River basins. Crayfish biodiversity rates within the region are low relative to other West Virginia river basins; however still warrant conservation efforts due to elevated levels of imperilment. Increased development, agriculture, and invasive crayfishes threaten this limited fauna. In response to these threats a survey was performed to determine the conservation standing of all Potomac River system crayfishes. Two species, *Orconectes (G.) virilis* and *Procambarus (O.) acutus*, are introduced, with this survey documenting *P. (O.) acutus* for the first time in the Potomac system of West Virginia. *Orconectes (G.) virilis* represents an important cause of decline for crayfishes in the region and currently is limited to the Potomac Drains and Shenandoah River basins. *Orconectes (C.) obscurus* and *Orconectes (F.) limosus* are native to the headwaters of the Potomac River. *Orconectes (C.) obscurus* is stable in the absence of *O. (G.) virilis*, while *O. (F.) limosus* appears to have been extirpated by competitive exclusion via *O. (G.) virilis*. *Cambarus (C.) b. bartonii* is found in all Atlantic Slope basins, and currently is stable. Given the xeric nature of the region, suitable habitat for burrowing species is extremely limited, and only occurs in higher elevations. *Cambarus (J.) dubius* was the only primary burrower collected in this survey, and reaches the western terminus of its range in West Virginia in the North Branch of the Potomac River basin.

Crayfish burrow use by herpetofauna

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Although herpetofauna have been documented to use crayfish burrows, researchers often ignore the potential importance of crayfish burrows as refugia. To demonstrate the nuances of crayfish/amphibian relationships, we subjected *Ambystoma talpoideum* larvae to artificial crayfish burrows occupied by four crayfish host species and unoccupied control burrows for two weeks. We selected the four crayfish host species because each species constructed burrows and was observed in temporary lentic habitats similar to those occupied by *Ambystoma talpoideum* larvae during May 2006. Survival analysis indicated that larval survival varied among the crayfish host species. Further, larval survival in unoccupied control burrows and in burrows occupied by some crayfish species did not differ, indicating that some crayfish species provide refugia for amphibian larvae, even when they occupy the burrows.

Evidence for proliferation of retroposable elements in the genome of the red swamp caryfish, *Procambarus clarkii*

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Crawfish genomes, like those of other decapod crustaceans, are comprised of large numbers of chromosomes. These numbers are hypothesized to have arisen from polyploidization, polyploidization, transposition, or combinations of these events. The genome of *Procambarus clarkii* is host to 192 chromosomes. Despite the historical, biological, and economic importance of this species, little is known about its chromosomal architecture. We sought to determine if retroposition might have contributed to this architecture. Retroposition is a widespread genetic phenomenon in animals and involves the intranuclear reverse transcription of RNA molecules into DNA, which are subsequently integrated into the chromosomes at random loci. When retropositional events occur in germlines, integration is heritable. Because retroposition and integration are random process, unique retroposition events will occur in different germ cells of different individuals, and genetic analysis of these events can be used to define the population of an individual's descent. In a PCR-based approach, we focused on isolating from *P. clarkii* DNA repetitive elements of the Penelope-Like Element (PLE) family of retrotransposons, an ancient family recently demonstrated in the genomes of other crustaceans. Using amplification primers based on conserved domains unique to enzymes encoded by PLEs, followed by amplicon cloning, nucleotide sequencing, and comparative bioinformatics, we have identified multiple gene loci showing significant

homology to conserved domains of the PLE enzymes. These results (1) suggest that the *P. clarkii* genome has undergone modification by retroposition and (2) provide a number of genetic markers potentially useful in population and further genomic studies.

Large Rivers Symposium

C. Murphy, coordinator

A tale of two rivers: Status and management of Mississippi River fisheries

Schramm, H., USGS Mississippi Cooperative Fish and Wildlife Research Unit

The Mississippi River has been variously altered for navigation and flood control but supports a diverse and relatively productive fish assemblage. In the upper, impounded reach, commercial fish harvest has increased for most species since 1945. The upper reach provides an extensive and moderately used recreational fishery resource. Limited information for the lower, unimpounded reach of the Mississippi River indicates commercial harvest is increasing. Neither the commercial nor recreational fisheries appear to be overharvested; however, scientifically designed monitoring programs for sturgeon and paddlefish are needed to support management of these species. Future fisheries production may be threatened by loss of aquatic habitat, altered spatial and temporal aspects of floodplain inundation, and nuisance species invasions. Water quality in most reaches has improved substantially from formerly severely degraded conditions. Navigation traffic affects fish survival and recruitment, and increases in navigation are forecast. Future conservation and management of the fisheries and aquatic resources of the lower Mississippi River will require substantial investments in effective assessment programs and achieving societal recognition of the diverse values of the resource.

River sturgeon (*Scaphirhynchus* spp.) in the Atchafalaya River: a natural condition or entrainment?

Hartfield, P. U.S. Fish and Wildlife Service, Dean, J. Natchitoches National Fish Hatchery, and B. Reed, Louisiana Department of Wildlife and Fisheries*

There is a growing body of evidence of the entrainment of juvenile and adult river sturgeon through water diversion structures in the Lower Mississippi River. Limited trawl samples made in the upper Atchafalaya River during 2005 resulted in the collection of a marked hatchery-reared (HR) juvenile pallid sturgeon (*Scaphirhynchus albus*) that had been released in the Mississippi River in 2004. Gill net collections for pallid sturgeon in 2007 in the Atchafalaya River below the Old River Control Complex (ORCC) Low Sill captured another 2004 Mississippi released HR pallid, along with a 1997 HR pallid that had been released in the Middle Mississippi River. The recent geomorphic history of the Atchafalaya, along with the absence of natural spawning substrate near the ORCC where river sturgeon congregate, short river length, and the absence of "typical" habitat for young of year recruitment in the system suggests that the Atchafalaya River may be a sink for entrained Mississippi River sturgeon. Additional evidence of river sturgeon susceptibility to entrainment was obtained following the closure of the Bonnet Carré spillway during the high water event of 2008, when sampling recovered wild pallid and shovelnose (*S. platyrhynchus*) sturgeon stranded in the spillway channel. Other existing and planned water and sediment diversions in the Lower Mississippi River have the potential to entrain sturgeons into habitats where they are unlikely to survive.

Establishment of a longterm fisheries monitoring program for the lower Mississippi River, Louisiana

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The Inland Fisheries Division of the Louisiana Department of Wildlife & Fisheries initiated a statewide river sampling program in 2002. Gathering fisheries information on the Mississippi River was at the centerpiece of the new program. The purpose of the program was to provide 1) baseline data on fish population status and relative abundance 2) assess invasive aquatic species and, 3) to begin a long term monitoring program to identify population status and abundance trends. River sampling occurred during

the summer months June – September. Gear types being used for fish sampling include gill nets, hoop nets, haul seines and electrofishing. Since 2002, a total of 44 sampling stations have been established along the Mississippi River from the Arkansas state line to the Head-of-passes on the delta. A total of 17,000 individual fish representing ninety-two species and 31 families have been collected and identified to date. Approximately 50% of the families were of marine origin making ephemeral migrations into freshwater environments. We used species diversity indices to describe species richness, and percent total numbers to report relative abundance. Clupeids and cyprinids were dominant in total numbers, while cyprinids and centrarchids were the most represented families.

Identifying gravel deposits in the Lower Mississippi River to support native fish habitat management

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In the Lower Mississippi River, gravel (material coarser than 2 mm and less than 75 mm in diameter) provides habitat for the endangered pallid sturgeon *Scaphirhynchus albus* and other native fish. The identification of gravel deposits, both subaerial and those existing as channel bed material, and the migration of these deposits are essential to fully investigate and understand the ecological and biological impact of a changing fluvial environment on fish habitat. Most gravel deposits, regardless of geographic or physiographic location, are Pleistocene (~3 million BP) or younger in age. Consequently, most gravel bodies occur as surficial deposits. Previous investigations focused on the alluvial floodplain deposits and the overall river channel morphology. Because of the difficulty in mapping sediment deposits, the identification and delineation of gravel deposits have largely been ignored. The study is divided into three phases. The initial phase is an evaluation of tools and methods applicable to locating subaqueous gravel deposits. The second phase to begin in the fall of 2008 will test selected techniques in field sites where pallid sturgeon habitat has been previously identified. Using data collected in the second phase, the third phase, scheduled for the spring of 2009, will consist of modeling the dynamic nature of the gravel deposits, thereby providing a predictive management tool.

Prioritizing restoration projects in the Lower Mississippi River - Decision modeling and a case history showing benefits

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The Lower Mississippi River Conservation Committee (LMRCC) conducted state-level planning meetings from 2001 - 2004 to identify aquatic habitat restoration projects on the Lower Mississippi River (LMR). Referred to as the Mississippi River Conservation Initiative, a total of 220 projects were selected by the six states bordering the LMR. In 2006, the LMRCC began to prioritize projects by first placing them into ten categories (e.g., notch dikes, restore flow into secondary channels, restore connectivity to lakes and backwaters). A Decision Support Model (DSM) was developed to rank categories according to their ecological significance defined by habitat scarcity/rarity, degree of connectivity/area of influence, and benefits to special status species. The highest ranked category was restoring flow in secondary channels. Consequently, a second DSM was developed to rank secondary channel projects according to a benefit-cost ratio. Using geo-referenced video and satellite imagery, various attributes (e.g., size, flow status, number of dikes, and number of habitats) of each secondary channel along the Arkansas border were evaluated. Environmental benefits were determined from these attributes based on long-term sustainability of the project, size and accessibility during lower river stages, and the suitability of the habitat to aquatic communities. Those projects with the highest B:C ratio will provide greater net benefits to ecosystem restoration per dollar expended. Overall, secondary channels can be restored relatively inexpensively, large aquatic areas can be re-watered, most secondary channels are within the Corps' authorized boundaries, and there is considerable interagency support for these types of projects.

Floodplain wetlands as nurseries for silver carp, *Hypophthalmichthys molitrix*: A conceptual model for use in managing Local Populations

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Silver carp, *Hypophthalmichthys molitrix*, were brought to Arkansas in 1973 to control algal blooms in catfish ponds. By 1980, silver carp were established in the Lower Mississippi River Basin due to flooding. Silver carp utilization and impacts in smaller water bodies are virtually unknown. Local silver carp populations in floodplain wetlands of the Mississippi River were monitored to describe habitat, population structure, relationships with other aquatic species, and hydrologic influences on movements. Fish were documented from one temporary pool, two semi-permanent pools, and a permanent water body, Forest Home Chute. Fishkills were documented in drying wetland pools with high water temperatures and turbidity, low dissolved oxygen and observed predation by wood storks. In all wetlands, silver carp were represented by a single size-age cohort. In Forest Home Chute growth and development were rapid. Two year old fish weighed 4.54-10.06 kg and many had maturing gonads while on subsequent trips, new immigrants showed similar maturation patterns. Sex ratio of male-female was calculated. Number of fish observed jumping varied seasonally. Evidence exists that silver carp are changing food webs in these wetlands. Paddlefish, the largest native zooplanktivore co-occurring with silver carp, were significantly underweight or completely absent. Feces removed from the rectum of silver carp contained viable phytoplankton that can be rapidly cultivated into algal "blooms." A conceptual model is presented that identifies critical hydrologic events and habitats of silver carp and which may be used to identify structural and restorative measures that will reduce recruitment of silver carp into riverine systems.

Field endoscopy for identifying gender, reproductive stage and gonadal anomalies in free-ranging sturgeon (*Scaphirhynchus*) from the Lower Mississippi River

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Data on reproduction are required for effective population modeling but are difficult to obtain for endangered fishes due to prohibitions on destructive or potentially injurious sampling. Endoscopy, a minimally invasive and safe diagnostic technique traditionally used in veterinary and laboratory settings, was evaluated for use in field studies of sturgeon in the Lower Mississippi River. Thirty-three shovelnose sturgeon, two pallid sturgeon, and one morphologically intermediate sturgeon (confirmed using multivariate analysis) were collected 31 Jan 2008 at RM 681-694 near Tunica, MS, anesthetized, insufflated, and examined telescopically. Gender, reproductive state, and anomalies were documented, biopsies collected, and digital photographs recorded. Some fish were implanted with sonic tags, prior to recovery and release. Shovelnose sturgeon consisted of 15 males (455-718 mm FL), 16 females (363-728 mm FL), and two hermaphrodites (572 and 594 mm FL). Of non-virgin males, 29% had large pink, apparently mature testes. Of non-virgin females, 20% had large black oocytes and an additional 26% had well-developed yellow oocytes. Pallid sturgeon were both immature females (710 and 720 mm FL). Subsequent histological analyses of biopsies indicated that gender was correctly assigned in > 93 % individuals. Study demonstrated that endoscopy is an effective field technique for establishing gender ratios, percentage of spawning fish, and percentage of intersexual fish. Repeated endoscopic sampling of a population can provide additional data on onset and duration of spawning season, chronology and duration of gonadal stages. Endoscopy can also be used to estimate fecundity and other parameters required for empirically based models of population viability.

Aquaculture Symposium

C. Green, coordinator

Optimizing feeding strategies for tank culture of sunshine bass using microcyst *Artemia* nauplii as an intermediate step between rotifers and standard *Artemia* nauplii

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Recently, sunshine bass larvae have been cultured without rotifers, by using *Artemia* nauplii from microcysts at first feeding. We wanted to see if survival and growth of sunshine bass larvae would be improved by including rotifers (*Brachionus plicatilis*), microcyst *Artemia* nauplii, and standard *Artemia* nauplii in sequence during a production run. Sunshine bass larvae, 4 dph (4.0 + 0.1 mm SL), were stocked into 100-L recirculating tanks at a rate of 75 larvae/L. The first feeding treatment was rotifers (40/mL) and *Artemia* nauplii (8/mL). The second feeding treatment was microcyst *Artemia* nauplii (20/mL) and standard *Artemia* nauplii (8/mL). The third feeding treatment was rotifers (40/mL), microcyst *Artemia* nauplii (4/mL), and standard *Artemia* nauplii (8/mL). Fingerlings were harvested on day 21 of the experiment. Thirty larvae from each tank were photographed at the end of the study. Standard lengths of larvae were determined using image analysis software. Average (SD) individual standard length of larvae was 9.08 (1.43) mm and ranged from 6.46 to 15.05 mm. Average length of larvae did not vary among treatments ($F=0.81$, $df=2$, $P=0.489$). Variability in survival was high. Survival ranged from 9% to 96%, and varied somewhat among treatments ($F=3.41$, $df=2$, $P=0.102$). The lowest two survival rates occurred in treatment two and the highest two survival rates occurred in treatment three. It appears that matching food size to larval size, as larvae grow, is likely to result in better survival. However, growth of larvae does not appear to improve similarly.

Effect of temperature on larval sunshine bass growth and survival to the fingerling stage.

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Determining the optimum conditions for tank culture of sunshine bass fingerlings will facilitate a year-round supply of seed for the production cycle of this increasingly popular food fish. This study determined the relationship between temperature and larval sunshine bass growth and survival to the time when fish were trained to accept commercial feeds. Four-day post-hatch (dph) larvae were stocked at five temperatures from 20-32°C at 3°C increments. There were two replicates of each temperature. The larvae were fed rotifers through 8 dph. Conversion to an *Artemia* nauplii diet began at 6 dph and training to dry starter feed began at 20 dph. At harvest, average total length and average weight of the fish increased in a linear relationship with temperature while relative survival and number of fish harvested decreased linearly with temperature. Tank yield had a curvilinear relationship with temperature. The temperature that provided maximum yield was 23.1°C. Although growth was faster at warmer temperatures, relative survival and yield were not. These relationships between tank culture conditions and production characteristics support optimization of tank culture to meet specific production goals. This should eliminate some of the logistical constraints to expanded tank culture of sunshine bass fingerlings.

Propagation and rearing methods for yellowcheek darter (*Etheostoma moorei*)

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Yellowcheek darter (*Etheostoma moorei*) are found only in the shallow, high gradient riffles of the tributaries of the Little Red River in Arkansas. Over the last twenty years *E. moorei* has undergone a

massive decrease in population. *E. moorei* was listed as a candidate species for addition to the Federal Endangered Species List in 2001. Our goal was to develop a successful propagation method and once propagation had occurred to develop an effective feeding schedule to culture *E. moorei* larvae. Adults were captured from the wild using kick seining or snorkeling methods. Two females and one male were stocked into 57-L recirculating aquaria and fed a diet of blackworms 2-3 times per day. They were monitored continuously to observe spawning activity and to determine when spawning had occurred. When spawning was observed, the eggs were photographed at scheduled intervals until hatching occurred. Larvae were passively collected from the adult aquaria using the surface overflow as they swam up. Larvae were transferred to the 1.5-L black round rubber rearing tubs. The larvae were photographed every two days. Larvae were initially fed a mixture of saltwater rotifers (*Brachionus plicatilis*) at a rate of 10/mL, *Nannochloropsis* algae paste, and artificial plankton. Once they reached a large enough size, they were fed a mixture of rotifers (10/mL) and microcyst *Artemia* nauplii (2/mL). Three larvae survived long enough to develop pigmentation and a benthic behavior.

Developments in hatchery propagation of the bigmouth sleeper *Gobiomorus dormitor*

Mace, C. and J.W. Neal, Mississippi State University

The bigmouth sleeper *Gobiomorus dormitor* is a diadromous species native to rivers in Puerto Rico. It is locally popular as a sport fish, and there is growing interest using this species in reservoir fisheries management as an alternative to introduced species. To accomplish this, hatchery rearing techniques are being determined. Spawning can be induced under hatchery conditions by hormone injection, particularly using Chorulon® in a series of injections 24 h apart. Usually following the second or third injection, bigmouth sleepers will passively spawn on cavity-type spawning structures in freshwater. Eggs hatch in 18-19 h at 23°C, and estimated clutch sizes of 40,000 – 80,000 larvae per spawn are typical. At hatch, larvae are very small (1-1.5 mm long), and do not have developed eyes or mouths. Larvae maintained in freshwater (0.3 ppt) die within 24-36 h post hatch. Increased salinities of 6 and 12 ppt following hatch effectively eliminate the short-term mortality (48 h survival increased to over 90%), and allow continued development of larvae. A fully-formed mouth and eye is evident by day 4, and first feeding occurs on day 5. Because of their small size, larvae require prey items that are less than 100 microns in maximum dimension. Several diets have been fed, and minimum success was obtained using artificial Rotifer Replacement Diet (O.S.I.®) and chicken egg slurry. However, these diets were not sufficient, and all larvae died by day 13. Future studies will examine the potential of brackish green-water culture and high-density rotifer culture.

Larval development and yolk utilization of the Gulf killifish (*Fundulus grandis*) in response to variations of temperature and salinity

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The marine baitfish industry holds incredible economic potential for coastal regions in the United States. Gulf Killifish (*Fundulus grandis*) are a preferred baitfish when fishing for popular sportfish; however, the majority of supplies are harvested from the wild making them inconsistent and unable to meet the demands that arise in late summer and fall. This study serves to determine the influence of incubation temperature and salinity on egg-yolk utilization upon hatch. Temperatures were maintained at 20, 22, 24, 26, and 28°C using incubation chambers. Incubation trays filled with 3-cm of water were maintained at salinity concentrations of 5g/L and 10g/L. Newly fertilized eggs were placed in the trays and checked daily for the presence of newly hatched larvae. Each individual was placed on their sagittal axis in a propylene glycol solution and photographed with a digital camera mounted on a dissecting microscope. Each image was analyzed by image analysis software to determine measurements of critical aspects of survival at first feeding and beyond, such as: body length, body depth at vent and yolk area. Higher temperatures are anticipated to produce larvae with the lowest incubation time and greatest yolk volume. However, if the larvae are not developed enough, i.e. smaller mouth gape, a faster hatch time may not be beneficial to

the larva. These data will support later investigations of development in this species to better facilitate larval rearing strategies.

Oyster spat (*Crassostrea virginica*) settle at different penetration depths and cultch types in aerated and non-aerated treatments

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The objective of this study was to test cultch type (whole oyster shell, crushed oyster shell and limestone) and penetration depth (top, middle and bottom) of oyster spat (*Crassostrea virginica*) settlement in aerated and non-aerated treatments. Approximately 350,000 larvae from the same hatchery-reared brood were added to two aerated and two non-aerated containers each with three cultch types seven inches deep. After 96-hrs, volumetrically equal samples (180 ml water displacement) of each cultch type were collected at each depth, placed in labeled bags and subsequently examined for spat set with a dissecting scope at 10-30x. Aeration had a significant effect on the depth distribution of oyster spat ($F(2,15)=29.12, p<0.0001$). Cultch type had a significant effect on the set of oyster spat ($F(2,15)=23.08, p<0.0001$). This study showed that oyster spat set more evenly across cultch depth in aerated treatments compared to non-aerated treatments. Spat settlement decreases with depth in non-aerated treatments. In aerated treatments, spat set mostly mid-depth for whole and crushed oyster shell and mostly on the bottom for limestone. Overall, spat set on limestone the least and whole oyster shell the most. These results serve useful applications in the remote setting of oyster larvae on alternative cultch.

High-throughput cryopreservation for fish and shellfish

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With the adoption of existing commercial mammalian technology, high-throughput cryopreservation is possible in aquatic species. As a first step, our goal was to adapt an automated system developed for livestock and humans for use in fish and shellfish. Our objectives were to: 1) compare existing and high-throughput fish procedures; 2) compare requirements of both procedures; 3) determine cooling and heating characteristics for different types of containers (straws). For high-throughput application, an automated process is needed for loading and printing of straws. We chose a system (MAPI) produced by Cryo Bio System (CBS) (<http://www.cryobiosystem-imv.com/>) that can fill, seal, and label about 11 straws per minute, and provides high biosecurity and quality control. The existing procedures of fish sperm cryopreservation use French straws which are available in 0.5-ml and 0.25-ml volumes. The MAPI uses CBS straws (0.5-ml and 0.3-ml) which are more flexible and stronger. In addition, the CBS straws have a white identification jacket, which affects the thermal characteristics. Under standard conditions in a computer-controlled freezer (Micro Digitcool UE 300, IMV, International), the CBS straws cooled more slowly than did French straws. Using a water bath and recording with a four-channel datalogger (HH147, Omega, Stamford, CT), we found that CBS straws required a longer thawing time than did French straws. With the use of this automated technology, we are cryopreserving species including catfish, flounder, crab, salmon, and zebrafish. Once established, this approach can also be of great value for genetic resource conservation of endangered species.

Application of ultrasound imaging to gonad assessment of channel catfish

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Ultrasound technology provides non-invasive visualization of reproductive processes for fisheries management and endangered fish populations. Channel catfish *Ictalurus punctatus* provides a useful model to evaluate ultrasound for broodstock management relevant to natural and induced spawning. Gonads of female channel catfish were assessed using ultrasound in Louisiana (LA) and Arkansas (AR) at sites located about 310 km apart. The objectives were to: 1) compare developmental stages of oocytes and corresponding gonads at both sites; 2) compare ambient water temperature profiles at both sites, and

3) evaluate induced spawning of females in Arkansas. Mature females (2.3 ± 0.5 kg) were transported to Louisiana from Arkansas in November, 2007, to advance gonadal development. In April, ovaries gonads were assessed by ultrasound imaging and visual inspection of secondary sexual characteristics. Gonad development was classified as: undeveloped (Stage 1); underdeveloped (Stage 2); developing (Stage 3); advanced (Stage 4); mature (Stage 5); and atretic (Stage 6). Gonad stage was significantly dependent ($P < 0.05$) on location. Ponds in LA (0.3-ha) reached the average daily temperature threshold (21°C) for gonadal recrudescence 26 days earlier than did AR ponds (2.6-ha). Gonads of 444 LA females (53%) were stages 4 and 5; $61 \pm 18\%$ spawned. Neurulation of egg masses at 28 to 30 h ($n = 180$; 300 to 400 ml eggs/mass) was $33 \pm 22\%$. Gonads of 129 AR females (11%) were Stages 4 and 5; 82 females were selected for induced spawning, and 50% spawned. Neurulation of egg masses ($n = 33$) was $30 \pm 16\%$.

Environmental influences on sperm motility activation in the estuarine fish *Fundulus grandis*

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Sperm motility in externally fertilizing fishes typically responds to the levels of specific ions and the difference in osmotic pressure between the surrounding water and the body tissues. Accordingly, the sperm of marine fish are activated by an increase in osmotic pressure, and those of freshwater species by a decrease. These stenohaline species exist in relatively stable environments, however, euryhaline fishes are exposed to wide salinity ranges, often resulting in external osmotic pressures that include those of the body (isotonic). To assess the ability of *F. grandis* sperm to adapt to changes in salinity, groups of five adult males were acclimated to salinities of 0, 5, 10, 20, 35, or 50 ppt and held for 30 days. Testes were dissected and sperm were activated with different osmolalities of Hanks' balanced salt solution (HBSS) and calcium-free HBSS (Ca-F HBSS). The osmolality eliciting the highest motility activation was significantly different ($P < 0.01$) among acclimated groups. It was evident that calcium or other ions played a role in motility which peaked after 30 sec exposure to HBSS, and decreased over 10 min. Motility exhibited a similar initial pattern when exposed to Ca-F HBSS. However, sperm gained motility at lower osmolalities over 10 min, exhibiting multiple peaks. These data indicate that attention must be given to the environment from which estuarine fish are removed at the time of sample collection. This has implications for activation and use of sperm samples, and may help explain contradictory findings dealing with reproduction in estuarine species.

Anadromous Fish Symposium

J.J. Isely, coordinator

Anadromous fish passage and population dynamics at Jim Woodruff Dam on the Apalachicola River, FL

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Jim Woodruff Lock and Dam on the Apalachicola River, Florida, USA, represents the first barrier to migration of anadromous fishes migrating from the Gulf of Mexico. As no dedicated fish passage structure exists, normal lock operation serves as the only means of fish passage. In this study, we use a combination of sonic telemetry and standard mark recapture techniques to evaluate passage efficiency and behavior during passage of Alabama shad and Gulf striped bass, both species of concern in the region. Over the course of the study, 17 – 53% of fish study fish passed. Transmitted fish aggregated during lock operation and passed within 45 minutes of gate opening. Fish exhibited directional movement against the current, but moved randomly during periods of no or non-directional flow. We conclude that we are able to track and document passage, that the lock can be an effective means of fish passage, and that addition of directional flow may provide cues that will enhance fish passage. The low abundance of migratory fishes continues to be of concern to managers.

Gulf sturgeon spawning habitat investigation on the Pearl River, Louisiana

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At present little is known about the Gulf Sturgeon's spawning habitats in Louisiana coastal rivers. The identification and characterization of essential spawning habitat for Gulf Sturgeon is a priority action item addressed in the Gulf Sturgeon Recovery/Management Plan. The low head sills on the Pearl and Bogue Chitto Rivers block spawning migration routes for the Gulf sturgeon and several other fish species. Telemetry tagged sturgeon migrated to the Bogue Chitto sill, but did not pass. Despite much effort, no evidence of spawning was observed in the area. In a proposed study, Gulf sturgeon will be captured and transported above the Bogue Chitto Sill. These fish would be tracked to potential spawning sites located above.

Gulf sturgeon activity patterns in Pensacola Bay, Florida

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Fifty-eight Gulf sturgeon *Acipenser oxyrinchus desotoi* were tagged with ultrasonic transmitters and released within tributaries of Pensacola Bay in June – October 2005. Study fish were monitored by underwater acoustic receivers stationed throughout the bay from October 2005 through June 2006 (study period 1) and from September 2006 through August 2007 (study period 2). We tested the hypothesis that there was no difference in activity of Gulf sturgeon between seasons and times of day. We determined that sturgeon were most active in morning hours and at night. Sturgeon were also more active in spring and fall. In general, study fish moved <1 km per day, but were capable of movements in excess of 10 km/d during migratory seasons. We found no relationship between sturgeon movement and depth. However, mean continuous detection time at an individual receiver was positively correlated with depth.

Anadromous fish restoration efforts in South Carolina Rivers

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Few fish passage facilities exist in the Southeastern US. In South Carolina, Federal, State and private organizations are collaborating to enhance existing opportunities and to create new passage facilities. On the Savannah River, a facility has been proposed for passage at New Savannah Bluff Lock and Dam, the first barrier to migration. On the Santee-Cooper system, existing facilities at St. Stevens Dam are being enhanced. At Wateree Dam, fish passage is being installed. At Columbia Diversion Dam, a vertical slot fishway has been installed. Efforts are underway to initiate additional passage facilities and research the effectiveness of passage structures is being assessed.

Recruitment Dynamics of Atlantic Sturgeon in the Altamaha River, Georgia

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Recent studies of Atlantic sturgeon spawning runs in the Altamaha River, Georgia, have documented annual run sizes of approximately 200-400 adults. While these studies suggest that the population has recovered significantly since the 1996 Federal closure of the US Atlantic sturgeon fishery, little is known about recruitment mechanisms for this species. The objectives of this study were to (1) estimate annual abundance (cohort size) of juvenile Atlantic sturgeon in the Altamaha River and (2) identify likely environmental factors affecting annual survival and timing of outmigration. From June to July, 2004-2007, we used variable mesh entanglement gear to sample juvenile Atlantic sturgeon throughout the tidally influenced portion of the Altamaha Estuary. Using program MARK, we developed M-strata, Robust Design, and Pradel models to estimate various demographic parameters of the juvenile population, including annual cohort sizes, survival, and out-migration. Although these parameters were variable among years, we found that age-1 and age-2 juveniles were consistently more abundant than older juveniles, suggesting that peak out-migration probably occurs during the 2nd or 3rd year of life. We also documented an unusually strong year class in 2005; however, causal mechanisms and biological significance were difficult to evaluate in the absence of historical recruitment data or comparable studies in other southeastern rivers. Nonetheless, our results confirmed previous studies that suggest that the Altamaha population of Atlantic sturgeon has recovered significantly during the past decade.

Critical habitat for southern flounder, *Paralichthys lethostigma*: Do coastal rivers play an important role in life history and growth?

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The North Carolina Division of Marine Fisheries (NCDMF) highlighted the importance of protecting and improving critical fish habitat for southern flounder in the 2005 North Carolina Southern Flounder Fishery Management Plan (FMP). The goal of the FMP is to increase overall growth, survival, and reproductive success for this species. One of the goals of this study was to use fishery-independent sampling to evaluate critical habitat for southern flounder in freshwater, oligohaline, and mesohaline environments. From September 2007 to November 2008, southern flounder were collected from the lower Tar River by electrofishing. Twenty-four southern flounder were collected from freshwater habitat with a size structure that ranged in length from 197 to 447 mm TL (mean = 297.1 mm TL; SD = 73.6). The oligohaline and mesohaline habitats were sampled from May 2008 to November 2008 using experimental and commercial gill nets in Pamlico River ($n = 339$) and Pamlico Sound ($n = 441$). The size structure of the fish harvested from the Pamlico River ranged in length from 206 to 465 mm TL (mean = 331.0 mm TL; SD = 60.1). And fish harvested from the Pamlico Sound ranged in length from 213 to 525 mm TL (mean = 351.5 mm TL; SD = 42.3). Fish from the various habitat types were compared for condition factors (Fulton's K Factor), length:weight relationships, length:age relationships, gonadosomatic index (GSI), and liversomatic index (LSI). This comparison will help determine the importance and potential of freshwater habitat for southern flounder in the Tar-Pamlico River system.

Spawning activity and migratory characteristics of American shad and striped bass in the Cape Fear River, NC

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Anadromous fish populations within the Cape Fear River, NC have experienced declines since the late 1800s. Three low-head lock and dam structures contributed to this decline by limiting access to upstream habitat. We used 2008 egg and larval fish sampling and sonic telemetry to characterize patterns of migration and spawning activity for American shad and striped bass. Plankton samples were taken below each lock and dam, and at two locations further upstream. Distribution of American shad eggs and observed spawning activity suggest that most American shad spawning took place below the lowermost lock and dam (rkm 97). Collected eggs decreased by an estimated 80% for each successive dam. Twenty American shad and 20 striped bass were tagged and released downstream of the lowermost lock and dam. Telemetry results show 65% of both species made upstream movements past the lowermost lock and dam. Furthermore, 46% of American shad and 23% of striped bass that made upstream movements were able to migrate upstream of the uppermost lock and dam (rkm 186). Egg collection results indicate spawning activity of American shad is greatest in areas below the dams, while telemetry data shows usage of upstream habitat by both species

Movements of juvenile striped bass *Morone saxatilis* between habitats in Albemarle Sound, NC inferred from otolith and water chemistry.

Mohan, J.A.* and Rulifson, R.A. *East Carolina University, Department of Biology and Institute for Coastal Science and Policy, Greenville, NC.*

The juvenile striped bass population of Albemarle Sound, North Carolina has been monitored for over five decades. The NC Division of Marine Fisheries established their Juvenile Abundance Index (JAI) using otter trawls at permanent sampling locations. The JAI displays a pattern of high young-of-year striped bass densities occurring in low salinity habitats of the open sound. Lower densities are found in the tributary river habitats, where salinities tend to be higher and anthropogenic pollution is concentrated. Fish residing in habitats with unique multi-elemental water chemistries develop distinctive multi-elemental "signatures" in the otoliths, which can be used to infer specific habitat utilization. Young-of-year otoliths provide information on age and growth through discrete daily ring formations and movement by trace element analysis across increments - spatial changes in otolith chemistry reflect chronological changes in habitat use. However, closer examination into the correlative relationship between otolith chemistry, water chemistry, and rates of elemental incorporation are rarely partaken in otolith element studies. We employed a broad water-sampling regime from July to November 2008 to explore the spatial and temporal stability of habitat-specific dissolved elemental concentrations of water using inductively coupled plasma optical emission spectrometry. Preliminary results indicate considerable differences between habitats for Sr, Mg, and Ca concentrations, which are highly correlated to salinity ($R^2 = 0.98$). We hypothesize that fish collected from distinct river habitats will display unique chemical otolith signatures. Information on growth and habitat utilization is useful to assess and identify Strategic Habitat Areas in Albemarle Sound.

Effect of zooplankton density on growth of larval American shad *Alosa sapidissima*: An experimental approach

Riley*, K.L., Binion, S.M., Williams, T.T., and A.S. Overton, *East Carolina University*

Widespread declines in stocks of American shad *Alosa sapidissima* along the Atlantic Coast have been attributed to overfishing, decrease in water quality, and loss of habitat. Recent surveys in North Carolina suggest that stocks are continuing to decline despite extensive management and stock enhancement efforts. The goal of this study was to conduct laboratory trials to evaluate the effect of prey density on growth and survival of American shad. Larvae were reared from 12 to 20-d posthatch in five treatments:

(1) starvation; (2) low-prey, which simulated prey densities in Roanoke River; (3) medium-prey, which simulated prey densities in adjacent riverine systems; (4) high-prey, and (5) *Artemia* nauplii. Zooplankton collected from local waters were used as prey. Larval survival was $35 \pm 7\%$ and was not significantly different among treatments. The highest survival was observed with fish fed high concentrations of prey ($46 \pm 18\%$) followed by *Artemia* ($40 \pm 16\%$). The lowest survival was observed with starved fish ($22 \pm 12\%$). Length-specific growth rates determined from total length measurements were 0.069 for *Artemia*, 0.056 for high-prey, 0.029 for medium-prey, 0.017 for low-prey, and 0.009 for starved treatments. Larval growth as a function of length was not significantly different between *Artemia* and high-prey; however, these treatments were significantly higher than the lower prey densities (ANOVA; $P < 0.0001$). Weight-specific growth rates (G_w) determined from dry weight measurements were significantly higher for *Artemia* ($G_w = 0.851$; $P < 0.0001$) and remained relatively low for all other treatments ($G_w = 0.617$). Evidence from this research shows that zooplankton densities common to Roanoke River and Albemarle Sound are not optimal for growth of American shad. Releases of hatchery-reared fish should be timed to coincide with peaks in zooplankton production.

Larval collection and observed movements of telemetered bigmouth sleeper *Gobiomorus dormitor* in Puerto Rico

Adelsberger*, C.M. University of Arkansas at Pine Bluff, Neal, J.W. Mississippi State, and S.E. Lochmann, University of Arkansas at Pine Bluff

In general, there is little published information about tropical freshwater larval fishes. However, there is a growing interest in conserving and enhancing native freshwater fisheries in tropical regions worldwide. Effective management and culture for stock enhancement requires a thorough understanding of life history. In Puerto Rico, the bigmouth sleeper *Gobiomorus dormitor* is found in rivers and reservoirs, targeted by anglers, and is a candidate for culture and management. The life history requirements of bigmouth sleeper are uncertain, so conditions for culture are unknown. This study examined spawning location and migration using larval sampling and radio telemetry. Larval sampling was conducted during the presumed spawning season in 2007 for 24-hour periods in two river mouths. In summer 2008, larvae were sampled for 12-hour periods in one river at four locations (river mouth, 3 km, 6 km, and 9 km upstream). Radio tagged bigmouth sleepers were released in January 2008, and monitored from February to November. Bigmouth sleeper larvae were caught at the surface and bottom in drift nets and light traps. Bigmouth sleeper larvae appeared only in river mouth samples, and no fish larvae were caught upstream of the river mouth. Observed movement of adult bigmouth sleeper suggested that some fish migrated to the river mouth, and at least one left the river system, returning several months later. It is unclear whether these movements were directly related to spawning activity, but it was apparent that larval bigmouth sleeper likely spend some period in high salinity water to complete its life cycle.

Contributed Papers: Presenters noted with *. Students are in bold.

Saturday, January 17th

Oak Alley/Madewood Suite 10:00-Noon

Black Bass Contributed Papers

Assessment of catch and exploitation of largemouth bass *Micropterus salmoides* in the lower Arkansas River

*Fontaine**, **B.V.**, Eggleton, M.A., University of Arkansas at Pine Bluff, Aquaculture/Fisheries Center, and C.P. Hutt, Mississippi State University, Department of Wildlife and Fisheries

Historically, limited information has been available for largemouth bass *Micropterus salmoides* populations in the Arkansas River downstream of Lake Dardanelle. The objectives of this research were to characterize angler effort, catch, and harvest on Arkansas River Pool 4. In September 2007, 845 largemouth bass 330-mm total length and greater were collected, tagged, and released for a tag-rewards study designed to assess largemouth bass exploitation in Arkansas River Pool 4. Concurrently, bus route access-point creel surveys were conducted to generate effort, catch, and harvest statistics, and assess angler satisfaction. After one year (October 2007-September 2008), 624 angler surveys were completed and anglers returned 28.9% of the tags. Following adjustment for angler non-response, tagging-associated mortality, and tag loss, adjusted catch rates of largemouth bass were 70.3% and adjusted exploitation of largemouth bass was 13.8%. Compared to national averages, largemouth bass exploitation was low in Arkansas River Pool 4, as the fishery appeared to be largely catch and release. Conversely, largemouth bass catch rates were greater than national averages. Levels of mortality associated with routine handling of bass by both recreational and tournament anglers are not currently known. However, mortality could be significant under certain conditions at such high catch rates.

Movements, behavior, and habitat use of three species of black bass in the Flint River, Georgia.

*Gocłowski**, **M.R.**, and S.M. Sammons, Department of Fisheries, Auburn University

The Flint River in Georgia supports a unique black bass fishery composed of the endemic shoal bass *Micropterus cataractae*, and the native largemouth bass *M. salmoides*. Recently spotted bass *M. punctulatus* were introduced into this river and have become abundant in certain reaches formerly dominated by shoal bass and largemouth bass. The objective of this study was to obtain information on the movements, habitat use, and behaviors of the three species within the system to aid biologists in making decisions about how to manage the fishery. Thirteen shoal bass, ten largemouth bass, and six spotted bass were implanted with radio transmitters in the Flint River and tracked approximately every 14-d from January 2008 to December 2008. Daily movement of all three species was greater in the spring than in all other seasons. Largemouth bass exhibited greater daily movement than spotted bass. No differences in daily movement were evident between largemouth bass and shoal bass or between shoal bass and spotted bass. Diel movement was significantly greater in spring than in summer and winter for all three species, but did not vary among species. Temperature, time of day, and discharge were all correlated with diel movements. Woody debris was used as cover in 95% of all largemouth bass locations, 79% of all spotted bass locations, and 37% of all shoal bass locations. Rock was used as cover in 41% of all shoal bass locations, 8% of all spotted bass locations, and 2% of largemouth bass locations.

Supplemental stocking of fingerling largemouth bass in the tidal Chickahominy River system: Looks like it worked, now what?

Greenlee, R. S. Virginia Department of Game and Inland Fisheries (VDGIF)*

Largemouth bass (*Micropterus salmoides*) populations in many of Virginia's tidal river systems experienced recurrent poor recruitment during a period of prolonged drought (late 1990's – 2002). If supplemental stocking were found to be effective in tidal systems, fisheries managers would have a mechanism for augmenting weak year-classes during periods of poor natural recruitment – resulting in more stable bass fisheries in these highly dynamic systems. The efficacy of supplemental stocking over existing largemouth populations in large, complex, open systems has not been determined. To assess the viability of supplemental stocking in Virginia's tidal river systems, oxytetracycline (OTC) marked F1 hybrid (Florida X northern) fingerling largemouth bass were stocked at a rate of 62 fish/ha in the tidal Chickahominy system (1,856 ha) each year from 2005 through 2007, with assessments to occur at 5, 11, 17, and 29 months post-stocking. While issues related to fish condition, stocking methodology, and environmental conditions likely lead to poor survival of stocked fingerlings in 2005 (at 5 months post-stocking, OTC-marked fish accounted for just 8.2% of the year-class), the 2006 and 2007 stockings were successful, at least in terms of relative abundance and contribution to year class of stocked fish. At 17 months post-stocking, stocked fish accounted for 73.7% of the 2006 year-class sampled, and boat electrofishing catch per effort was 23 fish/hr for 2006 OTC-marked fish. OTC-marked fish accounted for 65.8% of the 2007 YOY collected at 5 months post-stocking, and 50% of the year-class at 11 months post-stocking.

Effects of closed seasons or areas on fish reproduction: an example using nest building largemouth bass *Micropterus salmoides*

*Gwinn, D.C. *, and M.S. Allen, The University of Florida*

We used an age-structured model to evaluate the impacts of recreational angling during spawning on largemouth bass *Micropterus salmoides* populations and the effects of temporal/spatial closures as potential management strategies. We manipulated the proportion of the annual catch that occurs on spawning fish to mimic the effects of seasonal/spatial closures during the spawning season. A range of exploitation rates and two minimum length limits common in black bass fisheries (355 mm and 457 mm) were used. We simulated two hypothetical populations; a high productive low-latitude largemouth bass population (HPP) and a low productive high-latitude largemouth bass population (LPP). Simulated temporal/spatial closures during the spawning season had minimal impacts on recruitment to age-1. Harvest had a much stronger impact on all population metrics than reductions in fecundity via catch and release fishing during the spawning season. We found no substantial difference between the effects of recreational fishing and harvest during the spawning season between the HPP and the LPP, suggesting that our results were robust to life history characteristics.

The effects of stocking hatchery reared largemouth bass on the 2007 year class of wild largemouth bass in backwaters of the Arkansas River

Horne, J.R., and S.E. Lochmann, Aquaculture/Fisheries Center, University of Arkansas at Pine Bluff

The effects of stocking largemouth bass have been studied in detail for reservoirs, but little research has been conducted on rivers. In fall 2007, Jolly-Seber mark-recapture studies were conducted to estimate abundance of wild age-0 largemouth bass in 10 backwaters of the Arkansas River. Hatchery-reared largemouth bass were stocked at 60 fish/ha into five backwaters after the Jolly-Seber study. In fall 2008, Jolly-Seber mark-recapture studies were conducted to estimate abundance of wild age-1 largemouth bass. At stocking, there were no differences in weight ($T=-0.32$, $df=8$, $P=0.76$), length ($T=0.46$, $df=8$, $P=0.66$), or condition ($T=-0.62$, $df=8$, $P=0.56$) of wild age-0 and hatchery-reared largemouth bass. Daily instantaneous mortality rates for wild largemouth bass in stocked backwaters ranged 0.0006 to 0.0066 with an average (SD) of 0.0048 (0.0036). Mortality rates in unstocked backwaters ranged from 0.0004 to 0.0100 with an average of 0.0051 (0.0048). No significant difference was found between daily instantaneous mortality rates from stocked and unstocked backwaters ($T=-0.08$, $df=7$, $P=0.94$). There was no significant difference in relative weight ($T=0.62$, $df=7$, $P=0.55$) or growth ($T=0.06$, $df=7$, $P=0.95$) between wild age-1 largemouth bass from stocked and unstocked backwaters. In this case, stocking hatchery-reared largemouth bass did not appear to affect the wild year class.

Effects of a water level drawdown and muck removal on the largemouth bass population at Lake Tohopekaliga, Florida

O'Rourke, P. M. and M.S. Allen, University of Florida,*

Human-facilitated drawdowns are a tool used by managers of lakes and reservoirs to counter habitat loss and improve recruitment of sport fishes. Drawdowns along with muck removal have been implemented to improve fish habitat at Lakes Tohopekaliga and Kissimmee in the Kissimmee Chain of Lakes (KCOL), Florida. We analyzed electrofishing, angler survey, plant survey and water level records from 1983-2007 to explore the effects of a drawdown at Lake Tohopekaliga in 2004 and compare them to previously-studied drawdowns at Tohopekaliga in 1987 and Kissimmee in 1995-1996. Previous authors suggested that these drawdowns resulted in some short-term benefits to largemouth bass (LMB) fisheries, such as increased mean total length (TL) of age-1 LMB. However, we found no significant differences in mean age-1 TL, mean age-1 electrofishing catch per hour (CPH), mean total electrofishing CPH or angler CPH of LMB following the 2004 drawdown at Lake Tohopekaliga. Effects of hurricanes in 2004 could have confounded our results at Lake Tohopekaliga. However, our summary of these large lake drawdowns at the KCOL suggest that benefits to largemouth bass populations will be short lived at best, and negligible at worst. Drawdown and muck removal projects prohibit expansion of dense plants, and thus may prevent large-scale habitat loss that could occur over decades. However, short-term benefits to largemouth bass fisheries should not be an expected outcome of these efforts.

Oak Alley/Madewood Suite 1:00-2:40 PM

Fisheries Management Contributed Papers 1

Does venting promote survival of released fish?

Wilde, G. R. Texas Tech University

Fishes captured and brought to the surface by commercial and recreational fishers may suffer a variety of injuries that collectively are referred to as barotrauma. To relieve barotrauma symptoms, particularly those associated with an expanded swim bladder, some anglers deflate, or vent, the swim bladder of fishes before releasing them. I compiled 17 studies that assessed the potential benefits of venting swim bladders in 21 fish species and one composite group. These studies provided 39 sample estimates that compare survival ($N = 18$) and recapture rates ($N = 21$) of vented and unvented fish. I used relative risk to summarize results of individual studies, which allowed me to combine results from experimental and capture-recapture studies. Overall, there was very little evidence that venting benefited fish survival. Venting was equally ineffective for freshwater and marine fishes and its efficacy was unaffected based on whether venting was performed by fishery biologists or anglers. The effects of venting did vary with capture depth: venting was slightly beneficial to fish captured from shallow waters, but was increasingly harmful for fish captured from progressively deeper waters. The available evidence suggests that venting fish should not only be discouraged by fishery management agencies, but given the possibility that venting adversely affects survival of released fish, this practice should be prohibited, rather than required by regulation.

Stock assessment of flathead catfish in two Mississippi rivers following Hurricane Katrina

Barabe, R.M., and D. Jackson, Mississippi State University*

Although the age and growth of flathead catfish *Pylodictis olivaris* has been studied in North America, no pre- or post-hurricane stock assessments have been documented for the Pascagoula and Tchoutacabouffa rivers in southeast Mississippi. We quantified individual growth rates and age structure for flathead catfish populations in both rivers following the passage of Hurricane Katrina. Low frequency,

pulsed DC electrofishing was used from May through July 2007 and 2008 for fish collection. Sectioned pectoral spines were used to determine ages and back-calculate growth rates. The age structure of flathead catfish in the Pascagoula River was dominated by fish age 4 or less (99% in 2007, 96% in 2008), while the age structure in the Tchoutacabouffa River exhibited a lower percentage of individuals age 4 or less (72% in 2007, 56% in 2008). Similar differences are present in the average back-calculated length-at-age data. The growth rate in the Pascagoula River was similar to growth rates reported in a past study for the Big Blue River in Kansas, where the flathead catfish is native. Growth rates for the Tchoutacabouffa River are similar to those reported in the literature for the Northeast Cape Fear River, North Carolina, where the flathead catfish is non-native and faster growth rates have been documented. Changes in age the structure and growth rate of flathead catfish after the passage of a hurricane could be indicative of the need for different management strategies immediately following landfall of a hurricane.

Testing of bubble plume diffusers installed at Broken Bow Reservoir to reduce temperatures for trout in Mountain Fork River, Oklahoma.

Balkenbush, P. E. Oklahoma Department of Wildlife Conservation, Mobley, M. H., Mobley Engineering, and G.L Hauser, Loginetics, Inc.*

The lower Mountain Fork River below Broken Bow Reservoir (BBR), Oklahoma supports a year-round trout fishery. Seasonal heating of the stream limits potential of the trout population and angler success. Oklahoma Department of Wildlife Conservation has teamed with Loginetics, Inc. and Mobley Engineering, Inc. to address this issue. Early efforts showed no reasonable strategies for operation of BBR outlets that would reduce tailrace temperatures. However, selective cold water withdrawal was identified as a potential solution that should be evaluated. Bubble plume diffusers are designed to move cold water up from the bottom of stratified reservoirs where it can be entrained in outflow currents. Three such diffusers were installed and tested at BBR in July 2007. Diffuser effectiveness was monitored with temperature recorders and manual profiles. These data were then applied to a model for assessment of system potential over a longer run time. The diffusers produced dramatic upwelling plumes, raised a large quantity of cold water, increased metalimnetic dissolved oxygen and caused local mixing. Tailrace temperature reductions were not realized after 10 test days. Subsequent modeling suggests cooling would occur after about one month of continuous system operations. The diffuser system at BBR remains an inexpensive option for reducing outflow temperatures if it can be made to work. Exhaustive field exploration of system potential will occur if additional modeling of test data verifies initial predictions showing release temperature reductions after a longer operational period.

Assessment of striped bass in the Arkansas River through Tulsa County using ultrasonic telemetry

*Whisenhunt, C. *, and B.Gordon, ODWC*

As part of the Tulsa County Vision 2025 economic development plan, the Arkansas River Corridor Master Plan involves the construction of a series of low water dams along a 42 mile stretch of the Arkansas River through Tulsa County. An important resource to the sport fishery in this area and to the Oklahoma Department Wildlife Conservation is the striped bass (*Morone Saxatilis*). Little is known of the actual immigration/emigration patterns of this fish within this stretch. Construction of such dams will interfere with the reproduction, movement and collection of the striped bass. Ultrasonic telemetry is currently being conducted to monitor these immigration/emigration patterns. Ultrasonic transmitters were surgically implanted into the stomach cavity of 32 striped bass in the early springs of 2006 and 2007. A total of sixteen were collected, tagged and released below Keystone Dam. A total of sixteen were collected, tagged and released below Zink Dam. Eight submersible ultrasonic receivers are being monitored for fish passage from Keystone Dam to the Tulsa/Wagoner County line, while a directional ultrasonic hydrophone is being used to manually locate fish between receivers. Dates, times, locations, and water quality data are being recorded upon successful location of fish. Monitoring will continue through March 2009.

Movement of blue catfish in Wilson Reservoir, Alabama

Hunter, R.W., Marshall, M.D. and M.J. Maceina, Department of Fisheries, Auburn University*

Twelve large (> 6 kg) blue catfish *Ictalurus furcatus* were collected and fitted with one-year radio transmitters, just below Wheeler Dam in Lake Wilson, Alabama, in April-May 2007. In addition, 1,709 blue catfish (>300 mm) were captured and tagged with Carlin dangler tags from October 2004 to August 2007 and information on angler tag returns were used to describe movement of blue catfish. Radio-tagged blue catfish were tracked over an 11 month period; 10 fish survived for at least 90 days. Four of these fish remained in the area where they were tagged for the entire 11 months of tracking. Very little movement was observed for these fish during weekly and 24-hour tracking events. Six fish moved away from the Wheeler Dam tailrace. Of these, four fish moved down river and likely inhabited depths beyond the effective range of our radio telemetry equipment. One radio tagged catfish emigrated downstream from Wilson Reservoir into Pickwick Reservoir. Ninety percent of Carlin dangler tags returned by anglers came from fish captured within 8 km of Wheeler Dam, in the same area where they were tagged. Ten percent of tag returns came from fish captured in downstream portions of the reservoir (>8 km from Wheeler Dam) and one tag was returned from nearly 1,000 km away in the Mississippi River. Thus, although some blue catfish in Wilson Reservoir made long migrations, a substantial proportion of the population was sedentary and moved very little throughout the year.

South Ballroom 2:00-2:40 PM

Coastal Ecology Contributed Papers 1

Regional patterns of juvenile reef-fish recruitment to high-salinity seagrass habitat along the Gulf coast of Florida

Switzer, T.S. and S.F. Keenan, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute*

Reef fishes support extensive commercial and recreational fisheries throughout much of the west Florida shelf. Many reef fishes are broadly-distributed, occupying estuaries as juveniles before undergoing ontogenetic migrations to nearshore reef habitat as sub-adults. Recent reviews of reef-fish assessments have repeatedly highlighted the need for increased fisheries-independent surveys of reef fish resources, especially for juvenile reef fishes immediately prior to emigrating from estuarine nurseries. As an initial step towards the development of a long-term monitoring survey, we conducted exploratory seine and trawl surveys in five estuarine systems (St. Andrews Bay, Apalachicola Bay, the Big Bend, Tampa Bay, and Charlotte Harbor) in 2008 to examine patterns of recruitment and habitat use by juvenile reef fishes throughout the Gulf coast of Florida. Several managed reef fishes were frequently collected in these surveys, including gag, *Mycteroperca microlepis*, red grouper, *Epinephelus morio*, black sea bass, *Centropristis striata*, hogfish, *Lachnolaimus maximus*, gray snapper, *Lutjanus griseus*, and lane snapper, *L. synagris*. Although juvenile reef fishes varied somewhat with respect to overall habitat preferences, most taxa were substantially more abundant over shallow, polyhaline seagrass beds. Reef fish abundances were highest from July – October, although minor latitudinal differences in the timing of recruitment and emigration from estuarine nurseries were evident. Results from these preliminary surveys will be discussed in the context of developing and implementing a broad-scale monitoring program in support of the assessment and management of reef fishes on the west Florida shelf.

Evaluation of bycatch reduction devices in the Gulf of Mexico shrimp fishery

Parsons, G.R., Foster, D.G, and M. Gaylord, University of Mississippi

Bycatch in the Gulf of Mexico, shrimp trawl fishery may be contributing to declining stocks of commercially important species. The red snapper, *Lutjanus campechanus* has undergone significant reductions in stock. Mortality of juvenile red snapper in the shrimp trawl fishery has been estimated at 25 to 45 million per year. In this study, we investigated the behavior of red snapper in the laboratory and then attempted to apply these data to develop a more effective bycatch reduction device (BRD) for use in the shrimp trawl fishery. We discovered four snapper behaviors that were considered for BRD application: 1. response to altered flow 2. negative phototaxis response after dark adaptation 3. the optomotor response and 4. refuging behavior. We field tested various devices south of Pascagoula, MS on a working shrimp vessel (M/V Simple Man) in the northern Gulf of Mexico. Using paired trawling, we evaluated BRD's for shrimp retention, total bycatch reduction and red snapper bycatch reduction. The behaviors that were found to be most useful in BRD design were response to altered flow and negative phototaxis. We designed the Nested Cylinder Bycatch Reduction Device (NCBRD) that exploits altered flow to direct fish to an escape opening in the trawl. Depending upon BRD configuration, this device was found to provide approximately 40 to 55% total bycatch reduction, whereas shrimp retention ranged from about 84 to 94%. Illumination of the BRD during testing was found to increase red snapper bycatch reduction from about 13% to 42%.

South Ballroom 3:00-5:00 PM

Stream Ecology Contributed Papers 1

Fish assemblage structure and associations with environmental conditions in a Texas spring-fed river

Kollaus, K.A. and T.H. Bonner, Department of Biology/Aquatic Station Texas State University

Numerous spring systems in the Edwards Plateau and Trans-Pecos regions of Texas support two distinct fish assemblages, spring-associated fishes and riverine fishes. Spring-endemic fishes are often concentrated near the spring source and rarely in the mainstem, whereas riverine fishes are common in the mainstream and absent or in low abundance near spring sources. Among environmental factors, constant water temperature is commonly recognized as the segregating factor, but these conclusions are based on data collected from assemblages that lacked adequate controls and independent treatment of temperature to distinguish whether temperature was the cause for segregation. Here we address the influence of water temperature, among other environmental conditions, on spatiotemporal patterns in fish occurrence and abundance along the Devils River, Texas. Multiple spring sources along a 64 km course of the Devils River allow an opportunity to test the influence of temperature on spatiotemporal patterns in spring fish occurrence and abundance. Seasonal transect sampling was used to gather fish assemblage and environmental data at four longitudinally arranged sites. Analysis of similarities (ANOSIM) was used to detect assemblage similarities among sites and canonical correspondence analysis (CCA) used to assess fish and habitat associations across sites and time. Occurrence and abundance of some spring-associated taxa (e.g., *A. mexicanus*, *D. argentosa*) were correlated with water temperature; however, others that were previously described as spring-associated taxa (e.g., *D. diaboli*, *E. grahami*) were not. Consequently, unregulated anthropogenic groundwater usage may result in diminishing abundances of some spring-associated taxa.

Ichthyofaunal responses to hydrologic variation in a lotic system: A long-term, assemblage and species scale approach

Perkin, J.S., and T.H. Bonner, T.H. Department of Biology/Aquatic Station, Texas State University*

Riverine flow regimes are naturally dynamic systems that become less variable with anthropogenic flow alterations. Loss of dynamism disrupts naturally occurring structuring mechanisms within the associated biotic communities, causing shifts in composition. Here we consider how stream fish communities in two Central Texas rivers changed after alteration of flow regime by either construction of a mainstem, deep

storage reservoir or flood-retarding structures. We used Indicators of hydrologic alteration (IHA) and daily flow data to assess changes in flow for the mainstem Guadalupe River and associated tributary San Marcos River. Historical ichthyofauna data ranging 1938 to 2006 was used to assess changes in species abundance and assemblage composition for each river. Analysis of similarities (ANOSIM) were used to detect assemblage similarities before and after stream regulation, and Joinpoint regression models were used to assess the onset of species decline or increase in abundance. Fish assemblage similarities were significantly different for reaches with reduced frequency of floods, which subsequently related to timing of stream regulation. Specifically, fluvial specialist species reduced in abundance, whereas exotic and habitat generalist species increased in abundance. Our results demonstrated that flood pulses are an important component for structuring stream fish assemblages and naturally occurring (i.e., drought) and artificially induced (i.e., flood control) low flow periods favor invasion by both native and exotic habitat generalist species.

Evaluating effects of physical disturbance on stream benthic macroinvertebrate communities in southeastern Louisiana

Markos, P, Kelso, W. E. and M.D. Kaller, School of Renewable Natural Resources, Louisiana State University Agricultural Center.*

Periodic physical disturbance is a common phenomenon in lotic ecosystems and is known to be important in structuring resident biotic communities. In Louisiana, prior studies have found that disturbances typically associated with stream degradation do not correlate well with macroinvertebrate community structure. However, it is still believed that disturbance plays a role in determining macroinvertebrate community species composition and abundance in these systems. This study evaluates the response of benthic macroinvertebrate communities to streams that differ in physical disturbance, and we hypothesize that physical disturbance is an important determinant of benthic macroinvertebrate community composition in southeastern Louisiana. A physical disturbance gradient has been established among stream sites, based on parameters such as the Pfanckuch stability index, discharge and flow, temperature, woody debris, substrate size and primary productivity. Disturbance gradients were determined through ordination, and will be related to macroinvertebrate community composition with techniques such as MANOVA or logistic regression. Our results will assess the magnitude of physical disturbance impacts on macroinvertebrate communities in Southeastern Louisiana, and will be used to evaluate reference conditions in Lawrence Creek, Bogue Lusa Creek, and Pushepatapa Creek in the Louisiana southeastern plains ecoregion.

Effects of land development on fish assemblages in low order streams of the Bogue Chitto watershed, Louisiana

Ward, B.M., Kelso, W.E., and M.D. Kaller, School of Renewable Natural Resources, Louisiana State University Agricultural Center

Considerable evidence has demonstrated that in-stream habitat is influenced by surrounding land uses. In developing areas such as Washington Parish, LA, it is important to better understand the mechanisms by which land development influences stream habitat. We intend to construct those relationships for 10 Wadeable tributary streams and the main channel of the Bogue Chitto River. We are collecting fishes with seines and electrofishing gear during the summer, winter, spring and fall, in combination with measures of in-stream physical habitat and water chemistry. Using 2001 US Geological Survey Land Use and Land Cover data, we will measure the surrounding watershed land use, and investigate the relative influences of instream habitat and watershed land use on fish community structure in these streams. These analyses will permit assessment of the relationships among land use practices, in-stream habitat, and the species richness and abundance of the resident fish communities.

Effects of road salt on urban fish assemblages

Morgan, R.P., Appalachian Laboratory, University of Maryland Center for Environmental Science

In urban environments, road salt usage is significant to ensure safe winter driving conditions on high traffic volume highways and secondary roads. However, there are often excessive and repetitive applications of road salt, depending on storm severity and frequency. I used the Maryland Biological Stream Survey (MBSS) data base to examine water quality collected during the MBSS Spring Index period and fish assemblage data from the MBSS Summer Index period for the highly urbanized Eastern Piedmont of Maryland. Statistical analyses indicated that there are significant changes in fish assemblages in first, second and third order streams of the Eastern Piedmont, with simpler assemblages (2-3 tolerant fish species) present in streams with high chloride levels. The number of intolerant fish species declines significantly at chloride levels greater than 100 mg/L, along with decreases in fish assemblage diversity and the Maryland Fish Index of Biotic Integrity. Chloride levels during the spring often exceed 150 mg/l, and may underestimate winter levels. Although there is a complex of stressors present in urban systems, road salt is an important stressor to fish assemblages, and needs to be considered in conservation of intolerant Maryland fish species and stream biodiversity.

Vegetative habitat changes in Florida's spring-fed, coastal rivers: consequences for faunal communities

Lauretta, M.V., Pine, W.E., Frazer, T.K., University of Florida, and E. Nagid, Florida Fish and Wildlife Conservation Commission*

Patterns of aquatic vegetation abundance, distribution, and species composition in several spring-fed rivers along the Gulf coast of Florida have changed markedly over the last decade coincident with increased nutrient loading. Of particular concern is the loss of macrophytes and concomitant increase in percent composition of filamentous macroalgae. Invertebrate and fish community monitoring was initiated in the Chassahowitzka and Homosassa Rivers in 2007 to complement an existing long-term water quality and vegetation monitoring program. Macroinvertebrates associated with sediments were sampled with a push core and invertebrates associated with submersed aquatic vegetation were sampled with a fine-mesh, netted ring sampler. Fish abundance, biomass, and species composition were estimated from multiple-pass mark-recapture electrofishing surveys and block-netted seine depletions. Fish diet compositions were examined with gastric lavage and stomach dissection analyses. Invertebrate assemblages associated with submersed aquatic vegetation differed considerably between rivers, while invertebrates assemblages associated with sediments were similar in composition. Freshwater and saltwater fish abundance and biomass estimates were greater in river reaches where submersed aquatic vegetation was most prevalent. Crustaceans were found to be an important food source for invertebrate-feeding fishes in both systems, and substantial differences were observed in the composition of crustaceans consumed between seasons and rivers. Piscivorous freshwater fishes consumed a wide range of freshwater and saltwater prey species; differences in the composition of fish species in diets were also observed between seasons and rivers. Preliminary results suggest that large-scale changes in vegetative habitat may impact faunal assemblages in spring-fed, coastal rivers.

Oak Alley/Madewood Suite 3:00-5:00 PM

Fisheries Management Contributed Papers 2

A profile of anglers utilizing Arkansas' Family and Community Fishing Program

Hutt, C.P., and J.W. Neal, Mississippi State University*

Declines in recreational fishing participation, under-representation of women and minorities among the angling population, and increased urban immigration and sprawl has prompted the development of urban fishing programs. Arkansas Game and Fish Commission (AGFC) initiated their urban fishing program, the Family and Community Fishing Program (FCFP), in 2001. This study sought to develop profiles of anglers living within 5-mile radiuses of ten FCFP ponds located throughout the state of Arkansas. Mail surveys were sent to 5,000 randomly selected anglers living within the study areas, and 1,725 were returned for a 40% response rate when adjusted for non-deliverable surveys. We found that 20% of anglers (N = 352) within these areas utilized FCFP ponds. Anglers fished FCFP ponds an average of 7 times a year, and spent 6 of those trips on the pond they fished most often. The most commonly pursued fish on FCFP ponds were stocked catfish (70%), bream (48%), and stocked trout (46%). FCFP anglers were 28% more likely to have fished with a child in the previous year, and were generally more representative of the area's minority populations than the general angling population within the area. Forty-seven percent of anglers reported being satisfied with their fishing on FCFP ponds.

Angler attitudes, harvest rates, and channel catfish population sizes at Close-to-Home Fishing Program ponds.

Balsman, D.M., and D.E. Shoup, Oklahoma State University*

The Close-to-Home Fishing Program (CTHFP) was developed to provide Oklahoma City metropolitan residents with quality fishing opportunities. We conducted angler interviews using a roving creel survey at three ponds over a two-year period to assess angler demographics, angling interests, and level of satisfaction with the fishery in the CTHFP ponds. Additionally, channel catfish were sampled with tandem hoop nets to estimate population size, size structure, and growth rates. While there was some lake-specific variation in angler demographics, anglers at all ponds were predominantly 18-45 year old Caucasian males with at least some college education and a mean household income of \$50,000 - \$100,000. However, there were also a significant number of young anglers present (approximately 30%). Anglers typically traveled 12-17 minutes to get to the ponds. Channel catfish were among the most sought species and anglers preferred catching a few large fish over numerous smaller fish. They indicated they would be happy with more restrictive regulations if it improved fishing. Channel catfish population data indicated most fish were slow-growing resulting in small average size with few harvestable-size fish in lakes with high fishing pressure. We therefore recommend resources be allocated to stocking larger harvestable size (> 12 inches) channel catfish.

Changes in angler and harvest characteristics of Greers Ferry Tailwater, AR: A historical perspective.

Schroeder, M.D., and Williams, J.S, Bly, T.B, and C.A. Perrin, Arkansas Game and Fish Commission (AGFC)*

Greers Ferry Tailwater, located in north central Arkansas, has experienced changes in angler and harvest characteristics over the past 30 years. During the 2004-2006 creel survey, anglers spent an average of 549,119 hours/year fishing Greers Ferry Tailwater. The percentages of anglers who used artificial tackle and bait were 40% and 44%, respectively. The remaining 17% used both artificial tackle and bait while fishing. Most (72%) of the anglers were using spinning equipment, while 23% were using fly fishing gear. An average of 367,000 trout were stocked annually below Greers Ferry Dam. Anglers caught an average of 688,988 trout, of which 186,895 (27%) were harvested and the remaining 502,093 (73%) were released. Catch rates on Greers Ferry Tailwater (1.3 trout/h) were some of the highest observed on Arkansas tailwaters. Rainbow trout made up the majority (92%) of the fish that were stocked annually. This species also made up 84% (1,150,534) of the total trout catch and 97% of the total trout harvest (363,521). Although, angling effort increased and harvest rate of rainbow trout decreased, stocking levels have continued to increase over time. This has resulted in a reduction in stocking efficiency. Due to these changes in angler and harvest characteristics, a change in management was warranted. A new species and river wide 16-24in. protective slot limit, changing catch-and-release areas to special regulations

areas, and reductions in stocking have been initiated to encourage the harvest of the smaller individuals, while allowing fewer, larger individuals to achieve a trophy size.

Comparing striped bass production between the two major river arms of Lake Texoma, OK-TX, and determining the influence of river flows.

Kuklinski, K.E., and J. Boxrucker, Oklahoma Department of Wildlife Conservation (ODWC), Oklahoma Fishery Research Laboratory*

The striped bass *Morone saxatilis* fishery at Lake Texoma is estimated to provide \$28 million to the local economy annually. As such, this fishery is arguably the single-most valuable fishery resource in Oklahoma. Recently, the status of the fishery has been threatened by proposed water development projects in the upper Red River watershed which has the potential to reduce flows in the Red River and alter the water quality of Lake Texoma. These changes could have significant impacts on striped bass reproduction and recruitment. Summer seine and winter gillnet samples were conducted annually from 2000 to 2008 to determine striped bass year class strength and over-winter survival. Additionally, annual forage abundance estimates were obtained by fall gillnetting. Striped bass reproduction and recruitment, and forage abundance was compared between the two major river arms of the lake (Red River and Washita River). Abundance of age-0 striped bass as measured by seine and gillnet samples was highly variable and differed between river arms in only half of the sample years. Shad abundance between river arms did not differ in six of nine sample years. The relationship among these measures and the influence of river inflows will be discussed.

Angler effort and success for rainbow trout on the White and North Fork of the White Rivers, Arkansas with implications for management.

*Williams, J. S. *, Port, P. Schroeder, M. Todd, C. S., and M. Bivin, Arkansas Game and Fish Commission*

The rainbow trout fisheries of the White and North Fork of the White (North Fork) Rivers, Arkansas are managed primarily as put-and-take fisheries with certain river sections managed under special regulations to provide anglers with opportunities to catch quality (> 406 mm) trout. A creel survey conducted by the Arkansas Game and Fish Commission (AGFC) between September 2001 and August 2008 provided data on angling effort and success for these fisheries. Angling pressure on the North Fork River (29,853 hr/km) was nearly four times greater than that observed on the White River (8,320 hr/km). Although catch rates for rainbow trout on these two rivers were high (&ge 1.1 fish/hr), harvest rates were low. Anglers harvested these fish at a rate of 0.3 fish/hr on the White River and 0.2 fish/hr on the North Fork River. Rainbow trout represented most of the total catch (> 76%) and nearly all of the harvest (99%) of trout on these waters. However, the total harvest of rainbow trout represented 31% and 12% of the rainbow trout caught on the White and North Fork Rivers, respectively, suggesting a high rate of voluntary release by anglers. The majority (> 53%) of rainbow trout caught by anglers on these waters measured less &le 300mm in length. Less than 5% of the rainbow trout caught by anglers exceeded 406mm. The results of this creel survey coupled with a stated desire by many stakeholders for larger rainbow trout suggest the need for AGFC to evaluate the strategies currently used to manage these fisheries.

Effectiveness of a locally-run bi-lingual marketing campaign targeted at non-traditional anglers in an urban area—a progress report

*Scott, M. K. *, Taylor, J. B. and J.D. Leitz, Texas Parks and Wildlife Department (TPWD), Inland Fisheries Division*

To combat slowing angler recruitment, the Texas Parks and Wildlife Department has initiated a statewide Neighborhood Fishing program that provides angling opportunities to residents of Texas' metropolitan areas. One of the major challenges facing this program is satisfactorily reaching and recruiting the target audience (non-traditional anglers) in a cost-efficient way. Our study's objective is to evaluate an

inexpensive bi-lingual marketing strategy that will utilize the knowledge and talents of local professionals and students. In our first phase, we conducted a mail survey (in Spanish and English) using approximately 2,000 names and addresses randomly generated from a list of San Angelo, Texas residents. The survey contained questions designed to assess each resident's awareness and current utilization of the Neighborhood Fishing and associated tackle loaner program, as well as the resident's native language and preferred methods of receiving information. We used this initial survey to establish a pre-marketing baseline, and also to provide us with detailed information about the utilization of the Neighborhood Fishing program by non-traditional angling groups, especially "Southwestern Families"—a target demographic characterized by lower- and middle-class young Hispanic families. After the initial survey is complete, a bi-lingual marketing campaign will commence under the direction of a locally-run marketing workgroup that includes Spanish-speaking high school students. At the end of the marketing campaign, another survey (identical to the first questionnaire) will be mailed to 2,000 new randomly-chosen San Angelo residents to assess the effectiveness of the marketing campaign.

Royal Conti 2:20-5:00 PM

Invasive and Native Species Contributed Papers

Beetles for bio-control (of Alligatorweed)

Gilliland, G.. Oklahoma Department of Wildlife Conservation*

Alligatorweed *Alternanthera philoxeroides* was intentionally released or escaped from an Oklahoma City water garden into a homeowner association pond in 2003. By 2005 the weeds were established downstream in seven ponds along Spring Creek with coverage ranging from 20 to 60%. Homeowners were spending over \$10,000 per year on herbicides but continued chemical use had become objectionable to many residents. Members of the seven associations formed the Spring Creek Alliance to find a solution to the infestations. Coincidentally that same year, the Oklahoma Department of Wildlife Conservation (ODWC) began an aquatic nuisance species program and produced the *Don't Free Lily* brochure to warn water gardeners about the perils of introducing non-native plants into ponds, lakes and streams. Members of the Alliance saw a brochure and contacted the agency for help. A control plan was developed using the Alligatorweed Flea Beetle *Agasicles hygrophila* as a bio-control agent. An import permit was granted by the Oklahoma Department of Agriculture (ODA) and the beetles were obtained from the U. S. Army Corps of Engineers. Corps personnel reported that this introduction may be the furthest north that Alligatorweed bio-control has been attempted. With winterkill of the beetles a distinct possibility; a three-year stocking protocol was implemented. Personnel from ODWC and ODA were assisted by Alliance members in monitoring the introductions. By 2008, the weeds were reduced to less than 10% of peak coverage, were completely absent from some ponds, and the need for herbicide treatment has been eliminated.

Major factors impairing fish habitat in southeastern reservoirs

Dunn III, W. O., Spickard, M., Webb, K.M., and Aycok, J. N. Department of Wildlife and Fisheries, Mississippi State, and L.E. Miranda, USGS Mississippi Cooperative Fish and Wildlife Research Unit

Impounding a river to create a reservoir generates aquatic habitats that are unique relative to those in the original river and in natural lakes. Along with unique habitats, reservoirs have distinct problems that impair fish habitats. The extent of such impairments has been documented for a limited number of selected reservoirs but not over broad geographical scales such as the Southeastern U.S. The goal of this study was to identify major factors impairing fish habitat in Southeastern reservoirs. We compiled a list of 16 key potential causes known to impair fish habitat in reservoirs, randomly selected about 250 reservoirs within the Southeastern U.S., and conducted an online survey of reservoir fisheries biologists to rate each habitat impairment cause in each reservoir. Lack of woody debris, lack of aquatic macrophytes, and sedimentation were rated as the top three major causes of impairment in Southeastern reservoirs. Cluster

analysis identified five distinct reservoir groups including a cluster consisting of reservoirs with minimum impairment (24% of the sample); a cluster where excess and invasive aquatic macrophytes represented the major impairment (28%); a cluster with high impairment scores for most causes (12%); and two clusters with sedimentation, lack of macrophytes, and lack of woody debris as major causes of impairment but differing from each other relative to impairment by either mistimed water level fluctuations (18%) or nutrient levels (20%). This knowledge can help better understand the interaction among habitat problems, can guide research, and can steer habitat restoration/enhancement programs by identifying reservoirs with similar impairments.

Responses of nuisance aquatic vegetation species to focused herbicide applications following an extended drawdown on B.A. Steinhagen Reservoir, Texas 2007-2008

Elder, H.S. , and D.L. Bennett, Texas Parks and Wildlife Department (TPWD)*

An extended drawdown of B.A. Steinhagen Reservoir, a 16,830-acre impoundment located in Jasper and Tyler Counties of east Texas, was conducted by the US Army Corps of Engineers (USACE) from May 2006 through June 2007 in an effort to reduce nuisance aquatic vegetation to more manageable levels. Following the drawdown, a formal aquatic vegetation management plan was cooperatively written and adopted by the USACE, the Lower Neches Valley Authority (LNVA), and Texas Parks & Wildlife (TPWD) to address problems associated with nuisance aquatic vegetation on the reservoir. Based on Integrated Pest Management principles and supported by the commitment of \$150,000 from LNVA the plan included systematic herbicide treatments throughout the 2008 growing season and the introduction of bio-control agents for alligatorweed (*Alternanthera philoxeroides*) and giant salvinia (*Salvinia molesta*). Comparison of TPWD spring and fall surveys indicated dramatic reductions in water hyacinth (*Eichhornia crassipes*), common salvinia (*Salvinia minima*), and alligatorweed populations due to focused herbicide applications. Comparing results from historical control efforts, surveys strongly suggest the combination of an extended drawdown and a well-supported and dedicated herbicide operation is more effective in the control of problematic vegetation species on B.A. Steinhagen than any single control effort alone.

Discovery and distribution of the Northern Snakehead (*Channa argus*) in eastern Arkansas

Holt, R.L. Arkansas Game and Fish Commission (AGFC)

The presence of a single, wild northern snakehead *Channa argus* was confirmed in Eastern Arkansas on April 14, 2008. In the weeks following this discovery, additional sampling within the Piney Creek drainage, using a variety of gear types, yielded 133 additional specimens. Several different year classes and the presence of NSH fry indicated that there is an established population of northern snakeheads in Eastern Arkansas (Lee and Monroe Counties). Extensive sampling efforts in adjacent drainages indicated that NSH are currently confined to Piney Creek and its tributaries. The northern snakehead population confinement to the Piney Creek drainage justifies an eradication effort. The eradication effort is currently being planned and is scheduled to begin in March of 2009.

Native aquatic vegetation: A necessary component of aquatic plant management

Dick, G.O. Corps of Engineers-Lewisville Aquatic Ecosystem Research Facility

Management of nuisance aquatic plants can be achieved in a number of fashions, including use of herbicides, biological control agents, etc., but these often do not address ecosystem conditions that resulted in infestations in the first place. Management of aquatic ecosystems includes consideration of the niche left open following control of problem plants. If action is not taken, this niche is likely to be filled with the same or other invasive species, except in cases where adequate seed banks of native plants are present. In many cases, however, especially in newer reservoirs, seed banks of native plants have not established or declined due to the presence of exotics, and enhancement of the native plant community may be necessary. We have developed an approach for large-scale establishment of native aquatic plants using relatively small plantings (founder colonies). Efforts focus on establishing and maintaining

founder colonies, which later produce propagules such as seeds and fragments for spread to other areas of a lake. This presentation focuses on techniques we developed to establish founder colonies and outlines successes and failures of this approach for establishing native aquatic vegetation in lakes and reservoirs.

Preliminary studies on invasive island applesnails in southern Louisiana.

Carter, J., Jenkins, J., Broussard, L., USGS National Wetlands Research Center, and T. Ruth, Louisiana Department of Wildlife and Fisheries.

The island applesnail (*Pomacea insularum*) is an aquatic snail indigenous to South America. Recently they have been found in the vicinity of Gretna, Mandeville, and Shriver, Louisiana, and we expect their range to expand. Applesnails can have profoundly negative impacts on freshwater ecosystems by removing vegetation and out-competing native snails. Our objectives are (1) predict spread and (2) investigate mechanisms for snail control in natural communities, such as marshes and swamps. To predict which refuges, parks, and management areas are at risk to invasion, we are combining a cold-hardiness map and GAP Analysis map. To provide information useful for management, we are conducting experiments on physical, chemical, and biological control methods. Below are our preliminary results.

Physical Control: Knocking egg masses from where they are laid into water is an often used control method. Our experiments show many eggs hatch after this treatment; hence this method may be ineffective. Crushing may be more effective.

Chemical Control: Two commercial molluscicide formulations, one a saponin and the other a niclosamide, were effective against adults, and are now being tested for toxicity to other species including red swamp crayfish, (*Procambarus clarkii*), minnows, and carp.

Biological Control: Newly hatched applesnails are consumed by crayfish establishing crayfish as a potential biological control agent.

These preliminary results suggest that an integrated pest-management approach may help control island applesnails; however, additional laboratory studies and field-testing are needed.

A real-time aerial mapping system to monitor aquatic vegetation distribution in reservoirs

Janssen, F. W., Texas Office of the Attorney General*

The Inland Fisheries Division of the Texas Parks and Wildlife Department annually monitors the coverage and distribution of noxious plants annually where they occur. Because many Texas reservoirs have noxious plant populations, and are relatively large water bodies, conducting surveys of the plants and performing data analysis has put a burden on some district management crews. Traditional surveys required circumnavigating the entire reservoir, locating known colonies of noxious plants and searching for new ones. When the plants were located, they were mapped with global positioning systems (GPS). After the surveys were complete, all of the GPS data had to be converted to polygons in ESRI's ArcView software to calculate areal coverage. The time required to monitor the noxious plant problems on reservoirs > 40,000 hectares almost made surveys unfeasible. Due to tremendous amount of time required to conduct surveys using the traditional method, we developed a new survey technique which utilized aircraft to fly the extent of the reservoir while data were captured directly into GIS. During each flight, one or two spotters identified target species for mapping while another individual assigned the species to pre-built grids on a tablet computer using a custom-designed ArcView 3.x extension. The individual conducting the data entry was able to assign the species to the correct grid by using another ArcView extension and GPS which provided a real-time cursor on the tablet screen. Since we began using the new survey technique, we have been able to survey areas previously inaccessible by boat, we have significantly reduced the effort required to conduct surveys, lowered operating costs, and plant distribution and coverage are available to managers or contractors at the end of the sampling day.

Teche/Belle Grove 4:20-5:00 PM

Coastal Ecology Contributed Papers 2

Movements of spotted seatrout, *Cynoscion nebulosus*, in a Louisiana estuary determined by acoustic telemetry

Callihan, J.L and J.H. Cowan, Jr., Louisiana State University, Department of Oceanography and Coastal Sciences*

Within-estuary movements of adult spotted seatrout are poorly understood, and such information would aid in defining habitat use (and by inference relative value) patterns for this recreationally important species. We used acoustic telemetry to investigate the seasonal migration, behavioral ecology, and habitat use of spotted seatrout in Calcasieu Lake, LA (400 km²). The movements of 75 telemetered fish (302 - 725 mm TL) were monitored from May 2007 through August 2008 using a synoptic array of 60 receivers (Vemco VR2) deployed throughout the entire estuarine system. For fish that remained within the estuary, the median maximum distance traveled was 17.1 km (range 2 - 43 km) and did not differ significantly among size or sex. Salinity had a strong influence on the spatial distribution of fish. Most individuals utilized the polyhaline zone of the estuary during the summer spawning season. Moreover, a winter freshet caused a precipitous decline in salinity (<5) in the upper estuary and triggered a southward emigration (to higher salinities) of all telemetered fish (n=10) present in that region. At a finer spatial scale, spotted seatrout incidence was significantly higher on flood than ebb tide at certain sites, suggesting these areas may constitute important foraging grounds. Finally, 24% of telemetered fish emigrated from the estuary, presumably to the nearshore Gulf of Mexico, from late May to early October across years and did not return, implying that stock boundaries lie at a spatial scale larger than the estuary.

Using Ecopath with Ecosim to explore nekton community responses to freshwater input from a Mississippi River diversion in Breton Sound, Louisiana.

de Mutsert, K. Department of Oceanography and Coastal Sciences, Louisiana State University, Walters, C. Fisheries Centre, University of British Columbia, Roth, B. Department of Fisheries and Wildlife, Michigan State University, and J.H. Cowan, Jr. Department of Oceanography and Coastal Sciences, Louisiana State University

Historically, freshwater flooding from the Mississippi River was responsible for creating and maintaining wetlands in Louisiana. River diversions like the Caernarvon River Diversion (CRD) can mimic flooding of the Mississippi River and are thereby expected to restore wetlands and wetland function. More than 50% of US fisheries yields have historically been derived from estuarine or estuary-dependent species, which makes wetland restoration vital to fish and fisheries. However, reductions in salinity associated with freshwater inputs are also expected to affect current estuarine nekton communities. To study the effects of the CRD on nekton biomass and community composition in Breton Sound, we used Ecopath with Ecosim (EwE) to simulate how salinity changes could affect nekton communities. For this approach, we created an Ecopath foodweb model based upon five years of monitoring data collected prior to opening of the diversion (1986-1990), as a base model for Ecosim model runs. Once the base model was complete, we simulated the effects of freshwater discharge on food web dynamics and community composition using a novel application of Ecosim, which allows the input of salinity as a forcing function, coupled to user specified salinity tolerance ranges for each biomass pool. Extensive fisheries independent monitoring data of nekton biomass, along with long time-series of salinity data by station, all collected from 1986 to 2007, are used to inform the models. To study movement of species as a result of salinity changes we are currently developing an Ecospace model, which is a temporal and spatial dynamic module of EwE.

Contributed Papers – Sunday, January 18th

South Ballroom 8:00-9:40 AM

Coastal Ecology Contributed Papers 3

Obtaining *in-situ* behavior and abundance estimates of schooling fishes in Southeast Alaska with an imaging sonar (DIDSON)

Boswell, K.M., Louisiana State University, and R. Heintz, Auke Bay Marine Laboratories, NOAA

There is concern over the status of certain sub-populations of Pacific herring (*Clupea pallasii*) in southeast Alaska. Currently fishing has been halted on some populations and others have been proposed to be listed as being threatened or endangered. The failure of recovery for some sub-population is largely unknown, but may be a result of increased predation by marine mammals and a concomitant decrease in fish condition. Given the concern of the stock and importance for reliable indices of abundance, particularly for obligate-schooling fishes, we have developed an approach to enhance the resolution of the stock abundance and to describe the *in situ* properties at the scale of the school and the individual. We propose a technique to acquire high resolution information at both scales by implementing an imaging sonar (DIDSON) to compliment traditional survey methods (e.g. multi frequency echosounder surveys) and to 'calibrate' the abundance estimates derived from echo integration methods. A DIDSON and 120 kHz transducer were deployed at depth (~50-100 m) inside the fish school to estimate the abundance of pre- and over-wintering herring. Density estimates derived from the DIDSON were strongly associated with surface based echo integration estimates and suggest the ability to better predict fish abundance during population surveys of this ecologically and commercially important species.

Trophic interactions of fish species in Maryland's coastal lagoons

Black R. B., University of Maryland Eastern Shore

Maryland's coastal lagoons are a dynamic system that supports many species. Approximately 140 native and migratory fish species occupy Maryland's coastal lagoons, as well as 120 species of epibenthic and benthic fauna. These coastal lagoons are nurseries for many Atlantic species and are often used as feeding grounds as well. There is very little exchange of water between the coastal lagoons and the Atlantic Ocean (via the Ocean City and the Chincoteague inlet). Environmental variables (dissolved oxygen, temperature, and salinity) are very dynamic in the coastal lagoons. These variable conditions within coastal lagoons may affect prey and predator relationships among fish species. The objectives of this study were: (1) to provide feeding habit information; 2) to determine if there was a relationship between prey availability and diet habits; and (3) to generate a complex food web among fish species from the coastal lagoons. I specifically targeted common and/or fishery-important fish species: summerflounder (*Paralichthys dentatus*), silverside (*Menidia menidia*), weakfish (*Cynoscion regalis*), silver perch (*Bairdiella chrysoura*), mummichog (*Fundulus heteroclitus*), striped killifish (*Fundulus majalis*), spot (*Leiostomus xanthurus*), black drum (*Pogonias cromis*), striped bass (*Morone saxatilis*), and bluefish (*Pomatomus saltatrix*). I predicted that fish species consumed the most abundant prey for each coastal lagoon sampled. I also predicted larger juveniles had a more diverse diet than smaller juveniles. Of the 731 individual fish examined, some of the common species such as Black drum (*Pogonias cromis*) specifically preyed on polychaetes. In contrast spot's (*Leiostomus xanthurus*), diet consisted of a variety of prey for example: amphipods, copepods, small clams, and foraminiferan. *Gobiosoma bosc* was found in the gut of silver perch (*Bairdiella chrysoura*), but silver perch also preyed on amphipods. Preliminary results suggest there be many guilds between common and fishery important species in the food webs throughout the coastal lagoons.

Red Snapper, *Lutjanus campechanus*, foraging strategies on artificial reefs structures in Alabama waters

Shipley, J.B. NOAA Fisheries, Pascagoula Laboratory, and J.H. Cowan, Jr. Louisiana State University*

Research objectives included a synthesis of field research and emphasis upon environmental factors to address the need for a spatial and temporally explicit model to describe the artificial reef as an ecosystem with red snapper as the focus. Red snapper population dynamics on a single artificial reef put into motion across time and space included hurricane and storm influences not considered in the other Ecopath with Ecosim studies to date. Hurricane-type effects show a much greater impact on red snapper than to most prey species, excluding other fish species and mantis shrimp. The results of this study support that spacing of habitats in consideration of the resource mosaic hypothesis does make a difference. Managers in designing new reef zones should consider that systematically placed reefs displayed higher biomass levels when compared to both “blocked” and “clumped” reef systems. Additionally, more reefs in the system contributed to decreases in biomass levels by dividing the initial biomass over the basemap regardless of placement strategy. Evidence provided by foraging halos for the prey species of the red snapper as well as within the red snapper biomass pools contributes to the debate that overlapping halos are counterproductive to habitat utilization. Unresolved in this study is whether any spatial arrangement can offer better protection to the already endangered red snapper in GOM waters, especially during severe storm temporal seasons. Still, the results of my studies of red snapper provide a unique spatial and temporal model for red snapper in the Alabama shelf region of the GOM.

Differences in Feeding Success on Natural Prey Between Hatchery-Reared and Wild Spotted Seatrout (*Cynoscion nebulosus*)

Littleton, L.A., Rakocinski, C.F., and R.B. Blaylock, Department of Coastal Sciences, University of Southern Mississippi, Gulf Coast Research Laboratory*

Stock enhancement is being investigated as an additional management tool for the recreationally important spotted seatrout (*Cynoscion nebulosus*) at the USM Gulf Coast Research Laboratory. Hatchery-reared juveniles are fed a pelleted diet, and thus lack experience with recognition and capture of live prey. The objectives of the current study were to: (1) compare feeding performance between hatchery-reared and wild juvenile fish; and (2) elucidate improvement in feeding success across a series of feeding trials over a 3 d period. Hatchery-reared and wild fish experienced six 1.5 hr feeding trials involving exposure to live grass shrimp prey. Feeding performance was recorded using video cameras. Feeding success improved significantly across successive trials ($F = 4.5$; $P = 0.001$) within a repeated measures ANOVA. Improvement was parallel between hatchery-reared and wild fish, as shown by a non-significant interaction ($F = 0.111$; $P = 0.99$). Wild fish successfully captured and consumed significantly more grass shrimp than did hatchery-reared fish ($F = 15.5$; $P = 0.001$); this between-subject effect explained more than twice the variance in feeding success than did the within-subject effect (partial $\eta^2 = 0.46$ vs. 0.20 , respectively). Feeding behavior was still plastic enough during the juvenile stage to enable hatchery-reared fish to switch to natural prey.

Evaluation of Artificial Reef Design and Placement for Post-Hurricane Katrina Restoration of Fisheries Along the Mississippi Gulf Coast.

Brandt, J.R., and D.C. Jackson, Mississippi State University*

Red snapper, *Lutjanus campechanus*, represent one of the more economically important fisheries in the northern Gulf of Mexico, but red snapper abundance has decreased by almost 90% in the past two decades. The use of artificial reefs could aid in the rehabilitation of red snapper stocks by providing refuge for juveniles and a place of foraging and recruitment. A program was initiated to determine the effectiveness of placement and distribution of artificial reefs in attracting and sustaining pre-recruit red snapper in the northern Gulf of Mexico. Between September 2007 and October 2008, fish traps were

deployed on pyramid shaped artificial reef structures at reef site FH-13, 40 km south of Pascagoula, Mississippi. Two reef designs were tested. One consisted of five closely spaced pyramid units and the second had an additional two sets of two outliers at varying distances. In 23 sampling trips, 825 red snapper were captured and 751 tagged with t-bar anchor tags. Only 14 were of legal recreational size [> 406 mm (TL)] and not used in analysis. Highest CPUE (Mean= 2.69 red snapper/h; SE= 0.77) occurred on the outlier pattern with the largest horizontal spread (91 m) and in the shallowest section of FH-13 (20-24 m). A total of 30 red snapper were recaptured (tag return rate 4%), with 29 recaptured at original site of tagging. Mean growth rate of recaptured fish was 0.3 mm d^{-1} (FL). Results indicate that artificial reefs are effective at attracting and maintaining pre-recruit red snapper, which could aid in the rehabilitation of red snapper stocks.

North Ballroom 8:00-9:40 AM

Coastal Ecology Contributed Papers 5

Identification and evaluation of sub-adult shark bycatch in Georgia's commercial trawl fisheries

Belcher, C. N., Georgia Department of Natural Resources, Coastal Resources Division, and C.A. Jennings, USGS Georgia Cooperative Fish and Wildlife Unit

Overfishing has dramatically reduced many shark populations along the east coast of the United States. Many states have recreational and commercial fisheries that occur in nursery areas occupied by sub-adult sharks, which raises concerns about mortality rates for these life stages. Georgia is one of few states without a directed shark fishery; however, the State is home to a large trawl fishery for penaeid shrimp, and small sharks occur as bycatch in shrimp trawls. During fishery-dependent sampling events from 1995-1998, 34% of 127 trawls contained sharks. This bycatch totaled 217 individuals from 6 species, with Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) the most common, and finetooth (*Carcharhinus isodon*) and blacktip (*Carcharhinus brevipinna*) the least common. The highest catch rates for sharks occurred during June and July, which coincided with the peak months of the pupping season for many species. Fishing characteristics (i.e., tow speed and tow time) did not significantly affect catch rates for shark species. Gear configurations (i.e., net type, turtle excluder device, bycatch reduction device) did affect catch rates for shark species. Management strategies that may reduce shark bycatch in this fishery include possible gear restrictions, a delayed season opening and/or reduced bar spacing on turtle excluder devices.

Advances in Fisheries Contributed Papers 1

Lateral Migration of Fishes in the Lower Verdigris River, Oklahoma

Lorensen, J. and W. Fisher, Oklahoma USGS Fish and Wildlife Research Unit, Oklahoma State University

The lower Verdigris River forms the uppermost portion of the McClellan- Kerr Arkansas River Navigation System (MKARNS). The U.S. Army Corps of Engineers plan to deepen the MKARNS navigation channel to 3.66 meters and mitigate by dredging cutoff channel connections. We are assessing lateral movements of fish in cutoff channel connections at four diel and three hydroperiods. We are also continuously measuring directional flow, water depth, temperature and dissolved oxygen during each diel sample. Sampling was conducted during spring-summer high water and summer-fall low water periods of 2007 and 2008. An intermediate water level period was also sampled in 2007. Thirty species were captured in cutoff channel connections during the high water periods, 21 species during the low water periods and 11 during the intermediate water level period. Gizzard shad, white crappie, freshwater drum and bluegill were most abundant in cutoff channel connections during the high water period whereas gizzard shad, threadfin shad, white bass, channel catfish and bluegill were most abundant during the low

water periods. Fish abundance during the high water period was highest during the sunrise periods while in low water periods, abundance was highest during sunset in 2007 and sunrise in 2008.

Catch efficiency and length bias of electrofishing for blue catfish

Bodine, K.A.*, and D.E. Shoup, Oklahoma Department of Wildlife Conservation and Oklahoma State University

After evaluations of Oklahoma's blue catfish fishery, it appears there is large potential for overharvest of preferred length fish. However, current sampling methods for blue catfish are suspected to be strongly size-biased, making it difficult to accurately assess population density and size structure. To understand this potential bias, we sampled blue catfish using a population with a known length frequency and size distribution using low-frequency, pulsed (15 pps) DC electrofishing (1,000 volts, 4 amps). Approximately 300 blue catfish (approximately 25 fish / 100-mm length class) were collected and transported to a 25-acre impoundment where no blue catfish were previously present. This 'artificial population' was sampled to determine which length classes (200mm-1000mm) were more vulnerable to electrofishing. No difference in catch rate was detected for any length classes ($P < 0.05$) and mean total catch was less than 10% of the population. Results from this experiment were compared to data collected from a larger project that evaluated seasonal and habitat specific length bias on 3 reservoirs in Oklahoma. This data indicated total CPUE and CPUE of preferred-size fish (>762 mm, TL) was significantly higher for warmer water temperatures. Catch rates were also higher in the upper portion of the reservoirs.

Using bioelectrical impedance analysis to estimate fat levels and growth in fish

Hartman*, K.J., Hafs, A., West Virginia University, Wildlife & Fisheries, Margraf, F.J., USGS Alaska Cooperative Fish and Wildlife Research Unit, Sweka, J.A., USFWS, and M.K. Cox, Sitka Sound Science Center

Many studies of interest to fisheries biologists, ecologists, and managers alike involve the accurate measure of condition and growth, or quantification of fat and energy content of fish. Bioelectrical impedance analysis (BIA) is a tool that can be used to estimate body composition of fish. Once models have been developed and evaluated for a species, BIA models can be used to estimate percentages of water, protein, ash and fat. Bioimpedance analyzers are portable electronic devices that pass a weak electrical current through the fish. BIA measures are fairly easy to take, but a number of external variables can influence the measures. Among these are the temperature of the fish, electrode placement, and electrode type. Using examples from studies on bluefish, striped bass, chum salmon, and brook trout we show how these variables influence BIA readings and present recommendations for standardization in methods for researchers using BIA.

Assessment of a Bridge-Mounted Hydroacoustic Telemetry Array

Casto-Yerty*, M., and P.W. Bettoli, USGS Tennessee Cooperative Fishery Research Unit, Tennessee Technological University.

The distribution and movements of federally endangered pallid sturgeon *Scaphirhynchus albus* in the Mississippi River are poorly understood. Ultrasonic submersible receivers have been attached to the downriver side of bridge pylons to document the passage of pallid sturgeon implanted with ultrasonic tags. A protocol has been developed to test the range of the receivers via a series of transects demarcated by GPS and using a submerged ultrasonic pinger tag to simulate fish passage during low and high river stages. Ultrasonic receivers ($n = 8$) were attached to interstate bridges that span the Mississippi River at three sites in Tennessee. Transmitter detection varied with the receiver's proximity to the main channel and was much lower in areas of turbulence (e.g., near the main channel). Placement of receivers in locations removed from high turbulence will maximize the likelihood of detecting the passage of tagged pallid sturgeon, but only if tagged fish frequent those overbank habitats.

Regal 8:00-9:40 AM

Population Biology Contributed Papers

Evaluation of reintroduction success of smoky madtom *Noturus baileyi* and yellowfin madtom *Noturus flavipinnis* in Abrams Creek, Great Smoky Mountains National Park *

Throneberry, J.K. and S.B. Cook, Tennessee Technological University*

Evaluation of reintroduction success of smoky madtom *Noturus baileyi* and yellowfin madtom *Noturus flavipinnis* in Abrams Creek, Great Smoky Mountains National Park * J.K. Throneberry and Dr. S.B. Cook Department of Biology Tennessee Technological University In 1957 Abrams Creek was treated with rotenone, a piscicide, in conjunction with impoundment of the Little Tennessee River by Chilhowee Dam in an attempt to establish a trophy rainbow trout *Onchorynchus mykiss* fishery. Of the 46 species extirpated, four are currently listed as federally threatened or endangered, including smoky madtom *Noturus baileyi* and yellowfin madtom *Noturus flavipinnis*. In an effort to reestablish sustainable populations in Abrams Creek, Conservation Fisheries Inc. (CFI) in cooperation with the Great Smoky Mountains National Park (GRSM) have implemented stocking strategies throughout areas of optimal habitat during the last twenty years. Habitat and snorkeling surveys were conducted throughout a 20 km length, terminating in Lake Chilhowee, in the summer months of 2007 and 2008 and yielded current distribution, habitat parameters influencing distribution, and density within range for both madtom species. Smoky madtom and yellowfin madtom only inhabited 8.8 km and 15.4 km reaches, respectively, and average density, catch per unit effort (CPUE), throughout range was 0.83 fish/person/hour and 0.46 fish/person/hour, respectively. Statistical analysis of habitat parameters will identify significant variables influencing distribution and dispersal of each species. * This is a study in progress to be completed Spring 2009.

Dispersal, recolonization, and population connectivity of grotto sculpin (*Cottus carolinae*) in cave and resurgence streams

Day, J.L., Johnson, C.R., Adams, G.L. University of Central Arkansas, and J.E. Gerken, USGS Kansas Cooperative Fish and Wildlife Unit, Kansas State University*

Grotto sculpin are unique populations of banded sculpin (*Cottus carolinae*) endemic to cave systems underlying Perry County, Missouri. These troglomorphic fish are state-threatened and a federal endangered species candidate. Due to the unstable nature of the cave environment, grotto sculpin are highly susceptible to pollution via suspected agricultural and waste runoff. We used a long-term mark-recapture study to examine dispersal and recolonization potentials of grotto sculpin, focusing on two cave populations and their corresponding resurgences. Sites were divided into 10m sections and fish tagged using unique elastomer combinations every four to twelve weeks beginning in August 2005. We also monitored a 68m stream section where a known point-source pollution event occurred just prior to starting this study. Most fish moved less than 50m (67%) however, substantial movements of over 201m (14%) were observed. In resurgence streams we found a marked decline of adults in late winter (January-March) and a peak in abundance of young-of-year in May, corresponding to the presence of larval sculpin drifting from resurgence springs. This late winter decline in adults may indicate a subterranean migration of adult fish for reproduction. Seasonal abundances and recapture rates drop considerably in winter but increases during spring and summer, supporting movement out of the study area, or deeper into the caves, during winter. Our data demonstrate a dynamic demography with higher recolonization and dispersal potential than published cottid literature indicates.

Contaminant concentration analysis of cave streams utilized by grotto sculpin (*Cottus carolinae*) in Perry County, Missouri.

Fox, J.T, Adams, G.L., and K. Steelman, University of Central Arkansas (UCA),*

Recent studies have employed polar organic chemical integrative samplers (POCIS) and semipermeable membrane devices (SPMDs) to assess contaminant levels in aquatic ecosystems. The current study is among the first to use these sensitive, *in-situ* samplers to monitor water quality in subterranean streams. Streams chosen for assessment are located in Perry County Missouri, and represent the only known habitat for the Grotto Sculpin, a rare hypogean fish allocated to the Banded Sculpin (*Cottus carolinae*) complex, and a species of high conservation concern. Of particular interest is the widespread use of sinkholes for disposal of various agricultural, industrial and domestic wastes. Intensive agriculture, petroleum products manufacturing and wood curing operations are also suspected sources of contaminants. Thin or unconsolidated soil layers underlying many Perry County sinkholes allow contaminant-laden rainwater to flow directly into caves without filtration and remediation. As a consequence, water quality can quickly and severely decline with rapid transmission of pollution from the surface into caves and conduits of the karst aquifer. In order to assess contaminant levels, perforated stainless steel canisters containing POCIS and SPMDs were deployed in five cave streams for a period of 30 days during May 2008 and again during June 2008. Upon collection, accumulated chemicals were extracted and purified in preparation for qualitative and quantitative analysis by gas chromatography (GC) – mass spectrometry, and GC – electron capture detection. Concentrations of individual contaminants were used to calculate and compare time-weighted average concentrations of contaminants.

Development and testing of adaptive cluster sampling designs for monitoring the endangered duskytail darter*

Davis, J.G., and S.B. Cook, Department of Biology, Tennessee Technological University*

The duskytail darter *Etheostoma percnurum* is a federally-endangered species in Tennessee in need of conservation due to declines in population size and habitat loss. The goal of this study was to develop, simulate, and test adaptive cluster sampling (ACS) designs in order to construct a cost-effective monitoring program that can detect changes in and estimate population size. ACS is a flexible and efficient design used to sample various rare and endangered species and may be applicable to habitat-specific stream fishes. Baseline data was collected by snorkeling at three sites on the Big South Fork River and was then used in computer simulation of various adaptive designs. Sampling designs consisted of combinations of the following variables: initial sample size, neighborhood type, condition factor, stopping rule, and number of strata. Simulations resampled baseline data from each site to estimate population size, mean units sampled, and mean squared error. Designs that performed well were field tested at 15 sites to determine applicability and sampling effort. Duskytail darters were located at two additional undocumented sites, but population size was less than previously reported for downstream sites; upstream sites had larger populations. ACS designs with a high stopping rule and low condition factor had the lowest error, but required large sampling effort and were not the most cost-effective. ACS designs successfully located duskytail darters and may be an alternative method for sampling rare or endangered stream fishes. However, further testing is required to find a balance between sampling effort and error. *This is a study in progress to be completed in summer 2009.

Teche/Belle Grove 8:00-9:00 AM

Community Ecology Contributed Papers

Population age structure and mortality of fish species in the upper White River watershed of southern Missouri-northern Arkansas

Beckman, D.W. Missouri State University*

Populations of eleven fish species were sampled by electrofishing in streams, rivers, or reservoirs of the upper White River Watershed of southern Missouri-Northern Arkansas. Species included predatory game fish (spotted bass and walleye), suckers (white sucker, and black, golden, and river redhorses), minnows (striped and dusky stripe shiners), and riffle-oriented species (rainbow darter, and Ozark and slender madtoms). Each species was collected from one to three locations where they predominated. Age estimations were made for each species using validated otolith techniques to obtain population age structure data and mortality estimates. Recruitment, mortality, and longevity were assessed and compared among species. Longevity varied from 5-6 years for shiners, darters, and madtoms; 8-15 years for suckers; and 11-12 years for predatory game species. Population age structures for most species showed a similar pattern, with one or two dominant early year classes (typically year classes 1-3) indicating recruitment into the populations; declines in relative abundance indicated relatively constant mortality through older ages. Notable exceptions to this pattern were observed in populations of walleye, white suckers, and dusky stripe shiners, where older year classes were also prevalent. Reasons for similarities and differences in population structures among species are not known, but could include natural variability in life history strategies and mortality, environmental influences, and/or fishing pressure.

Spatial and temporal variability of fish assemblages on gravel bars in the Arkansas River

Will, L. and S.E. Lochmann, University of Arkansas at Pine Bluff*

We examined temporal and spatial variability of fish assemblages on 18 gravel bars in the Arkansas River. The influence that specific environmental variables, such as water quality and substrate composition, have on fish assemblage structure was also examined. Gravel bars were stratified by depth and distance from an upstream lock and dam. Fish assemblages on each gravel bar were sampled six times. Each sample consisted of duplicate trawls using a 3-m Herzog Armadillo trawl. Water quality parameters were measured in conjunction with fish sampling. Substrate samples were collected on each gravel bar using a standard Ponar dredge. The fish assemblages on gravel bars in the Arkansas River are primarily dominated by juvenile Ictalurids, Cyprinids, and Centrarcids. Of those, juvenile blue catfish, channel catfish and silver chub were the most abundant. Fish species richness was significantly different between shallow and deep gravel bars ($P < 0.0001$) and among the seasons ($P < 0.0001$). Catch per unit effort (CPUE) for the three most abundant species was analyzed for differences among depths, distance strata, and seasons. There were differences in CPUE among depths ($P = 0.03$) and seasons ($P < 0.0001$) for blue catfish. There were differences in CPUE among depths ($P = 0.01$, $P < 0.0001$), distances ($P = 0.04$, $P < 0.0001$), and seasons ($P < 0.0001$, $P < 0.0001$) for channel catfish and silver chub. The spatial and temporal variability in fish assemblage structure suggests that shallow gravel bars during the summer and fall seasons may be important habitat for some fish species.

Relation between stream hydrology and a fish community in an arid river, the Devils River, Texas

Reeves, K.S., and G.P. Garrett, Inland Fisheries Division, Texas Parks and Wildlife Department*

The life-history of fishes is adapted to the hydrologic variability of their native range, and this variability, in part, results in the dynamic nature of fish communities. Though the results of altered hydrology are easily seen, the specific hydrologic component causing community change is difficult to identify. We collected more than 20,000 specimens of five cyprinid species (*Cyprinella proserpina*, *C. venusta*, *Dionda argentosa*, *D. diaboli*, and *Notropis amabilis*) from the upper 25 km of the Devils River, TX during annual summer surveys from 2000-2004. We then used Indicators of Hydrologic Alteration software and a Midwestern streams flashiness index to characterize environmental flow components (EFC) over this period. Direct and indirect gradient analyses were used to identify EFC with the greatest effect on catch-per-unit-effort (CPUE). Of the 71 EFC analyzed, five comprised the models accounting for the greatest variance in CPUE: fall flashiness, median fall discharge, median November discharge, date of maximum discharge, and duration of extreme low-discharge. These parameters affected species CPUE in different ways and specifically CPUE of *C. proserpina* (state threatened) increased with lower fall and November discharge and as fall discharge flashiness increased and maximum discharge occurred later in the year. Also, CPUE increased with longer periods of extreme low-discharge. *Dionda diaboli* (state threatened,

federally threatened) CPUE increased with increased fall and November discharge and with shorter periods of extreme low-discharge. Understanding how stream hydrology affect species improves our ability to protect imperiled species and predict effects of future hydrologic modification.

Fish community structure of Arkansas River throughout Tulsa County, Oklahoma

Groom, D.W., and B. Gordon, Oklahoma Department of Wildlife*

The Arkansas River is a large prairie river that begins in the mountains of Colorado, flows through Kansas, Oklahoma and Arkansas before emptying into the Mississippi River (2,334 km). Public and private entities seek to construct a series of low-head dams throughout Tulsa County, Oklahoma to encourage urban development. Flood control, hydropower demands, and an existing low-head dam heavily influence fish community structure and passage in this section of the river. The fish community structure in this 42 mile stretch of the Arkansas River was sampled by seine, hoop netting, and boat electro-fishing using the *Rapid Bio-Assessment Protocols for Sampling Fish in Non-Wadeable Rivers*, Utrup, Fisher, 2006. Sampling began October 10, 2006 and concluded September 13, 2007. These sites included an area immediately below Keystone Lake Dam, above and below an existing low-head dam in Tulsa (Zink Lake/Zink Dam) and two sites downstream (Jenks and Tulsa/Wagoner County line). Temporal and spatial data, habitat type and water quality measurements were collected at each site. Collective samples identified 40 species and 11 families. Species abundance and diversity varied among sites, seasons, and sample methods, but generally did not increase until approximately five miles downstream of the low-head dam.

Assessing the cumulative impact of road crossings on fish communities in a Ouachita mountain stream

Ryles, J. and C. Gagen, Arkansas Tech University

This study was conducted to assess the cumulative impacts of multiple road crossings on fish community composition, movement, and recolonization. This study is being conducted in Long Creek, a tributary to the Little Missouri River, in the Ouachita National Forest, Arkansas. Long Creek was selected for this study because of nine road crossings within a 7 km section of the stream. The objective of this study is to describe the impacts of multiple road crossings on fish communities and the capacity of fish to recolonize sites following depletion as might occur in intermittent streams during summer months. Fish were removed from six depletion zones a total of 680 m using a backpack electrofisher in the summer of 2008. Acrylic polymer was used to make subcutaneous marks on all fish captured for 100 m upstream and downstream of depletion zones. Variations in color of polymers serve as indicators of location of origin for recaptured fish. PIT (passive integrated transponder) tags were used to identify smallmouth bass (*Micropterus dolomieu*) and northern hog suckers (*Hypentelium nigricans*) for analysis of migration tendencies following successive recaptures. A total of 2883 fish were removed in the depletion zones of which 35.9% (1036) were central stonerollers (*Camptostoma anomalum*), 22.5% (649) orangebelly darters (*Etheostoma radiosum*), and 16.9% (489) longear sunfish (*Lepomis megalotis*). The results presented were gathered in the first of two summer field seasons and detail community structure as monitoring for movement through recapture will be the focus of the second field season in summer 2009.

Oak Alley/Madewood 8:00-9:40 AM

Paddlefish Contributed Papers

Paddlefish harvest in Oklahoma (1979-2008)

Gordon, B. D. N.E. Regional Fisheries Supervisor, ODWC

The paddlefish (*Polyodon spathula*) fishery in the Neosho River – Grand River system has been investigated since 1979 to determine the harvest and rate of exploitation by sport and commercial fisheries. Creel information in recent years (2008) showed sport angling pressure and harvests had increased from levels observed in 1992. Angler exploitation in 2003 was substantially lower when compared to 1992 and 1993 (2,932, 7,715 and 4,725 respectively). Although exploitation and population size/structure were of concern from 1979 thru 1993, subsequent establishment of more conservative paddlefish regulations followed by intense monitoring of this fishery appears to have been successful in allowing the population to rebound to more desirable levels. Observations of commercial fishing operations were also made to determine the exploitation and utilization by this fishery.

Results of a post-season survey of paddlefish permit holders following the opening of the Paddlefish Research and Processing Center in Oklahoma

Crews, A.J., Foster, A.F., Gordon, B.D., and V.K. Green, Oklahoma Department of Wildlife Conservation (ODWC)*

The Oklahoma Department of Wildlife Conservation (ODWC) opened its Paddlefish Research and Processing Center (RPC) in February of 2008. The ODWC conducted a post-season survey of paddlefish anglers. The survey was designed to measure fishing participation in 2008, use of the RPC by anglers, satisfaction with the experience and the impact the RPC may have had on paddlefish harvest. 29,338 free Paddlefish Permits had been issued as of June 2008. A randomly selected 5,600 of these permit holders provided the sampling frame for the survey, and an adjusted response rate of 35% was received. Overall, 46% of respondents fished for paddlefish. Permit holders reported fishing for paddlefish between one and 150 days, for an overall average of 6.6 days. Respondents reported keeping between zero and 80 paddlefish during the season, for an overall average of 2.4 fish kept. Respondents reported releasing between zero and 440 paddlefish during the season, for an overall average of 11.6 fish released. Overall, 28% of active permit holders reported having fish processed at the RPC. The main reason RPC regional anglers did not use the RPC was that they preferred to process their own fish. Paddlefish anglers who used the RPC were asked to rate their satisfaction with six aspects of the operation, and in all cases more than half of the respondents were very satisfied. Results of the survey do not seem to indicate a significant increase in paddlefish harvest as a direct result of the RPC and the free meat processing service provided.

Stock assessment of a paddlefish population located On the Neosho River system using the paddlfish research and processing center

*Moore, K. N. *, Gordon, B.D., Green, V. K., Oklahoma Department of Wildlife Conservation (ODWC), and D.L. Scarnecchia, University of Idaho*

Paddlefish (*Polyodon spathula*) populations have declined in their native range over the past century due to destruction of habitat, over harvest by poachers for their valuable roe and many other factors. With a world class paddlefish fishery located on the Neosho River system, snagging has gained in popularity over the past two decades. Therefore, monitoring is imperative to prevent over harvest. On February 18, 2008 The Oklahoma Department of Wildlife Conservation (ODWC) opened the Paddlefish Research and Processing Center (PRPC) at Twin Bridges State Park. The anglers in the area voluntarily brought their paddlefish to the center and allowed us to obtain data from the fish, in return for getting their fish cleaned and packaged. The roe from the females that were brought in was donated to the department and processed into caviar for legal sale on the world market to fund future paddlefish research and management. Of the 4,221 fish that were processed at the center 1,723 (41.8%) were females and 2,498 (59.1%) were males. The average weight and length of the females was 17.391 kg and 1014 mm respectively. While the average weight and length for males was 11.418 kg and 913 mm respectively. Dentary bones were taken from every fish brought in to determine the age of the fish and are still being analyzed. The findings of this ongoing study will give biologists an independent stock assessment of the paddlefish population located in the Neosho River system above Grand Lake.

Monitoring paddlefish movement with ultrasonic telemetry in the Grand River system

James, K.H., and B. Gordon, Oklahoma Department of Wildlife*

Construction of impoundments along the Grand River System in northeast Oklahoma negatively impacted historical migration routes and spawning sites of paddlefish (*Polyodon spathula*). Protection of existing migration routes and spawning sites are crucial to the health of the paddlefish populations throughout this system. Environmental data, i.e., flows, water temperature, were monitored to predict when spawning migrations commence. Sexually mature paddlefish (22) were surgically implanted with ultrasonic transmitters in December 2007 and January 2008. Movements were monitored over a 12-month period using Submersible Ultrasonic Receivers (SURs) deployed at strategic locations in addition to roving surveys using hydrophones. Paddlefish staged in the upper 30% of the reservoir beginning early winter (December). Spawning runs began in late February and ended by late April. Peak spawning runs were triggered by flows of approximately 25,000 – 35,000 cfs (Grand River) and 60,000 cfs (Spring River) at water temperatures between 7° C and 13° C. External jaw tags along with research signs at access areas were used to notify anglers of the project. The data gathered from this telemetry study will provide valuable information to incorporate into a statewide comprehensive management plan for paddlefish.

Movements and distribution of a reintroduced population of paddlefish in Lake Texoma

Patterson, C. P., Oklahoma Department of Wildlife Conservation, and W. L. Fisher, USGS New York Cooperative Fish and Wildlife Research Unit, Cornell University*

The U.S. Fish and Wildlife Service reintroduced paddlefish into Lake Texoma by stocking approximately 119,000 fish from 1999 to 2007. Annual netting surveys indicate that paddlefish abundance in Lake Texoma is below that produced from other paddlefish restoration projects. To help fish managers develop more efficient and representative sampling programs, seasonal distribution and movement patterns of individual populations and their habitats are needed. In 2007 and 2008 we implanted 30 paddlefish with ultrasonic transmitters in Lake Texoma. The lake was searched approximately twice per month from February 2007 to December 2008. Most fish inhabited the upper ends of the reservoir throughout the year. The two main tributaries of Lake Texoma, the Red and Washita Rivers, were also monitored in 2008 with four stationary receivers to verify if transmitter implanted paddlefish left the lake on a spawning migration. Three paddlefish logged on a receiver 37km up the Washita River suggest that adult paddlefish are making reproductive migrations.

Bienville 8:00-9:40 AM

Aquaculture Contributed Papers

The attraction response of male blue catfish (*Ictalurus furcatus*) and male channel catfish (*Ictalurus punctatus*) to channel females injected with either pheromonal steroids or prostaglandin T

Broach, J.S., England, S.E., and R.P. Phelps, Auburn University*

The hybrid between female channel catfish (*Ictalurus punctatus*) and male blue catfish (*Ictalurus furcatus*) exhibits better traits for commercial aquaculture than do channel catfish. However, the two species do not naturally hybridize very readily. A lack of the male blue's interest and attraction to the female channel is thought to contribute to the low success. This study was conducted to determine if a blue and channel male's attraction to channel females could be increased using 17alpha, 20beta-dihydroxy-4-pregnenone-3-one (17,20beta-P), its glucuronated form (17,20beta-P-Glucosiduronate), or prostaglandin F-2alpha (PGF-2alpha) as potential pheromones. Channel females were injected intraperitoneally with an ethanol solution containing either 0.0 mg/kg or 0.5 mg/kg of one of the following: 17,20beta-P; 17,20beta-P-

Glucosiduronate; or PGF-2alpha. The females were then placed in traps and distributed equally into ponds containing only male blue or male channel catfish. Channel males were attracted to PGF-2alpha injected females on 22.9% of their given opportunities, and were attracted to control females only 1.4% of the time. Blue males responded to 17,20beta-P-Glucosiduronate and PGF-2alpha injected females 8.3% of their given opportunities for each treatment, but were not attracted to the control females. Over 90.0% of the trappings occurred between 48 and 96 hours post-injection. One PGF-2alpha injected female attracted 66.7% of the channel males trapped during that trial. Only 15% of blue males used were attracted to channel females, but those blue males were attracted on multiple occasions. These results suggest that PGF-2alpha injections into female channel catfish may elicit a blue and channel male's attraction.

Comparison of rainbow Trout (*Onchorhynchus mykiss*) and smallmouth bass (*Micropterus dolomieu*) primary hepatocyte cultures for in vitro estrogen screening.

Chambers, E.B., Mazik, P.M. West Virginia University and V.S. Blazer, USGS*

A suspected contributing factor of intersex, the presence of immature oocytes in the male testes of fish, and the fish kills occurring in local rivers is believed to be the exposure of these fish to estrogenic endocrine disrupting chemicals (EEDCs). EEDCs are often seen in the effluent of wastewater treatment plants. A simple and common way to look at estrogenicity in water is to deploy POCIS (polar organic chemical integrative sampler) passive water samplers and extract the filters with methanol for hydrophilic compounds. Samplers have been deployed upstream and downstream of two wastewater treatment plants, one on the Conococheague River and one on the Monocacy River, both of which are in Maryland. For comparison, a sampler has been deployed in Blue Plains, just outside of Washington, D.C. and one was deployed at a control site in a closed pond at the National Fish Health Research Laboratory in Kearneysville, WV. Primary hepatocytes isolated from rainbow trout and smallmouth bass will be exposed to screen for estrogenic compounds found in the extracts of the deployed water samplers and using vitellogenin induction as an endpoint. Rainbow trout hepatocytes are often used for estrogenicity screening.

Preliminary histological evaluation of ultrasound imaging for use with induced spawning of channel catfish

Kuenz, D.E. Novelo, N., Green, C., and T.R. Tiersch, Louisiana State University Agricultural Center*

Many stages of ovarian development are present in populations of channel catfish before, during, and after the spawning season. The goal of this study was to adapt ultrasound technology for use in fish to increase the efficiency of induced spawning. Our objectives were to gain insight into the reproductive timing of channel catfish by better defining the classifications developed for ultrasound imaging of females through the use of body condition indices and histological assessment of ovaries. In total, 51 females were sampled from April through July, 2008 in Baton Rouge, Louisiana. An ultrasound image of the ovary was captured and classified from "Stage 1" (undeveloped) to "Stage 6" (atretic). Individual attributes recorded were: body length, weight, girth, and gonad and liver weight, from which were calculated indices including hepatosomatic index (HSI), gonadosomatic index (GSI), and Fulton's condition factor (FCF). Digital images were used to record condition of fish and organs. Tissue sections were taken from the middle of the ovary to represent the area viewed by ultrasound. These were fixed in 10% buffered formalin and stained with hematoxylin and eosin. Histological oocyte maturation was classified from "Stage 1" (pre-vitellogenic) to "Stage 6" (atretic). Body condition indices were significantly different [HSI ($p < .04$), GSI ($p < .01$), FCF ($p < .01$)] across the ultrasound stages and followed trends through the reproductive process. When the ultrasound stages were compared with the histological stages no significant correlation was determined ($r = 0.1016$, $p > 0.05$).

Sperm vitrification in the live-bearing fish *Xiphophorus helleri*

Cuevas-Uribe* ,R., Lang, P., and T.R. Tiersch, Aquaculture Research Station, Louisiana State University Agricultural Center

Xiphophorus fishes are some of the long-standing animal models for cancer research because hybrids of these fishes can develop melanomas. Inbred lines have been available for research since 1939. Despite the significant costs to maintain and generate these lines, few possibilities currently exist to preserve them safely for future research. Cryopreservation of sperm is a suitable strategy for the conservation of important individuals, strains, and lines including endangered species. Vitrification is an increasingly popular method of cryopreservation which involves the solidification of water into a glass-like state (non-crystalline ice). By increasing the cooling rate (to >1,000 C/min) and increasing the concentration of cryoprotectant (to 30-50%), samples can attain an amorphous glassy state before the formation of ice crystals. This ultra-rapid cooling is typically done by plunging small volumes of sample into liquid nitrogen. The goal of this project was to develop streamlined protocols that could be integrated into a standardized approach for vitrification of aquatic species germplasm. The specific objectives were to: 1) measure acute toxicity of cryoprotectants at varied concentrations; 2) test various solutions for vitrification; 3) evaluate different warming methods, and 4) evaluate the ability to fertilize eggs. From 9 cryoprotectants and 5 vitrification solutions, motility was observed for 3 cryoprotectants at glass-forming concentrations. Acceptable rates of thawed motility (>10%) were observed for sperm suspended in 40% glycerol, or with 20% ethylene glycol + 20% glycerol, and in samples warmed in Hanks' balanced salt solution at 300 mOsmol/kg at either 24 or 37 C.

The application of computer-assisted sperm analysis (CASA) to biomedical research fish models

Chen, Y.* , Yang, H. and T.R. Tiersch Aquaculture Research Station, Louisiana State University Agricultural Center

Zebrafish, medaka, and *Xiphophorus* are important fish models for biomedical research on developmental biology, physiology and disease. Gamete quality of these species is receiving more and more attention due to its importance in fertilization success and larval survival. Computer-assisted sperm analysis (CASA), which was originally applied to mammals, has been introduced to fish and shellfish since 1995 in following areas: sperm motility after cryopreservation, motility changes after exposure to toxic chemicals and hormone treatments, sperm enzymology, and motility characteristics in relation to storage solutions (e. g. pH, buffer, and osmolality). As research models, zebrafish, medaka, and *Xiphophorus* fishes are characterized by small body size (2-4 cm), study of CASA application to these fishes are rarely reported. The goal of this research is to establish suitable and reliable CASA parameter profiles including image capture, cell size, speed values, light intensity, and photometer settings for each species based on sperm characteristics. A commercially available CASA system (CEROS, Hamilton Thorne Biosciences) with modifications by manufacturer was used for this study. Different cell conditions (e. g. fresh vs. thawed) were compared and evaluated for CASA parameter settings. After establishment of parameter profile, these settings will be verified by sperm samples with known motility, and will be applied to evaluate sperm quality for future research such as motility activation and sperm cryopreservation. Establishment of reliable CASA analysis can provide an objective and accurate evaluation of sperm quality.

South Ballroom 10:20-Noon

Coastal Ecology Contributed Papers 4

The use of ultrasonic telemetry to estimate movement patterns, residency, and fishing and natural mortality of red snapper, *Lutjanus campechanus*

Topping*, D.T., and S.T. Szedlmayer, Auburn University Marine Fish Lab

Site fidelity, emigration, and mortality were estimated from telemetry for large (500 – 860 mm TL) red snapper *Lutjanus campechanus* (N = 92) from five artificial and one natural reef in the northeastern Gulf of Mexico. From Dec 2005 to 2008 we used arrays of five ultrasonic receivers at each site. Each array consisted of one receiver at the center with four receivers placed 1100 or 600 m north, south, east, and west of center. As of Oct 2008, 21% were caught, 34% emigrated, 12% died, 29% are still present, and 4% uncertain. Preliminary estimates of total mortality (Z) range from 0.31 to 0.72, fishing mortality (F) from 0.18 to 0.37, and natural mortality (M) from 0.14 to 0.35. Median residence time was 479 d, and ranged from 1 to 783 d, with 62% of fish staying at least one year at the site and 75% were present for at least 200 d. Some fish visited up to three sites (~7 km), and some returned after emigrating. Red snapper (N=6) tracked manually by boat over continuous 24-h periods stayed near (~100 m) the site during these tracks. These mortality rates were similar to past estimates while residence time was longer than any previous estimate.

Delivery of hatching larvae to estuaries by an amphidromous river shrimp: test of hypotheses using larval molting requirements and distribution

Rome, N.E., Conner, S.L., and R.T. Bauer, Department of Biology, University of Louisiana, Lafayette*

The river shrimp *Macrobrachium ohione* is abundant in the Atchafalaya and lower Mississippi rivers and formerly sustained a fishery as far north as the lower Ohio River. It is amphidromous, i.e., adults live and breed in freshwater but the larvae require marine development. In an amphidromous species, larvae may arrive at downstream estuaries without help from the female (stream drift); alternately, females may migrate from upstream habitats down to river mouths to hatch Stage-1 larvae into or near saline water. We tested predictions from these alternate hypotheses about larval delivery to the sea. A factorial experiment was conducted on the effects of residence time (time spent by Stage-1 larvae in freshwater before encountering seawater: 1, 3, or 5 days) and of salinity levels (2, 6, or 10 ppt) on molting success from Stage 1 (hatching stage, nonfeeding) to Stage 2 (first feeding-stage). Relative abundances of Stage-1 larvae were measured with plankton tows at two locations: the Atchafalaya Delta (AD) and Butte la Rose (BLR), ~ 150 km upriver. Larvae from 1-day and 3-day residence times showed no difference in molting success but the frequency of molting in larvae of 5-day treatments was significantly lower. Molting success varied significantly with salinity, with greater molting frequency at higher salinities. Larval abundances at the downstream (AD) location were an order of magnitude higher than those at the upstream (BLR) location. These results support the hypothesis of a hatching migration by females of *M. ohione* to deliver larvae to downstream estuaries.

Oyster Meat Yield From Selected Public Grounds of Terrebonne Parish, Louisiana

Kinsey, D.L., Hein, S., and P.D. Banks, Louisiana Department of Wildlife and Fisheries (LDWF), Marine Fisheries Division*

Oyster meat yield was investigated from January 2002 through December 2007 in the Sister Lake and Bay Junop Public Oyster Seed Reservations in Terrebonne Parish, Louisiana. The purpose of this study was to determine monthly oyster meat yields and to address the concerns of industry that oyster yields have steadily declined in recent years. For yield calculations, dredge samples were collected each month in both Sister Lake and Bay Junop. Each sample consisted of 105 lbs of culled, single, legal sized (>3") oysters. Oysters were counted, measured, and yield determined. The five year study determined oyster yields peak in February-March with sack yield averaging 9.7 lbs meat /105 lb sack in Sister Lake and 10.27 lbs /sack in Bay Junop. September had the lowest yields of 5.9 lbs/ sack and this may be due to the reproductive activities of the animals during this time. Initial statistical analysis determined no significant difference in yield between water bodies, but found a statistical difference between years with a general trend of increasing yield since 2002. This result is in direct contrast to industry claims of decreasing meat yields. Additional relationships between meat yield and factors such as salinity, water temperature, Mississippi River discharge, Atchafalaya River discharge, and monthly rainfall are currently being analyzed.

Louisiana Department of Wildlife and Fisheries Oyster Habitat Development Projects in the Pontchartrain Basin

Lindsey, T., Lezina, B., and V. Cefalu, Louisiana Department of Wildlife and Fisheries*

Oyster reefs provide important habitat for many marine species and are critical in the establishment and maintenance of fish populations. Although the Louisiana Department of Wildlife and Fisheries (LDWF) has undertaken numerous oyster habitat projects in the Pontchartrain Basin over the last 100 years, concentration will be given to rehabilitation efforts on historical oyster reefs damaged by Hurricane Katrina. Those efforts include spreading more than 80,000 tons of cultch material (i.e. limestone rock, crushed concrete, and oyster shells) on the water bottoms of Mississippi Sound and Black Bay in 2007. Additionally, LDWF plans on spreading an additional 80,000 tons of cultch material in the Mississippi Sound and Black Bay areas in 2009 to rehabilitate historical reef areas. The LDWF also manages a federally funded program in which Louisiana resident oyster harvesters perform rehabilitation activities on private oyster leases in the Pontchartrain Basin area. The private lease program began in the summer of 2007 and will continue through June 2009 providing reimbursement assistance for documented rehabilitative work. These actions are intended to promote oyster larval recruitment in the Pontchartrain Basin area, which benefits the basin in a variety of ways including strengthening existing reefs and supplying habitat for estuarine-dependent fish species. Additionally, the LDWF has performed ground truthing through side-scan sonar in Morgan Harbor and Drum Bay in 2008. A general overview of the results will be presented, which will promote a better understanding of the water bottom terrain of these areas in the Pontchartrain Basin.

Spatial Issues in Designing Marine Protected Areas for Gag grouper in the Gulf of Mexico

Ellis, R., Department of Oceanography and Coastal Sciences, Louisiana State University

Spatial scale is of particular importance for designing Marine Protected Areas used in fisheries management. While information about the spatial distribution and movement patterns of populations are critical for evaluating design, often there is a lack of this data. Simulation modeling is one way to create and compare different MPA designs across a range of presumed distribution and movement patterns, while identifying gaps in available scientific knowledge that will help improve management. This paper will present the results of a stage-structured model of the gag grouper (*Mycteroperca microlepis*) of the northern Gulf of Mexico and its particular life history. The model was created to investigate the efficacy of MPAs for the current management regime, and to investigate changes in the population dynamics of the fishery. Model evaluations guide the discussion of MPA design in the Gulf of Mexico by better defining the necessary information needs.

Daily growth differences of the juvenile Alabama shad, *Alosa alabamae*, in relation to mean daily river flow in the Pascagoula River drainage, MS.

Mickle, P.F., Department of Biology, University of Southern Mississippi*

In relation to life history, otoliths are a useful tool when aging fish whether it is on an annual or daily level. It is known that otolith daily ring width is related to growth rate, and differences in ring widths may be used to compare growth differences. Daily growth rings of the juvenile Alabama shad revealed that rings were not uniform throughout the otolith. Growth and larger ring widths may be a direct result of disparate flow levels in river systems. After determining spawn date from the otolith, the age data was overlaid with flow data to compare river flows with growth rate. 45 otoliths were analyzed in relation to ring width and compared with mean daily flow data. Flow differences may be a mechanism in relation to ring width differences (growth) within this species of fish as well as others. The flow differences and ring width relation is not fully understood, but may be used to address other species in rivers that are impounded and have altered flow levels.

North Ballroom 10:20-Noon

Rivers and Reservoirs Contributed Papers

Relation between reservoir hydrology and year-class strength of sport and forage fishes in a central Texas watershed.

Smith, N.G., Buckmeier, D.L., Daugherty, D.J., and K.S. Reeves, Texas Parks and Wildlife Department (TPWD) Heart of the Hills Fisheries Science Center

Successful fisheries management is often dependent on understanding, and when possible influencing, the factors controlling year-class strength. There is increasing evidence that reservoir hydrology plays a large role in regulating year-class strength of sport and forage fishes. Understanding these relations is becoming increasingly important in Texas, as changes in water supply and demand are influenced by human population growth and climate change. We examined the relation between year-class strength and hydrologic variables for several sport (largemouth bass, channel catfish, blue catfish, white crappie, black crappie, white bass) and forage (gizzard shad) fishes in five mainstem reservoirs (J.B. Thomas, O.H. Ivie, Buchanan, Lyndon B. Johnson, and Travis) in the Colorado River Watershed. Residuals of catch-curve regression were used as an index of year-class strength and correlated with reservoir hydrologic characteristics. In addition, growth was compared among reservoirs and related to reservoir hydrology. Hydrologic characteristics were variable across reservoirs which allowed for comparisons among different water level management options. Within each reservoir, we observed similar patterns among species, with the greatest differences in both recruitment and growth patterns found among reservoirs, suggesting that successful fisheries can be created or maintained under varying hydrologic regimes. Quantifying the relations between recruitment and hydrology will allow fisheries managers and policy makers to minimize, mitigate, or prevent detrimental effects, and adjust exploitation when weak year classes are expected.

Effects of water-level variations on littoral-zone habitat characteristics and angler access in four Texas reservoirs: a GIS-based approach.

Daugherty, D. J., Buckmeier, D. L. Heart of the Hills Fisheries Science Center, Texas Parks and Wildlife Department and P.K. Kokkanti, River Studies Program, Texas Parks and Wildlife Department*

Demands for freshwater in Texas are increasing as a result of human population growth and climate change. Water use is projected to increase by 27 percent over the next 60 years and by 2050 approximately 900 Texas cities will need to reduce water consumption or find alternative sources. Proposed changes in ground- and surface-water management, coupled with the effects of climate change, suggest it will be more difficult to maintain reservoir water levels throughout the state. As a result, greater water level variation may negatively affect the productivity of important sport fisheries and reduce boat and bank access for recreational users. In an effort to determine the magnitude of future water demands and reservoir management strategies on fisheries and angler access, we used predicted water availability (reservoir storage) models and hypsographic data in a geographic information systems format to predict variation in littoral-zone habitat quantity and quality and angler access in four Colorado River (TX) reservoirs. Results indicate that future reservoir water-level fluctuations ranging from -7 to +5 m are likely to occur, resulting in significant impacts on both littoral-zone habitat quantity and quality and angler access. The results of this study, combined with relationships between fish recruitment and hydrology, will provide fisheries managers and reservoir planning authorities the information necessary to ensure that the needs of both fish and anglers are met as demand for water increases.

Habitat suitability for shortnose sturgeon in the Ogeechee River, Georgia

Farrae, D. and D. Peterson, Warnell School of Forestry and Natural Resources, University of Georgia

The Ogeechee River, Georgia is thought to contain one of the smallest populations of the endangered shortnose sturgeon (*Acipenser brevirostrum*). Despite more than four decades of federal protection, the most recent information suggests that the population has not recovered. The objectives of this study were to: 1) estimate current population abundance, 2) evaluate seasonal habitat use, and 3) monitor seasonal changes in water quality and model habitat suitability based on established environmental tolerances of shortnose sturgeon. From June–August 2007 and 2008, we conducted a mark-recapture population estimate using entanglement gear deployed during slack tides within the tidally influenced portion of the Ogeechee River. In 2007, we marked 96 individual shortnose sturgeon, 15 of which were recaptured yielding a within year estimate of 368 (95% CL; 223–657). In 2008, we marked 71 individuals and recaptured 7, yielding an estimated 380 individuals (95% CL; 273–697). To monitor seasonal habitat use of adult shortnose sturgeon, we used sonic-telemetry to monitor the weekly movements of 18 individual adult shortnose sturgeon. Habitat use of these fish varied seasonally. During summer, freshwater habitats were preferred; however in cooler months, brackish water habitats in the lower estuary were preferred. The resulting habitat suitability models suggest that Ogeechee River habitats are either unsuitable or only marginally suitable for shortnose sturgeon during the summer months. Our findings indicate that low dissolved oxygen, in conjunction with elevated salinity and temperature during the summer months may be currently limiting recovery of the Ogeechee River population of shortnose sturgeon.

Habitat preferences of the stargazing darter (*Percina uranidea*) and genetic comparisons of disjunct and conjunct populations

Rigsby, J.M., Stoeckel, J.N., and T. Yamashita, Arkansas Tech University*

The distribution of the stargazing darter *Percina uranidea* is disjunct with populations occurring in the White and Ouachita River systems of Arkansas, Missouri and Louisiana and is currently listed as a species of lower risk near threatened on the IUCN Red List of Endangered Species. The bulk of the distribution occurs in Arkansas. This study has been designed to establish current distribution, relative abundance, microhabitat preferences and genetics of the species to determine if distinct populations can be discerned within the same river system and between the river systems within the Arkansas border. A total of 287 *P. uranidea* were collected from 30 sites of 166 sampled across seven rivers. Relative abundance ranged from 1/1.7 to 1/244 m² at sites where it was collected with a median of 1/122 m². Logistic regression using Principal components analysis showed three factors that can be used to predict presence/absence. Component 1 is defined as a relatively shallow habitat with high velocity and large substrates (+ influence), component 2 is defined as a relatively shallow habitat with low velocities and large substrates (- influence) and component 3 is defined as a relatively deep habitat with low velocity and small substrates (- influence). Electivity indices showed that *P. uranidea* prefers depths ≤ 2 m, 60% velocities >0.60 m/s, bottom velocities >0.30 m/s and substrate ranging from 100% gravel to 100% cobble. Genetics showed that *P. uranidea* has diverged when comparing the disjunct White and Ouachita River systems. No divergence is observed when comparing conjunct populations.

Effects of river discharge on abundance of larval and age-0 redhorses in the Oconee River, Georgia, USA

*Peterson, R. C. *, Georgia Cooperative Fish and Wildlife Research Unit, Warnell School of Forestry and Natural Resources, University of Georgia, C.A. Jennings and J.T. Peterson, USGS Georgia Cooperative Fish and Wildlife Research Unit, Warnell School of Forestry and Natural Resources, University of Georgia*

Robust redhorse (*Moxostoma robustum*) is a species of special concern that occurs in the Oconee River in middle Georgia. Attempts to investigate factors affecting the robust redhorse reproductive success have met with limited success. Therefore, catch of robust redhorse young were combined with catch of notchlip redhorse (*M. collapsum*) to increase sample size. The assumption was that these congeners with similar spawning repertoire would respond similarly to environmental conditions. River discharge during spawning and rearing seasons may affect abundance of both redhorses in the Oconee River. An information-theoretic approach was used to evaluate the relative support of models relating abundance of larval and age-0 redhorses to monthly discharge statistics for April through June 1995–2006. The

statistics represented magnitude, timing, duration, variability, and frequency of river discharge events. Model support was evaluated by calculating Akaike's information criterion corrected for small-sample bias and Akaike weights. The best-approximating model is 9.58 times more plausible than the next best-fitting model and indicated a negative relation between redhorse abundance and the mean maximum river discharge and the number of high pulses during June, and a positive relation with intermediate duration of low flows during April-June. The next best approximating model revealed a negative relationship between abundance and May mean maximum river discharge and the number of high pulses during June, and a positive relationship between abundance and intermediate duration of low flows during April-June. These models can be used to manage flows in the Oconee River, which may increase reproductive success of robust redhorse.

Use of sagittal otoliths to determine age of longnose gar (*Lepisosteus osseus*) with additional contributions to the life history

Osborne, J.H., and R.A. Rulifson, Institute for Coastal Science and Policy, and Department of Biology, East Carolina University

The longnose gar (*Lepisosteus osseus*) is a voracious predator; inhabiting fresh and brackish water and rapidly growing to a large size. This study determined ages using sectioned sagittal otoliths. Sagittae were extracted from longnose gar collected at the Lake Mattamuskeet National Wildlife Refuge and the Tar River in eastern North Carolina. Each fish was sexed and weighed; gonads were removed and weighed to determine gonadosomatic indices. Population length-weight relationships for the gar in these two populations were: $TL = 222.86\ln(WT) - 880.49$ ($r^2=0.8926$) for Mattamuskeet, and $TL=137.81\ln(WT) - 246.63$ ($r^2=0.9711$) for the Tar River population. Length-weight relationships by sex were $TL=161.96\ln(WT) - 441.54$ ($r^2=0.5493$) for Mattamuskeet males and for females was $TL=217.45\ln(WT) - 785.49$ ($r^2=0.882$). Tar River fish had length-weight relationships of $TL=163.62\ln(WT) - 412.04$ for males ($r^2=0.9399$), and $TL=129.83\ln(WT) - 200.44$ for immature fish ($r^2=0.9688$). Mature females were absent from this sample set. Results of sagittae ageing showed distinct age classes corresponding to the length-weight relationships. Sexes exhibited differences in otolith size at age. Gonadosomatic indices indicated longer spawning seasons than previously thought.

Regal 10:20-Noon

Stream Ecology Contributed Papers 2

Habitat selection in ammocoetes of the least brook lamprey (*Lampetra aepyptera*)

Smith, D.M., and S.A. Welsh, USGS West Virginia Cooperative Fish and Wildlife Research Unit*

Lamprey larvae (ammocoetes) commonly burrow into soft substrate of stream bottoms. Population declines of many species of lamprey have been attributed to habitat degradation. Although several observational studies have reported substrate selection patterns in ammocoetes, few experimental studies have quantified habitat use of ammocoetes. In this laboratory study, we quantified substrate selection in small (< 5 cm) and large (10-15 cm) ammocoetes of the least brook lamprey (*Lampetra aepyptera*). Ammocoetes were given the opportunity to burrow into six different substrate types (small gravel, coarse sand, fine sand, organic debris, silt/sand/clay mixture, and clay). Based on electivity indices, fine sand was the only substrate strongly-selected. Fine sand habitat is limited in many river systems, in part, owing to geology, but also as a result of excessive siltation – a conservation concern. Ammocoetes are not habitat generalists based on selection of fine sand habitat, hence, availability of fine sand habitat may limit distributions and population sizes.

Vertical habitat shifts and mixed-species shoals of closely-related native and nonnative cyprinids: a possible example of invasive mutualism

Welsh*, S.A., USGS West Virginia Cooperative Fish and Wildlife Research Unit, and B.J. Keplinger, West Virginia Division of Natural Resources

Species of pelagic cyprinids often segregate vertically within the water column. In the case of native and non-native cyprinids, vertical segregation in the form of habitat shifts may have important consequences for conservation. Alternatively, studies have documented mutualism between native cyprinid species in the form of mixed-species shoals. Few studies, however, have examined the effects of non-native cyprinids on vertical habitat use of native cyprinids. This experimental laboratory study quantified habitat shifts of two native species of the New River drainage (New River shiner *Notropis scabriceps* and spotfin shiner *Cyprinella spiloptera*) in the presence of non-native congeners (*N. telescopus* and *C. galactura*). Four 246 L aquaria and six vertical position categories were used to experimentally-examine shifts in water column positions. We examined differences in vertical distributions between single species (allotopic) and mixed species (syntopic) experimental trials. Although native/nonnative pairs differed significantly in vertical habitat use for both allotopic and syntopic comparisons, the overlap of vertical distributions between native/nonnative pairs increased greatly during syntopic trials. Laboratory results indicate that these native/nonnative congeners do not segregate during syntopy, but rather integrate into mixed-species shoals. If laboratory-observed patterns of species integration also occur in wild populations, then competitive interactions will likely occur owing to the close association between native and non-native species in the use of vertical habitat space. Alternately, integration of these closely-related native/nonnative species could represent a form of invasive mutualism.

Reproductive life history and laboratory spawning observations of the Western Sand Darter (*Ammocrypta clara*) from the Black River system in northeast Arkansas.

Driver*, L.D., and G. Adams, University of Central Arkansas

A reproductive life-history study was conducted on the Western Sand Darter, *Ammocrypta clara*, in the Black River system in northeastern Arkansas. While much is generally known about percid fishes within the genus *Ammocrypta*, limited research has been conducted specifically dealing with *A. clara*. A total of 362 adult specimens were collected during 2007 and 2008 from the Current, Strawberry, and Black rivers. Collection of gravid females and GSI indicate a late and protracted spawning season occurring between March and September with peak activity during May and June. Average size of adult males and females was 43 mm SL, and most individuals reached sexual maturity between 36-38 mm SL. Females outnumber males 1.3:1 throughout the sampling period. Maximum female GSI occurred in May and was 5.59%. Reproductively mature females contained 36-141 mature (MA) ova and average size of MA ova was 0.76 mm. Laboratory spawning was observed in specimens collected in August 2007. Males and females were observed undulating and vibrating vigorously in corners and along the side of the tank, creating depressions in the sand substrate. Spawning events varied in the number of individuals participating, from one male and one female, up to 8 individuals of unknown sex ratios. A total of 89 eggs were collected, most were buried singly below the sand surface. During the observation period, fish remained buried in the sand except in crepuscular periods. In the weeks and months following spawning adults were active diurnally. Laboratory conditions were replicated during summer 2008, and although many behaviors were similar, spawning was not observed.

Assessing relationships between aquatic habitats and small fish and macroinvertebrates: does plant type matter?

Camp*, E., W.E. Pine III, and T.K. Frazer, University of Florida, Department of Fisheries and Aquatic Sciences.

Modifications of aquatic habitats are widely expected to illicit marked changes in the abundances and distributional patterns of fish and invertebrate species that utilize these habitats. This expectation has motivated multiple state and federal agency initiatives directed at habitat management, such as the State Wildlife Grants Program. We are assessing linkages between aquatic habitats (submerged aquatic vegetation, SAV) and small bodied fish and macroinvertebrates (SFI) in the Homosassa and Chassahowitzka rivers; spring-fed rivers along the west coast of Florida. A decade of research indicates a shift in the SAV communities within each of these systems, with decreases in rooted macrophytes (e.g. *Vallisneria*) and concomitant increases in the relative abundance of nuisance filamentous macroalgae. To assess SFI and SAV relationships in each river, we used throw traps to sample SFI associated with five different SAV habitat types: *Vallisneria americana*, *Potamogeton* spp., filamentous macroalgae species, mixed assemblages of macrophytes and filamentous macroalgae, and unvegetated substrate. Preliminary results suggest that SFI densities were generally highest in filamentous macroalgae. However, diversity index values were lowest in this habitat type and higher in *Vallisneria*, *Potamogeton*, and mixed assemblages. Some taxa, such as Gulf pipefish (*Sygnathus scovelli*) were associated almost exclusively with these rooted macrophyte habitat types. Estimates of SFI density and diversity provide insights into how organisms that occupy higher trophic levels may respond to changes in habitat. This information is valuable for investigating the ecology of habitat-animal relationships as a decision support tool for managers.

Current status of the endangered duskytail darter *Etheostoma percnurum* and the threatened spotfin chub *Erimonax monachus* in Abrams Creek, Great Smoky Mountains National Park*

Gibbs, W.K., and S.B. Cook, Tennessee Tech University*

In an attempt to establish a trophy rainbow trout *Oncorhynchus mykiss* fishery, rotenone was applied to lower Abrams Creek in 1957. Reestablishment of riverine species into Abrams Creek was inhibited by creation of Chilhowee Reservoir on the Little Tennessee River. Four of the 46 fish species extirpated are currently federally listed as threatened or endangered, including duskytail darter *Etheostoma percnurum* and spotfin chub *Erimonax monachus*. Cooperatively, Great Smoky Mountains National Park (GRSM) and Conservation Fisheries, Inc. (CFI) have been stocking these federally listed species throughout lower Abrams Creek in an effort to reestablish sustainable populations. Habitat and snorkeling surveys were conducted during the summers of 2007 and 2008 throughout 17.4 kilometers (km) of lower Abrams Creek to assess the current status of these reintroduced populations. Duskytail darters inhabited a 4 km section of the study area while no spotfin chubs were observed in the entirety of lower Abrams Creek. Average relative abundance of duskytail darters throughout their distribution was 0.48 fish/person/hour. Utilization of GIS for watershed analysis of spotfin chub populations in Tennessee revealed factors contributing to absence in Abrams Creek. Variables influencing distribution and dispersal of duskytail darters will be identified with statistical analysis of habitat parameters. * This is a study in progress to be completed Spring 2009.

Habitat use by fish species in groundwater dependent ecosystems of southern Oklahoma.

Seilheimer, T.S., and W.L. Fisher, USGS New York Cooperative Fish and Wildlife Research Unit, Cornell University

Habitat selection by fish in springs and spring-fed creeks is poorly understood. We collected habitat preference data for four fish species (southern redbelly dace, redbelly dace, least darter, and orangethroat darter) in three groundwater dependent springs draining the Arbuckle-Simpson aquifer of southern Oklahoma. Habitat for each species was classified based on four variables: depth, velocity, substrate, and cover. We observed differences in habitat use within sites but variation primarily occurred between sites. Cluster analysis and principal components analysis were used to organize species by site and then within site. We developed habitat suitability criteria that can be used for instream flow assessments in other habitats in southern Oklahoma and also in other regions with similar habitat, such as the Ozark Highlands. This study improves our ecological knowledge of these species, which are vulnerable to habitat modification and extirpation resulting from groundwater withdrawals.

Teche/Belle Grove 10:20-Noon

Fisheries Management Contributed Papers 4

Potential population-level effects of black crappie Commercial gill net bycatch and recreational fishing mortality in a Florida lake

*Dotson, J. *, Johnson, B., and C. Steward. Florida Fish and Wildlife Conservation Commission*

We evaluated the potential population-level impacts of commercial gill net bycatch and recreational fishing mortality on black crappie *Pomoxis nigromaculatus* at Lake Griffin, Florida. Commercial bycatch can potentially cause population-level effects and represents serious concerns for the sustainability of fisheries. For this study, we estimated annual black crappie bycatch mortality from a commercial gill net fishery (2002-2008) with onboard observer data, quantified recreational fishing effort and harvest (1974-2006) with an annual peak season creel survey, and utilized an age-structured population dynamics model to investigate potential population-level impacts of bycatch and/or recreational fishing mortality. Simulations were performed from a stock reduction analysis (SRA) population dynamics model to investigate the sustainability of the black crappie fishery under different harvest policies utilizing a weighted transitional spawning potential ratio (SPR) as a biological reference point to evaluate the potential of recruitment overfishing. Our results suggest that recreational harvest decreased by approximately 90% from 1974-1999, prior to the establishment of a commercial gill net fishery. This was likely due to periods of recreational overharvest, periods of severely poor recruitment, and/or changes in population carrying capacity resulting from significant declines in water quality and available habitat. Annual commercial bycatch mortality (2002-2008) was relatively low compared to recreational fishing mortality. Model simulations suggest that the current harvest levels (recreational and commercial bycatch) are sustainable; however, increases in harvest levels from the recreational and/or commercial bycatch fisheries could risk recruitment overfishing. The greatest risk for recruitment overfishing due to bycatch occurs when recreational exploitation is already high.

Counterintuitive population effects due to interactions among common fisheries management strategies

Pine, W.E., III, University of Florida, Martell, S. J. D., University of British Columbia Coggins, L.G., Jr. USGS-GRMRC, Allen, M.S., Catalano, M.J., University of Florida, and C.J. Walters, University of British Columbia*

The ability of recreational fisheries to substantially modify fish populations through direct and indirect harvest effects has traditionally received much less attention than more highly publicized commercial fisheries collapses. When confronted with declining catch rates, management agencies commonly implement regulations such as size limits, bag limits, harvest quotas or some combination of each with the expectation that these regulations will conserve fish stocks by reducing harvest and ultimately increasing recruitment. Size and harvest limits are likely the most common regulatory tool for regulating catch, and examples of these restrictions can be found in every US state and Canadian province. We used an age and size structured population model that included post-release survival effects to evaluate the efficacy of size and harvest limits for a variety of recreationally important fish species. A key finding is the unexpected interaction between size and harvest limits on equilibrium recruitment. For some life history types, certain combinations of size and harvest limits can interact negatively to cause depensatory mortality – actually increasing the effective mortality rate when the objective of the regulation was to conserve fish stocks.

Privately-owned small impoundments of Central Alabama: a survey and evaluation of management techniques and enhancements

Haley, III, N.V., Wright, R.A., and D.R. DeVries, Auburn University, Department of Fisheries*

Angling quality for largemouth bass *Micropterus salmoides* and sunfish *Lepomis* spp. in small impoundments relates to the management techniques used. While standard management techniques can provide quality fishing, many pond owners wish to produce larger/more abundant gamefish. We surveyed 159 randomly-selected private pond owners in 23 central Alabama counties by telephone regarding their pond management techniques and enhancements. Of those surveyed, 48% fertilized, 37% applied pellet feed, 13% stocked supplemental forage fish, and 10% reported no active management. Survey results were used to identify ponds for fish population assessments in fall 2007 (n = 31) and spring 2008 (n = 34). Ponds were selected that were managed with all possible combinations of the three most reported management enhancements including fertilization, pellet feeding, and threadfin shad *Dorosoma petenense* as supplemental forage or no active management. Sites were sampled using electrofishing and seining, and abiotic data were collected. Results indicated high variability of abundance, growth, and condition of largemouth bass and sunfish both among and within these management strategies. This information provides insight as to whether these techniques/enhancements can maintain high quality sportfish populations in small impoundments, allowing pond owners and managers to decide on their utility.

Modeling redbreast sunfish nest survival in the regulated Tallapoosa River, Alabama: defining functional responses to discharge and temperature.

Martin, B.M., and E. Irwin, USGS Alabama Cooperative Fish and Wildlife Research Unit, Auburn University*

Nesting redbreast sunfish were monitored during 2006 and 2007 to acquire nest survival estimates downstream from R.L. Harris Dam, a hydroelectric facility, in support of adaptive management of the Tallapoosa River. Results from previous research estimated nest success during an extreme wet water year (1999) and a moderately wet water year (2000) and suggested that discharge negatively affected nest survival. A 10-11 day spawning window during mid-June was suggested to increase nest survival of redbreast sunfish. Data collected in the current study included nest success estimates for an extreme dry water year (2007) and another moderate water year. Detailed competing models of nest survival versus environmental factors were evaluated using Program MARK for both years. Nest survival was positively related to daily minimum discharge in 2006 and negatively related to daily maximum discharge in 2007. Spawning windows were supported from results and the proposed 10-11 day window appears sufficient. However, current results indicated a spawning window could occur as early as mid-May for increased nest survival and timing could allow for enhanced spawning success for other fish species. Results will be used in evaluation of discharge regime to enhance nest survival during spawning windows in an adaptive management context. Because discharge and temperature were correlated, specific effects of temperature on nest survival were not detected in this study.

Fluctuating asymmetry and condition in fishes exposed to varying levels of environmental stressors

Zuber, B.C. and J.F. Schaefer, The University of Southern Mississippi*

The ability of an organism to combat developmental stress correlates with its developmental stability which can be assessed by measuring fluctuating asymmetry. Fluctuating asymmetry (FA) is variation in bilaterally symmetrical traits, and deviations in bilateral traits from perfect symmetry may point to developmental stress. The purpose of this study is to assess the potential link between FA and putative correlates of fitness in freshwater fishes by addressing the following questions: 1) Do any differences in FA and/or measures of fitness exist that correlate with position of the fishes upstream or downstream or with increasing distance from a potential source, and 2) Is there any correlation between FA and measures of fitness? Sites were selected from around the Leaf River Pulp Mill, New Augusta, MS, and collections from each of three species (*Lepomis megalotis*, *Cyprinella venusta*, and *Carpionodes velifer*) were made in July, September, and November 2006. Several morphometric measurements were taken from each fish to determine the degree of FA. Percent lipids, Fulton's Condition Index, Gonadosomatic index (GSI), and fecundity were also measured as correlates of fitness. Differences were seen in FA

values with distance (*C. venusta*) and direction (*C. velifer*) from the source. No correlations between FA and measures of fitness were found. FA may be a better indicator of anthropogenic stress to an ecosystem than measures of fitness because FA is not seasonally variable. Also, FA can be measured on multiple species, abundant species, and species at various trophic levels.

Contribution of Stocked Sauger to the Broodstock Populations in R.S. Kerr and W.D. Mayo Reservoirs on the Arkansas River Navigation System.

Johnston, J.S., and G.L. Peterson, Oklahoma Department of Wildlife Conservation (ODWC)*

Sauger, *Stizostedion canadense* are native to Oklahoma, found in the Poteau, Illinois, Red, Neosho, and Arkansas Rivers. Little research on sauger has been conducted in Oklahoma to date. The Oklahoma Department of Wildlife Conservation (ODWC) stocked 15,000 sauger fingerlings in the Arkansas River from 2000 to 2002 to augment population size, but these stockings were never formally evaluated. Since the spring of 2002, no sauger have been stocked in the Arkansas River. Maceina et al. (1998) found sauger mature around 300 mm in the Tennessee River of Alabama with the average length of age-1 males 269 mm and age-1 females 268 mm. In 2002 over 30% of the sample collected below Webber Falls Dam on the Arkansas River was <300 mm in length. During the 2007 broodstock collection, no fish <300 mm were recorded. Sampling will be performed in 2008 and 2009 to evaluate the sauger population in R.S. Kerr and W.D. Mayo reservoirs. Otoliths will be removed from 10 fish per 25 mm length group. In 2010 and 2011, 20,000 sauger fingerlings will be marked with oxytetracycline (OTC) and stocked into R.S. Kerr Reservoir. Post-stocking sampling will be performed bi-annually in R.S. Kerr and W.D. Mayo Reservoirs and otoliths removed. Age-1 and age-2 sauger will be checked for OTC marks. Results from this study will indicate to what degree fingerling stocking impacts the sauger population, and whether continued stocking is justified. Literature Cited: Maceina, M.J., P.W. Bettoli, S.D. Finely and V.J. DiCenzo. 1998. Analysis of the Sauger Fishery with Simulated Effects of a Minimum Size Limit in the Tennessee River of Alabama. North American Journal of Fisheries Management, Vol. 18, No. 1, February 1998.

Oak Alley/Madewood 10:20-Noon

Fisheries Management Contributed Papers 4

National Fish Strain Registry: A management tool

Rankin, N.M. and C.R. Figiel, Warm Springs Fish Technology Center, U.S. Fish and Wildlife Service*

The National Fish Strain Registry (NFSR) is an internet-based database that assembles information on the life history, genetic, reproductive, and behavioral characteristics of wild and domestic broodstock strains throughout the United States. These strains are managed by state and federal agencies and cultured at federal, state, or private hatcheries. The database contains information on broodstock source, life history, reproductive characteristics, culture system, water quality, feed and performance analyses, stocking programs, habitat preference, genetic analysis and cryopreservation data. This management tool can assist fishery resource managers and producers with decisions on which populations will be most effective for production or conservation applications. As of September 2008, there are 527 strain records in the database, and the NFSR is designed to accommodate most fish species and will expand to collect strain information for endangered and other aquatic species.

You don't have to be a programmer anymore: Integrating new SAS technologies for data analysis and reporting

Janssen, F. W., Texas Office of the Attorney General, and J.B. Taylor, Texas Parks and Wildlife Department

There are several new technologies that SAS, a producer of statistical analysis software, has recently developed that offer much promise in furthering the analytical and reporting capabilities for fisheries and wildlife agencies. The steep learning curve required to program using SAS has been a barrier to harnessing SAS tools for many staff within fish and wildlife agencies. Texas Parks and Wildlife's Inland Fisheries Division has integrated three of these technologies. SAS's "Add-In for Microsoft Office" enables our staff to access SAS statistical and graphing procedures from within Excel, Word, or PowerPoint via a menu-driven interface. For more advanced users, SAS's "Enterprise Guide" allows users to access statistical and graphing procedures via either menus or more-traditional SAS programming techniques, but users can also construct analysis projects in a modular fashion and save these projects for later use and modification. These projects can then be converted into a stored process that can be served up to users through SAS's Web Report Studio via a web browser, enabling customizable queries and reports to be accessed by users over the internet without the need for SAS software to be installed on the user's computer. These technologies allow more of our staff to access data directly, generate reports efficiently, and better visualize data.

Hurricane effects on zebra mussels in Bayou Lafourche, Louisiana

Adkisson*, K.L., Ferrara, A., Fontenot, Q., Burke, S., and O. Smith, Nicholls State University, Bayosphere Research Laboratory, Department of Biological Sciences

During 2007 and 2008, we sampled invasive freshwater mussel populations in Bayou Lafourche, a former tributary of the Mississippi River. Mississippi River water is pumped into Bayou Lafourche, providing a veliger source of the invasive zebra mussel, *Dreissena polymorpha*. We assessed seasonal mussel populations using a ponar sampler in the main channel and a post-hole digger at the edges of the bayou. Additionally, settlement cages and bridge scrapings were used to determine the extent of zebra mussel colonization in Bayou Lafourche. High summer water temperatures are believed to prevent the establishment of populations in Bayou Lafourche, however, live zebra mussels were found on 26 June 2008, at 28.2°C. In September 2008, Hurricanes Gustav and Ike severely altered water conditions in southern Louisiana. Low flow rates and warm water temperatures ($\leq 28^\circ\text{C}$) combined with decomposing organic matter, reduced dissolved oxygen levels to less than 1.0 mg/L, resulting in fish kills. Post hurricane sampling collected live zebra mussels that survived hypoxic conditions (dissolved oxygen $< 2\text{mg/L}$). The survival of zebra mussels in high temperature and low oxygen environments with high sediment loads suggests a shift in zebra mussel tolerance in their extreme southern range.

Accuracy of snorkeling techniques for estimating stream fish populations

Weaver*, D.M., Kwak, T.J. USGS North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University, and K.H. Pollock, Department of Biology, North Carolina State University

Snorkeling is a potentially useful technique for estimating stream fish density when other sampling gears are not appropriate. While snorkeling techniques offer many advantages, the accuracy of resulting estimates is relatively unknown. We quantified the efficiency (percent of the true population sampled) of snorkeling counts by comparison with prepositioned electrofishing catch in the same stream reach. We assumed that prepositioned electrofishing best represented the fish community, as documented in other studies. We observed the lowest snorkeling efficiency with suckers (4.0%) and the highest efficiency with central stonerollers (19.5%). Overall, snorkeling detected 13.0% of the true total fish community. Among macrohabitat types, we found the highest snorkeling efficiency in riffle and run habitats for shiners and the highest efficiency in pools for darters, central stonerollers, and river chubs. Overall, efficiency was highest in pools (14.7%) compared to riffles (11.7%) and runs (3.8%). We then adjusted strip transect fish density estimates of count data for sampling efficiency. Strip transect and distance sampling density estimates were 12.0% and 15.2% of adjusted estimates, respectively. Our results demonstrate that while snorkeling, a large percentage of fish go undetected, and that strip transect and distance sampling estimates should be considered highly conservative. These findings aid and improve interpretation and application of fish abundance estimates using snorkeling techniques.

Maximum likelihood estimates of gill net selectivity, growth, and natural mortality for gizzard shad, with comparison to traditional methods

Catalano, M. J and M.S. Allen. School of Forest Resources and Conservation, Program for Fisheries and Aquatic Sciences, University of Florida*

We estimated natural mortality, growth, and gill net selectivity parameters for gizzard shad (*Dorosoma cepedianum*) using a multinomial maximum likelihood model and compared best-fitting parameters with those obtained by traditional estimation methods. The model estimated an asymptotic length parameter (L_{inf}) of 436 mm total length, a metabolic growth coefficient (K) of 0.51 yr^{-1} , and an instantaneous natural mortality rate (M) of 0.51 yr^{-1} . The estimated selectivity function was dome-shaped with maximum selectivity (1.0) at 385 mm declining to 0.2 at 450 mm. Estimated L_{inf} was higher and K was lower than growth parameters obtained by fitting a traditional least-squares growth model to mean length-at-age data. Natural mortality estimates from the model were similar to those obtained using empirical relationships such as Pauly's equation and Hoenig's relationship, but were substantially lower than estimates obtained from life history theory ($M = 1.5K$) and a catch curve. Our growth parameter estimates should be unbiased with respect to gear selectivity and could aid in parameterizing bioenergetics or ecosystem models. We also present valuable estimates of natural mortality and gear selectivity, which are rare for omnivorous fish in the literature.

Assessing potential competitors and predators of stocked striped bass fingerlings at time of stocking

Brey, M.K., Rice, J.A. and D.D. Aday, North Carolina State University*

Fingerling striped bass (*Morone saxatilis*) are stocked annually in many southeastern reservoirs to maintain recreational fisheries; however, the fate of these fish immediately following stocking is greatly unknown. In Lake Norman, a relatively unproductive reservoir of North Carolina, striped bass are stocked as fingerlings in the June of each year. In 2007 and 2008 electrofishing gear and experimental gillnets were used to sample newly stocked striped bass fingerlings and the associated fish community at 6, 24 and 48 hours post-stocking. Diets of potential predators were examined for the presence of fingerling striped bass, and the diets of potential striped bass competitors were examined for overlap with fingerling striped bass diets. Key predators of striped bass included flathead catfish (*Pylodictis olivarius*) and black bass (*Micropterus spp.*). Potential competitors included sunfish and young-of-year black bass. Information about key predators and competitors around striped bass stocking sites may help managers determine when and where stocking would be most successful as to minimize interactions with fingerling striped bass competitors and predators.

Bienville 10:20-Noon

Advances in Fisheries Contributed Papers 2

Spatial and temporal implications of day versus night electrofishing in a large floodplain river ecosystem

Carmean, N.J. and J.R. Jackson, Fisheries and Wildlife Program, Arkansas Tech University*

We compared species richness, catch per unit effort (CPUE), and species composition between day and night electrofishing in backwaters and dike fields of the Arkansas River, AR. Fish were sampled in the fall of 2007 in four different habitats: backwater shorelines (24 paired samples), dike tips (11 paired samples), dikes (10 paired samples), and interdike shorelines (23 paired samples). Richness was higher for night samples in all habitats and ranged from 34 to 37 species. During the day richness ranged from 26 to 34 species. Unique species were collected in all habitats both day (3 to 5 species) and night (7 to 10

species). Night electrofishing produced greater CPUE for largemouth bass (*Micropterus salmoides*), freshwater drum (*Aplodinotus grunniens*), black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), channel catfish (*Ictalurus punctatus*), and river carpsucker (*Carpionodes carpio*) in some habitats. Gizzard shad (*Dorosoma cepedianum*) and white bass (*Morone chrysops*) CPUE was greater during day sampling in some habitats. Species composition in each habitat tended to change from day to night. For example, day sampling in tip zone habitat produced longear sunfish (*Lepomis megalotis*) (40%), bluegill (15%), flathead catfish (*Pylodictis olivaris*) (7%), and blue catfish (*Ictalurus furcatus*) (6%). Night collections included longear sunfish (50%), bluegill (17%), spotted bass (*Micropterus punctulatus*) (6%), and freshwater drum (5%). Additional sampling was conducted in the summer and fall of 2008. These data will be incorporated into a more complete analysis of day and night electrofishing.

Effects of suture material and acoustic tag size on survival, growth, tag expulsion, and wound healing in rainbow trout.

*Ivasauskas, T.J.**, and *P.W. Bettoli*, USGS Tennessee Fishery Cooperative Research Unit, Tennessee Tech University

Biotelemetry depends on the key assumptions that the attachment of a transmitter does not affect fitness, behavior, or growth, and that the incidences of mortality or transmitter loss are minimal. Technical guidelines for surgically implanting transmitters are available; however, there are many variations on the basic technique. The objectives of this study were to evaluate the effects of suture material (i.e., monocril and silk) and transmitter size on healing, growth, and mortality, and to determine transmitter retention in hatchery-reared rainbow trout *Oncorhynchus mykiss* implanted with ultrasonic transmitters (n=60). Although surgery times were minimized by using silk suture material, monocril resulted in less inflammation of the incision site after 20 d. Growth of tagged fish was similar to control (n=20) and sham surgery fish (n=20) and was independent of suture material used. There was no relationship between the tag weight-initial body weight ratio and growth or healing; however, healing was inversely related to the tag volume-initial body weight ratio. Tag encapsulation occurred in all fish and tag expulsion was observed. Fish sutured with monocril were less likely to expel transmitters during the 60-d observation period. No mortality resulted from the surgical procedure or the encapsulation-expulsion process.

Geomorphic restoration of degraded reaches in an Ozark highlands stream.

*Vincent, J. R.**, and *P.E. Balkenbush*, Oklahoma Department of Wildlife Conservation

Restoration of degraded stream and wetland habitat is of key importance to many natural resource entities. Three such agencies partnered to demonstrate wetland and stream restoration using applied fluvial geomorphology techniques in Oklahoma. This project occurred on Honey Creek, an Ozark highlands stream, in Delaware County. Honey Creek is characteristic of a rebuilding C stream type within a relic F channel. The reach has slight entrenchment, meandering pattern and a riffle/pool sequence. Systemic degradation has resulted from poor resource management including instream gravel mining, riparian damage and road construction. Specific objectives of this initiative were to: 1) recover instream and wetlands habitat integrity; 2) improve flow and sediment transport regimes; and 3) reduce property loss from accelerated erosion. Integrative geomorphic techniques were successfully applied to about 4,000 linear feet of stream using native materials. J-hook, log and cross vanes were used to enhance habitat while maintaining newly established channel dimensions, pattern and grade. The project has resulted in enhanced in-stream and wetland habitat, establishment of a protective riparian buffer and preservation of adjacent lands. The area now serves as a demonstration platform to teach private landowners and educators about the value and use of these techniques. It is also a research and monitoring site for scientists.

Biochronology of freshwater mussel shells: an emerging tool for the study of aquatic ecosystems.

Rypel, A.L., Biology Department, University of Mississippi, and W.R. Haag, USDA Forest Service, Center for Bottomland Hardwoods Research*

For over a hundred years, terrestrial ecologists have utilized tree rings to study the past behavior of forest ecosystems. Many freshwater mussels are long-lived, and examination of growth patterns through time for a population (i.e., biochronology) can similarly yield environmental histories for aquatic ecosystems as well. Here, I provide a brief background on biochronology – its history, techniques, and directions. I then present examples on how biochronologies of freshwater mussel shells can be used to evaluate aquatic ecosystems and environmental change. First, results are presented on a comparative study of two southeastern USA rivers (one unregulated and one regulated) aimed at determining whether, and the extent to, which dams alter the growth of mussels. Results showed that freshwater mussel growth was significantly depressed due to the dam and also that synchrony of growth among individuals within the population was disrupted. Secondly, I present results from a regional study that examined similarities in growth among riverine mussels and their adjacent floodplain tree communities. Mussels grew well during years in which nearby trees grow poorly, and vice versa. This pattern was replicated across ecosystems and was apparently linked to variations in streamflow. Interannual mussel growth was significantly negatively correlated to streamflow, while tree growth was significantly positively correlated to streamflow. In the tailrace of a dam, correlations of mussel growth to streamflow were lost. Thus the overall integrity of these ecosystems is based on interannual variability in streamflow. Biochronology is a powerful tool for understanding aquatic ecosystems, especially over long time-frames.

Growth and Reproduction of Grotto Sculpin (*Cottus carolinae*), an Imperiled Cave Fish Endemic to Perry County, Missouri

Johnson, C.R., Day, J.L. , and G.L. Adams, Department of Biology, Environmental Science Program, University of Central Arkansas

Troglophobic species are considered one of the most threatened groups of organisms worldwide due to their limited range, specific habitat requirements, and limited biological information. Available data is usually limited to single season descriptive studies due to the logistically demanding cave environment. This project focused on long term seasonal length-frequency trends to determine critical life history characteristics including growth, longevity and timing of reproduction that may help conserve this unique fish threatened by pollution and invasive species. Grotto sculpin are a unique population of banded sculpin (*Cottus carolinae*) endemic to Perry County, Missouri and are believed to be in the process of adapting to the cave environment. Grotto sculpin were sampled in two caves and their corresponding resurgence sites every four to twelve weeks beginning in August 2005. Fish were measured (SL, TL, weight and eye length) and implanted with an elastomer tag for mark-recapture analysis. Growth rates, analyzed using FiSat, were found to be up to twice as high in surface populations compared to cave populations. Along with greater observed maximum lengths from fish found in caves, these growth data suggest fish residing underground are longer lived than their above ground counterparts. Large numbers of young-of-year fish were observed at surface sites from spring through fall (May-October) before disappearing, presumably into nearby caves. We believe grotto sculpin are using these resurgence sites as nursery areas to allow young fish to grow quickly before entering into the caves, minimizing chances for cannibalism by larger sculpin after migration underground.

An evaluation of the influence of barotrauma on sauger survival in Kentucky Lake, Tennessee

Kitterman, C.L. and P.W. Bettoli., USGS Tennessee Cooperative Fishery Research Unit, Tennessee Technological University

An intense winter fishery for sauger *Sander canadensis* exists in Kentucky Lake, Tennessee. Although previous research suggested that catch-and-release mortality due to barotrauma or other factors was not

a serious problem for undersized sauger (<356 mm total length), angler concerns persisted. The objectives of the present study are to assess survival of saugers inflicted with barotrauma and determine what factors (e.g., capture depth, ascent rate, fish size) contribute to the frequency and severity of barotrauma. In February 2008, we externally tagged and released 19 live and 1 euthanized barotrauma-inflicted saugers with ultrasonic transmitters. We documented the movements of those tagged saugers and developed a decision tree for determining their fate. Preliminary analysis indicates that most (82%) barotrauma-inflicted saugers survive. In winter 2008-09, 60 more saugers will be collected using conventional fishing gear, tagged, released, and tracked. Knowledge of catch-and-mortality rates will allow biologists to more effectively establish and justify minimum size limit regulations to enhance that sauger fishery.

Poster Abstracts

Food habits of sympatric spotted (*Lepisosteus oculatus*) and shortnose (*Lepisosteus platostomus*) gar during fooding of an Arkansas River tributary

Adams, S.R., Benton, J., Inebnit, T.E., and R.H. Walker., University of Central Arkansas

Gars are generally thought to be avid predators, predominantly feeding on fishes, and to a lesser extent, invertebrates. Though southern river systems typically contain multiple gar species, few studies have examined feeding characteristics of sympatric populations. Further, little information exists on food resources of shortnose gar *Lepisosteus platostomus*. We report results of an examination of diet in shortnose gar and spotted gar *Lepisosteus oculatus* from the Fourche LaFave River in Arkansas. Stomachs were dissected and examined from 74 adult spotted gar (46 - 81 cm TL) and 91 adult shortnose gar (49 - 76 cm TL) collected during May to July 2007, corresponding to back-flooding from the Arkansas River. Forty-seven (64%) spotted gar and 54 (59%) shortnose gar contained identifiable prey items. Considering frequency of occurrence, important food resources of spotted gar were fish (74%), crayfish (26%), aquatic insects (11%), and terrestrial insects (9%). Similarly, fish (59%) was the most commonly occurring food item in shortnose gar, but they consumed aquatic (24%) and terrestrial (35%) insects more frequently than spotted gar. Additionally, shortnose gar utilized amphibians (17%) as prey. Our analyses suggest similar-sized, sympatric spotted gar and shortnose gar had different feeding habits where shortnose gar utilized a wider variety of prey, including both aquatic and terrestrial food resources.

Hurricane Katrina's impact on age and growth of channel catfish and blue catfish in the Pascagoula River, Mississippi

Alford, J.B., Barabe, R.M., Jackson, D.C., and D.M. O'Keefe, Mississippi State University, Department of Wildlife and Fisheries.

Hypoxia-induced fish kills occurred for two weeks throughout the Pascagoula River following Hurricane Katrina. Many channel catfish (*Ictalurus punctulatus*) and blue catfish (*I. furctus*), which support important recreational fisheries in this system, were killed. We assessed post-hurricane age structure and growth for these stocks, and compared their growth to stocks from other systems. We also compared pre-hurricane (June-August 2001-2002) growth for channel catfish to post-hurricane growth (June-August 2007). Randomly-chosen river-kilometers were sampled along the entire main stem using electrofishing, hook-and-line gear and trot-lines. Pectoral spines were taken for age analysis, and lengths at age were back-calculated to estimate growth. Hurricane-related fish kills did not impact age structure to any appreciable extent for either species, and post-hurricane year-classes were abundant. Overall, channel catfish growth (N = 244) was relatively low (von Bertalanffy K = 0.09), while blue catfish growth (N = 195) was moderate (K = 0.22). Channel catfish growth rate was similar between pre- and post-hurricane periods, and to that in other systems, but magnitudes of mean lengths were approximately 100-125 mm greater for ages 1-6. Post-hurricane blue catfish growth for ages 2-6 (those that survived the fish kills) were greater than the average growth reported in other systems but within range. Our results suggest that, in general, hurricane-related fish kills did not negatively impact these fisheries. In the short-term, channel catfish that survived Hurricane Katrina took advantage of the ecological void created by fish kills and exhibited increased growth, and potentially reproductive success, due to reduced competition for resources.

Determining species diversity along with variation and catch per unit effort of small resident fishes within brackish marsh ponds

Bennett, E., Nicholls State University, and N. Cotten, Louisiana Universities Marine Consortium

Brackish marsh habitats are important for the productivity of estuarine fishes in that they provide nutrients for feeding, refuge from predators, and enhance reproduction. Many species of resident fish are provided with habitat when the marsh surface is flooded during high tide. This in turn also causes a distribution of

fish because organisms are able to easily travel back and forth among the marsh surface. Throughout the marsh, there are areas of shallow bodies of water known as ponds. Marsh ponds are isolated meaning that they are not connected to open water by means of a tidal creek or by a channel. They are most commonly formed through the process of vegetation deterioration. Our objective was to sample three sites containing marsh ponds around the LUMCON area in order to study species diversity along with catch per unit effort. Our main goal for this project was to study variation and the changing communities within each pond. As a side project, we also sampled these ponds with the intention of finding the marsh killifish, *Fundulus confluentus*, which normally resides to the east of the Mississippi river. We calculated catch per unit effort by dividing the total number of a given species per site or per week by the total number of minnow traps used per site or per week. We also recorded species diversity in order to give an analysis of the variation among each pond. Small resident fishes were sampled from each site repeatedly for 4 weeks during days when the tide was high in order to ensure a bountiful collection of specimens. Over the four week period, we collected a total of 673 fish in 25 collections.

Validation of annual periodicity and age estimation from shape analysis of otoliths from red snapper, *Lutjanus campechanus*

Beyer, S.G. and S.T. Szedlmayer. Marine Fish Laboratory, Department of Fisheries and Allied Aquacultures, Auburn University

The periodicity of otolith growth rings from adult red snapper was examined through a mark and recapture study. In 2005-2007, red snapper (n=251) were caught hook-and-line, injected with oxytetracycline, and released 15-40 km south of Dauphin Island, Alabama. Fish were recaptured up to 2.5 years after release (n=19). Sagittal otoliths were dissected, sectioned, and the number of growth rings past the OTC mark was compared to time at liberty of the fish. Preliminary findings support an annual periodicity of growth ring formation, however, all recaptured fish were less than 10 years of age and validation of older red snapper (>10 years) is still needed. Otolith shape analysis was applied to otoliths taken from hatchery reared known-age red snapper. Morphological shape indices were able to distinguish among age-0, age-1 and age-2 otoliths. Significant differences in the aspect ratio, box x/y, and radius ratio showed juvenile red snapper otoliths grew faster along the anterior-posterior axis compared to the dorsal-ventral axis. A discriminant function analysis and cross-validation showed an age classification success of 70% based on shape variables alone. The addition of otolith weight to the discriminant function increased classification success to 93%. Based on this data, we believe otolith shape analysis is a potential new method for ageing young red snapper at least to age-2.

Crustaceans are sensitive to gar oocyte extracts, but insects, mollusks, atinopterygian fishes, and frogs are not

Broussard, N., Ledet, J., Department of Biological Sciences, Nicholls State University, Farris, H., LSUHSC Neuroscience Center, Ferrara, A. and G. LaFleur Jr., Department of Biological Sciences, Nicholls State University

We present a study comparing neurotoxic effects of gar oocyte extract on a suite of animals representative of diverse phyla. Previously we confirmed reports that gar incorporate an unidentified toxin into oocytes; this toxin has been found to affect crawfish, turtles, birds, and mammals. We further documented that the toxin could also be isolated from fertilized eggs and larvae, and that it acted as a cardiotoxin on all crustaceans tested including crawfish, fiddler crabs and grass shrimp. We confirmed reports of an insensitivity of teleost fish to this toxin, showing that both Saifin mollies and Gulf killifish were not affected by extract injections. To address whether the gar oocyte extract would be an effective neurotoxin on other invertebrate groups, we tested its effect on an insect and a mollusc. We found that neither crickets nor marsh periwinkles showed any sensitivity to the gar oocyte toxin. To address its effect on another ancient fish whose ancestors may have co-existed with ancestral gar, we injected Paddlefish intra-peritoneally and intra-muscularly with equal and double doses that are effective on crustaceans, showing no significant sensitivity to the toxin. Finally, we have also tested the green treefrog and found no significant effect. If the gar oocyte neurotoxin represents a predator-avoidance adaptation, it is paradoxical that the extract would not be active on other aquatic animals presumably sharing a common

habitat range with the gars. This work was supported by the NIH COBRE program in collaboration with LSU Neuroscience Center.

Stream fish assemblages in an urbanizing watershed

Carter, C.K., Curtis, S.G., and F. Gelwick, Department of Wildlife and Fisheries Sciences, Texas A&M University

Carter Creek is a third-order stream located in the Navasota River drainage. It runs through urban and agricultural lands along the eastern edge of Bryan and College Station, TX and receives secondary treated wastewater at three locations. Fish samples were taken from five different sites in fall 2007 and 3 different sites in spring 2008 and compared based on the metrics used for an Index of Biotic Integrity (IBI). All fish caught were by the use of straight seines and bag seines. Preliminary analysis indicates that ten species made up 95% of all fish collected across both years, and among these were five native cyprinids (blacktail shiner, red shiner, Mississippi silvery minnow, bullhead minnow, and pugnose minnow), seven invertivores (including longear sunfish and blackstripe topminnow), three omnivores, five tolerant (including Western mosquitofish and bluegill), and one intolerant species (Ribbon shiner). The IBI shows us that there is a difference in sites between areas upstream and downstream of the Waste Water Treatment Plant outflow. This is measured by different metrics about the groups of fish listed above. The difference cannot be pointed solely at the WWTP, but we can deduce that there is an obvious fluctuation in the stream's ecology by the drastic drop in aquatic use scores beginning with the WWTP moving downstream.

Black drum (*Pogonias cromis* Linnaeus) in the western Gulf of Mexico: landings, fishing pressure and abundance, and their implications for life-history attributes

Dailey, W., Texas A&M University, and C. Howard, University of Houston – Clear Lake

We reviewed state agency data for black drum commercial landings, recreational landings and pressure, and abundance. Texas commercial landings from 1981 to 2001 averaged 731 thousand kg with a high of 1.9 million kg in 1996, and increased five-fold for the period from 296 thousand kg to 1.14 million kg in 2001. Black drum commercial landings in the Upper Laguna Madre (ULM) for the twenty-year period 1982 - 2001 peaked at 916 thousand kg in 1996, and were significantly higher than landings for other embayments. Galveston Bay ($37,042 \pm 5,611$ black drum) (mean \pm SE) dominated coastwide recreational landings ($88,754 \pm 7,777$), and fishing pressure (1.8 ± 0.061 million man-hours) in Texas from 1975 to 2002 averaging 4.8 million man-hours annually with a maximum of 6.4 million man-hours in 1999. ULM black drum abundance from fisheries-independent gill net catches (2.04 ± 0.28 black drum/hour) differed significantly from other embayments. Coastwide catch rates for black drum from 1976 to 2003 averaged 7.9 fish/hour peaking at 14.3 in 2001. Results were not indicative of detrimental impact of fishing mortality on populations or life-history attributes. However these attributes and high commercial and recreational value distinguish black drum among finfish in Texas, and consequently, necessitate proper and watchful management.

Population genetics & connectivity of grotto sculpin (*Cottus carolinae*), an imperiled, troglomorphic fish from Perry County, Missouri caves

Day, J.L., Starkey, D.E., Adams, G.L. University of Central Arkansas, and D.B. Keeney, Le Moyne College

There is a paucity of comprehensive studies on non-game fishes worldwide, including many benthic species, but still fewer have been conducted on cave-adapted fishes. Grotto sculpin are unique populations of banded sculpin (*Cottus carolinae*) endemic to cave systems underlying Perry County, Missouri. These troglomorphic fish are state-threatened and a priority two federal endangered species candidate. Due to the unstable nature of the cave environment, grotto sculpin are highly susceptible to pollution via suspected agricultural and waste runoff. It is therefore imperative that we understand, on both ecological and evolutionary time scales, the degree of connectivity these populations express. We used a multilocus phylogeographic analysis utilizing DNA sequence from the mitochondrial control region

and a nuclear intron locus, a-enolase, to address possible subspecies boundaries and provide substantial means of inference as to the dispersal potential and genetic connectivity of this threatened cavefish. Samples from nine caves, three resurgences, and two surface sites in Perry County were collected and sequence data from both markers analyzed using parsimony and maximum likelihood techniques. Two surface populations of banded sculpin outside Perry County were included for comparison. We found a substantial degree of population genetic structure within Perry County, suggesting gene flow may be limited among certain sites. Marked genetic divergence and indications of population isolation were also observed. Our data suggest that conservation of grotto sculpin populations remain a priority in order to preserve maximum genetic diversity. Inferences of evolutionary ecology gathered collectively from genetic, mark-recapture, and hydrological data will be presented.

Manipulation of the pond environment to increase harvest volume of Red swamp crawfish (*Procambarus clarkii*)

Delabbio, J. L., Collara, P., and S. Gabrey, Aquaculture Research Center, Biology Department, Northwestern State University

We investigated the effect of three environmental treatments on the production volume of Red swamp crayfish (*Procambarus clarkii*). The research took place at the Aquaculture Research Center in Lena, Louisiana during the spring 2008. Treatments were randomly assigned to twelve crawfish ponds, each with a water depth of 3 feet and surface area of one-quarter acre. There were three ponds per treatment and for the control. Treatment 1 (NETS) consisted of predator exclusion nets around the perimeter of the ponds as well as monofilament lines strung above the ponds. Treatment 2 (LIGHTS & NETS). These ponds each had 12 underwater lights that were on from dusk to dawn, and predator exclusion nets. Treatment 3 (SUBSTRATE) were ponds with an artificial horizontal substrate extending across the pond's surface area. The CONTROL were open ponds without underwater lights, predator exclusion nets and a submerged artificial substrate. Ponds were harvested through out the spring 2008 using baited pyramid traps. Harvested crawfish were graded into size classifications. All treatment groups outperformed the control ponds in total harvested crawfish/season. The treatment using underwater lights and predator exclusion nets had the highest mean harvest. The underlying reason for this result is not clear, and therefore further field and laboratory research is being conducted at the Aquaculture Research Center this crawfish season to explain this result.

Assessing fish density within Pleasant Grove Creek, an impaired watershed, Logan County, Kentucky

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Pleasant Grove Creek is located within the Western Pennyroyal Karst Plain Ecoregion north of Tennessee. The watershed is the focus of several surveys by the Kentucky Division of Water, Environmental Protection Agency, and Austin Peay State University. Pleasant Grove Creek has been identified as an impaired water body on the Environmental Protection Agency's 303(d) list since 2002. The watershed is located in the northern portion of the Red River, which are both a regional and a national priority watershed. The topography is an area composed of karst fractures and caves. Ninety-five percent of the land is allocated to agricultural practices. In 1994 and 1998, the Kentucky Department of Water sampled Pleasant Grove Creek for macroinvertebrates and fish. Although a limited number of fish were collected during these studies, little fish data exists in technical reports or journals for this region. Objectives of this study were to assess the environmental health of Pleasant Grove Creek utilizing the Kentucky Index of Biotic Integrity and by comparing historical data with data collected in 2007 and 2008. Fish assemblages were compared to habitat changes and an adjacent watershed, Whippoorwill Creek, a creek identified by Kentucky as an exceptional water resource. All protocols for sampling surface waters set forth by the state of Kentucky were followed except for electroshocking. Data indicate that Pleasant Grove Creek continues to be an impaired stream with diminished species richness. Results concluded that total fish density and biological index scores were significantly different between sampling sites.

The Piedmont Blue Burrower, *Cambarus harti*

Figiel, Jr. C. R. Warm Springs Fish Technology Center, U. S. Fish and Wildlife Service

The Piedmont Blue Burrower, *Cambarus harti* is a primary burrowing crayfish listed as endangered by the state of Georgia. The species has a limited range and habitat specificity and is only found in the Piedmont region of the Chattahoochee and Flint River basins in Meriwether County, Georgia. The fossorial nature of *C. harti* makes the species difficult to study and available life history data is limited to a small number of collected specimens during parts of the year. This presentation provides preliminary data (32 crayfish collected in 2007 and 2008) on the life history of this species. Juvenile crayfish less than 6 mm in carapace length were captured in January while first form males were collected in April through November. No female in berry has been collected at the time of this submission; however data indicate that copulation occurs in late autumn. Generally, these crayfish build complex tunnels, have more than one burrow opening, and have well-defined chimneys.

How many Gulf sturgeon were there? A preliminary stock reduction analysis (SRA) to estimate historic population size

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The goal of many species recovery plans is the restoration of populations to historic or pre-exploitation levels. However, there is often uncertainty in what these levels were, as is the case with Gulf sturgeon *Acipenser oxyrinchus desotoi* in Florida. We attempt to reconstruct the historic Gulf sturgeon population in Florida with an SRA (stock reduction analysis) model using a time series of landings records, population estimates, and biological data. Reliable estimates of historic population size provide important information for resource managers to assess magnitude in population change, develop more realistic recovery targets, and assess time to recovery estimates.

Flathead catfish and blue catfish exploitation and movement dynamics based on A reward tagging study in selected Missouri rivers

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Catfish represent one of the leading recreational and commercial fisheries in Missouri and consistently rank high in popularity among Missouri anglers. To address information needs related to flathead catfish *Pylodictis olivaris* and blue catfish *Ictalurus furcatus* in Missouri rivers, a five year study was initiated in 2005 with objectives that include determining exploitation rates and movement dynamics for these species. Segments of seven interior rivers and Pools 20-22 of the Upper Mississippi River were sampled in 2005 and 2006 using low-frequency electrofishing gear. A total of 5,101 flathead catfish and blue catfish ≥ 305 -mm total length were tagged with carlin dangler reward (US\$25) tags. Anglers have returned 1,138 (22.3%) reward tags and 83% of these fish were reportedly harvested. Tag return rates by river ranged from 8-30% with a mean of 20%. Once tag loss and estimated non-reporting rates were factored in, mean annual exploitation was 10% and 14% for flathead catfish and blue catfish, respectively. Initial results show that 508-762-mm flathead catfish and blue catfish were caught by anglers in greater proportion than this size group was represented in the tagged population. We suggest that this indicates growth overfishing may be occurring. The median dispersal distance of tagged catfish was 3.1-river km for flathead catfish and 8.4-river km for blue catfish based on the capture locations reported by anglers. These results will help guide future management initiatives in Missouri that will limit growth overfishing of riverine flathead catfish and blue catfish populations in selected management zones as part of Missouri's catfish management plan.

Factors influencing introgression of Florida-strain alleles in Louisiana largemouth bass (*Micropterus salmoides*) populations

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Since 1982, the Louisiana Department of Wildlife and Fisheries (LDWF) has stocked Florida-strain largemouth bass (FLMB; *Micropterus salmoides floridanus*) in Louisiana to enhance recreational opportunities. In 1988, we began conducting analyses using allozyme electrophoresis at two loci to determine the genetic identity of 16,875 LMB collected during routine fall electrofishing surveys. Previous analysis of this genetic data has shown that frequency of stocking and number of fish stocked do not account for between-system differences in FLMB introgression. In order to better understand factors that control introgression and persistence of Florida bass alleles in Louisiana largemouth bass stocks, we have begun a project to quantify the physiochemical and biological characteristics of stocked water bodies. To date, we have collected water quality (dissolved oxygen, temperature, pH, conductivity, and turbidity), lake morphology, aquatic vegetation, woody debris, and shoreline development data from 13 lakes throughout the state. We have used genetic data from these populations to determine the relative influence of water body characteristics on introgression success and stock production. Our findings provide the opportunity for LDWF to better understand the effects of their FLMB stocking activities and to modify their stocking protocols to better achieve the management goals of the largemouth bass program.

Electrofishing as a tool to reduce the numbers of Asian swamp eel in canals of the South Florida Water Management District

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Asian swamp eel (*Monopterus albus*) is a highly evolved air-breathing teleost, native to Southeast Asia. Their biology makes them well suited for a variety of habitats in Florida, including the Everglades. Asian swamp eels are very resilient, with a minimum population doubling time between 1.4 - 4.4 years. Because of these high fecundity rates an invasion in uncontrolled numbers could pose a significant threat to native wildlife by reducing the abundance of small prey species (insects, crayfish, tadpoles, etc.) that form the food base of fishes, wading birds, and other Everglades wildlife. Moreover, these eels have similar feeding and habitat requirements as American eel (*Anguilla rostrata*). A population of swamp eels is found in the canals (C-111 and C-113) of the South Florida Water Management District that border Everglades National Park near Homestead, and until 2008, only two individuals of this species has been found inside the Park. Therefore, our project objective was to use electrofishing gear to reduce the numbers and slow the spread of Asian swamp eels into wetlands in and adjacent to the Everglades National Park. Between June 2006 and February 2008, a total of 3,470 Asian swamp eels were removed from the project area using a 20-foot jon boat with a 9.0 GPP Smith-Root electrofishing unit. The average settings of the electrofisher were 8.0 Amperes, 30 volts DC, and operated until a 1-km transects was covered. The number of eels observed but not captured was 2,765 (capture efficiency of 55.7%). Fifty-two American eels (<1.1% of all eels) were seen during the collection period.

Effects of fluctuating hydrological regime and water temperature on juvenile channel catfish growth and survival.

Piper Goar, T. D. and E.R. Irwin, USGS Alabama Cooperative Fish and Wildlife Research Unit, Auburn University

We examined the effects of variation in flow and decreased water temperature on survival and early growth of young of year channel catfish *Ictalurus punctatus* during two 4- week laboratory experiments. Twelve 10-gallon tanks were fitted with Plexiglass inserts and variable flow water pumps to simulate conditions below R.L. Harris Dam, a hydropeaking facility on the Tallapoosa River, Alabama. The goal of these experiments was to determine how variation in hydrological regime and decreased water temperatures affect early growth and survival of YOY channel catfish. A secondary goal was to determine if patterns of slow growth and stress, previously documented on the otoliths as stress marks, could be replicated in an experimental setting, quantified, and related to water flow and temperature. We observed declines in survival and slower growth in high velocity-cold water treatments. We are currently examining otoliths for occurrence of stress marks. The results from these experiments will be implemented into models used to prescribe flows below Harris Dam. Flow manipulations are among

some of the strategies used in the adaptive flow management of dam-regulated portions of the Tallapoosa River beginning in spring 2005.

Quota monitoring of the summer flounder stock off North Carolina

Kemp, G.H., and S.W. McInerney, North Carolina Division of Marine Fisheries*

Summer flounder (*Paralichthys dentatus*) is one species managed by the joint Mid- Atlantic Fisheries Management Council and the Atlantic States Marine Fishery Commission Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan. In 1993, the National Marine Fisheries Service (NMFS) noted flounder as an overfished species and implemented state allocated commercial quotas for summer flounder to allow for stock recovery. Fishermen and dealers require proper licenses and permits to land or sell summer flounder. Starting in 1994, the NC Trip Ticket Program requires mandatory monthly reporting of commercial landings by all dealers, in addition permitted dealers are also required to report daily landings on a quota monitoring log (QMLog) to the DMF office by noon the next day. Reports late or incomplete could result in a revocation of licenses and/or permits. Trip ticket landings are compared to QMLogs to verify summer flounder landings, with discrepancies over 50 pounds being investigated. After landings are verified in house, landings are then verified with NMFS. Daily reporting of summer flounder landings, which has been in effect since 1999, allows for real time monitoring of the quota so that potential overages can be avoided. Cooperation between Atlantic states allows for transfer of quota across states when needed. For example 73,472 pounds of summer flounder were transferred from NC to VA and NJ due to severe weather conditions in the mid-Atlantic in 2007. Other species monitored daily include spiny dogfish, herring, striped bass, and black sea bass north of Cape Hatteras.

An investigation of diet overlap between largemouth bass and common snook from the coastal rivers of southeast Florida.

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Snook *Centropomus* spp. and largemouth bass *Micropterus salmoides* support some of the most important recreational fisheries in the state of Florida. These apex predator species coexist in many of Florida's coastal river systems. Detailed information on how populations of these two predators coexist is lacking. This ongoing study was designed to analyze diet habits of these two species and assess overlap between them in three southeastern Florida Rivers, the Loxahatchee, the St. Lucie (north and south fork), and the St. Sebastian. Thus far, seven random standard sampling trips and seven non-random directed diet-sampling trips were completed between May 2007 and June 2008. A total of 2,962 common snook and 355 largemouth bass were collected and examined for diet contents. Of those, 1575 (53%) common snook and 193 (54%) largemouth bass contained one or more food item. A total of 23 families and 12 functional groups (i.e., fish, crab, isopod, etc.) were identified within stomach contents. Diet analysis is still on going but diet overlap indices such as Schoener's (1970) will be used to quantitatively compare diets of largemouth bass and common snook. Cumulative prey curves will be used to determine whether a sufficient number of samples have been collected to precisely describe the diet for each species. Analysis of variance procedure will be used to determine if common prey items vary seasonally, by predator size, or habitat type.

Impacts of a reverse osmosis membrane filtration water treatment plant on benthic estuarine macrobenthos.

Kleber, K.E., East Carolina University

Daily demand on a limited resource leads to problems with providing for the ever increasing needs for potable water, not only for domestic consumption but also for industry and agriculture. In North Carolina, laws are being enacted to decrease reliance on ground water while at the same time increasing demand on surface waters. In coastal North Carolina, this growing need for the production of potable water is addressed by the construction of Reverse Osmosis Water Treatment Plants (RO-WTPs). Many of these

facilities are using brackish (briny) ground water resources with the associated production not only of potable water but also a briny concentrate which is often discharged into local surface waters. Models have been constructed to determine the diffusion of this brine into the environment, but no studies have addressed the entire biotic assembly until now. We sampled the macrobenthos at the Camden County, NC RO-WTP near the discharge pipe, two years post-construction, a control location .05 km downstream, and at the proposed discharge locations of two proposed RO-WTPs, pre-construction. We found that the macrobenthic assemblages present at all locations are typical for low salinity, estuarine environments. These assemblages did show seasonal as well as location-dependent variations in presence and density. There was little difference in the densities and species present in the benthic macroinvertebrate community relative to the diffuser pipe at the established plant. The differences observed are likely because of localized differences in salinity and patchy habitats. Because, until now, there have been no studies of the effects of briny discharge on biotic assemblages, there is no baseline to use to assess negative impacts on these assemblages that may be related to the briny concentrate. This study helps to establish a baseline for future studies on the impacts of RO-WTPs on estuarine macrobenthic assemblages.

Population parameters of crayfishes in regulated and unregulated reaches of the Tallapoosa River basin

Martin, M.M., and E. Irwin, USGS Alabama Cooperative Fish and Wildlife Research Unit

Crayfishes were collected using electrofishing techniques in the piedmont province of the Tallapoosa River basin to examine population parameters in relation to river regulation. Samples were collected from the mainstem Tallapoosa River below R.L. Harris Dam (regulated), the Upper Tallapoosa River (unregulated, near Heflin, Alabama) and Hillabee Creek (unregulated tributary of the mainstem). Samples were collected during summer and fall seasons 2005-2007. Three species were collected: *Procambarus spiculifer*, and two Tallapoosa basin endemics *Cambarus* (*Dessicambarus*) *englishi*, and *C.* (*Dessicambarus*) *halli*; specimens < 15 mm were not identified. Catch-per-effort (CPE) data and population size structure were compared among sites, seasons and years. Catch data varied among years for all species combined; catch was highest in 2006 and lowest in 2005. However, when individuals < 15 mm were excluded from the analysis, catch data were similar among years, potentially indicating a recruitment event in 2006. Comparisons between regulated and unregulated sites indicated that catch was higher at unregulated sites (1.15 CPE) versus regulated sites (0.41 CPE). In addition, higher proportions of *P. spiculifer* were captured at unregulated sites (62 %) versus regulated sites (41 %). However, no apparent increase in CPE was observed as distance from dam increased. Length frequency analysis indicated that smaller individuals were captured in the fall for two of the three species (*P. spiculifer* and *C. englishi*) and average length was greater at regulated versus unregulated sites. Specific habitat characters on shoals and effects of different hydrology (i.e., drought conditions) may help explain variation in catch among sites.

Improvements to commercial effort data for American Eel from North Carolina

McInerney, S.A., and G.H. Kemp, North Carolina Division of Marine Fisheries*

American eel (*Anguilla rostrata*) is an important fishery in North Carolina and the harvest of eel has been monitored by the NC Division of Marine Fisheries Trip Ticket Program (NCDMF) since 1994. Eels are harvested by commercial fishermen and held in pens across multiple trips before being sold to the dealer. This practice results in an underestimation of the actual number of trips taken by eel fishermen. Lack of effort data resulted in a requirement that states institute a reporting system to ensure that annual effort and landings of eel are reported by harvesters and/or dealers. NCDMF developed a logbook program to be filled out by the fishermen. For 2007, eighty-nine percent of the eel logs matched with trip tickets. The number of pounds reported through eel monitoring were very close to those reported on trip tickets. Catch per unit effort (CPUE) consisting of pounds per trip was compared across months and waterbodies. CPUEs using trip tickets were larger than those from the eel logs. September had the highest CPUE for both reporting programs. Based on trip tickets, Pamlico Sound had the highest CPUE across waterbodies. However, when using trips from eel monitoring logs, Albemarle Sound had the highest CPUE. Another CPUE was also calculated by dividing the number of pounds from trip tickets by "pot day".

Pot day is the number of pots fished multiplied by the number of days soaked. Success in logbook monitoring of this species will provide useful effort information for future stock assessments.

Adaptive oyster fishery strategies in a river diversion outfall area

Melancon, Jr., E.A., Department of Biological Sciences, Nicholls State University

The Barataria estuary is a good example of the national wetlands crises that Louisiana is experiencing. The Davis Pond water diversion is the estuary's cornerstone project to reintroduce Mississippi River water as an effort to maintain fresh to low salinity wetland habitats by reducing salinity encroachment from the Gulf of Mexico. Over the course of years, oyster data and fishery observations suggest that the two, diversions and oysters, can co-exist. To accomplish this coexistence, diversion managers and oystermen must develop management strategies that address the needs of both. Seasonal influences of salinity on oyster survival, rate of oyster shell growth to eventually produce a seed or sack product, the fuel and labor associated with a seed or sack fishery, and the ability to cope with the potential of fouling by the hooked mussel, *Ischadium recurvum*, are all matters of economic importance to an oysterman. I present potential resource management options for fishermen who have oyster leases located in a diversion plume environment.

Effects of American beaver dams and impoundments on endangered Okaloosa darters.

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American beavers (*Castor canadensis*) are ecosystem engineers that alter abiotic and biotic characteristics of lotic ecosystems through creation and maintenance of dams and impoundments. The endangered Okaloosa darter (*Etheostoma okaloosae*) is a small, benthic stream fish restricted to six stream systems in northwest Florida. Okaloosa darters inhabit relatively clear streams with moderate flow and sandy substrate, residing along stream margins in association with aquatic plants, roots, and other forms of cover. We report on a 'natural experiment' in which beavers constructed a dam immediately downstream of one of our long-term sites used to monitor population status of Okaloosa darters. Impoundment of Rogue Creek resulted in increased water depth, greatly decreased flow, accumulation of flocculent organic material, variable water temperatures, and increased abundance of larger, potentially predatory fishes. Okaloosa darter abundance at Rogue Creek decreased significantly within one year, but did not decrease at other monitoring sites. Removal of the dam led to restoration of pre-dam hydrologic conditions and re-colonization by Okaloosa darters within one year. These data indicate that Okaloosa darters are resilient to transient and localized changes in hydrologic conditions. Ongoing research is examining response of Okaloosa darters to removal of beaver impoundments in streams of varying sizes.

Feeding ecology of reef-associated fishes; a comparison of trophic niche space using stable isotope analysis

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There has been much debate about how structure, such as natural and artificial reefs, affects the community of reef-associated fishes at the process-level. Studies have shown fishes select habitat based upon needs for refuge from predators, substrate for spawning, or feeding, and, by extension, prey availability. Direct comparisons of trophic diversity among habitat types can be difficult owing to gear inefficiencies, which is particularly true for complex reef habitats. We used stable isotopes, specifically the $\delta^{13}\text{C} - \delta^{15}\text{N}$ biplot, as a method to determine trophic niche breadth in three species of fishes in the northern Gulf of Mexico with contrasting life histories that occupy different habitats. We compared the feeding ecology of red snapper (*Lutjanus campechanus*) among habitat types (reef, sand, and shell), age groups (0, 0.5, 1, 2, and 3+), and trawled and non-trawled habitat. Results were contrasted with those of spotted seatrout (*Cynoscion nebulosus*), and Atlantic croaker (*Micropogonias undulatus*) feeding over an inshore artificial oyster reef and a mud-bottom habitat. Results indicate differences in niche breadth among habitats for both spotted seatrout and Atlantic croaker, and due to trawling and ontogeny for red

snapper. Red snapper niche breadth was greater in trawled habitats as compared to non-trawled for all habitat types. Results also suggest age-0 red snapper have a relatively small trophic niche, which expands for older juveniles (age-0.5) and sub-adults (age-1), and then contracts as fish enter adulthood (ages 2 and 3+). Investigation of trophic niche breadth may be a promising technique to elucidate feeding patterns across species.

Crayfish ecology and harvest in moist-soil wetlands managed for waterfowl

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Our goal is to demonstrate additional ecosystem services and economic gains from managing moist-soil wetlands for wintering waterfowl in the Mississippi Alluvial Valley. Moist-soil habitat management for waterfowl parallels practices used to culture crayfish (*Procambarus* spp.) in traditional rice production systems. Additionally, management practices that promote aquatic invertebrate communities in moist-soil wetlands influence nutrient cycling and retention and provide sources of protein and other nutrients for waterfowl and other wetland wildlife. We are proposing research to evaluate responses by crayfish and other invertebrates and water-quality dynamics in relation to typical moist-soil management strategies including mid-season drawdown, seeding of annual grasses (e.g., millets), and disking. Complementary research locations will include idled catfish ponds containing moist-soil vegetation, Wetland Reserve Program lands, and public and private wetlands managed for waterfowl. Increased awareness of the multiple ecological and economic benefits of moist-soil management has potential to enhance wetland conservation and use by consumptive and non-consumptive users.

Relative abundance and size distribution of Shoal Bass in the Chipola River, Florida

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Beginning in July 2007, a study was initiated to determine incremental growth, relative abundance and size distribution of shoal bass *Micropterus cataractae* in the Chipola River, FL. Boat electrofishing was used to collect all shoal bass which were weighed (g), measured (TL, mm) and live released within the vicinity of capture. Shoal bass > 120mm TL were implanted with passive integrated transponder (PIT) tags for recognition during future sampling. Shoal bass were captured at a rate of 14.3 ± 1.8 fish per hour and ranged from 99 to 562 mm TL. A limited number of shoal bass have been recaptured since the beginning of this study. Future sampling through 2009 will be used to determine incremental growth via recaptures of PIT-tagged bass.

A biotelemetry approach to evaluate stocking of advanced fingerling bass.

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The Harris chain of lakes (76,000 acres) in Lake County, FL has suffered from low recruitment of largemouth bass as a result of habitat loss. Lake Carlton (303 acres) within this chain of lakes was stocked in 1994 with advanced fingerling pellet reared largemouth bass, resulting in low survival (2%) and low percent contribution (8%) to the native fish population. Due to its small size and representative habitat, Lake Carlton has been used as a research lake for stocking. Changes in hatchery protocol such as an improved diet, timing of stocking, and a shift to live prey before stocking have given us higher expectations for improved survival of pellet reared hatchery fish. We plan to stock Lake Carlton along with lake Griffin (9,400 acres) from 2009-2011 each with 25 fish per acre. A comprehensive stocking evaluation will include electrofishing and creel surveys to evaluate survival and contribution to the fishery. With the advancement in radio telemetry technology, we are now capable of tracking the movements, dispersal, behavior and habitat selection of 90-110-mm hatchery bass using 0.3 gram microtransmitters. We have adapted surgical procedures used on hatchery salmon smolts in the Columbia River Project. Preliminary studies on tag affects on mortality, growth and buoyancy appear to be promising and will be reported. The transmitters range, accuracy, battery life, and evacuation rate from predators have also been tested and will aid in project design.

Cyprinid community structure in coastal plain streams in southeastern Louisiana.

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Minnows are dominant members of lotic fish communities in southeastern Louisiana, occurring in a wide variety of habitats and providing an important trophic link between primary producers and larger piscivores. The terrace upland ecoregion located in southeastern Louisiana, known as the Florida Parishes, contains unique watersheds that were historically surrounded by agricultural and forested land, but are becoming increasingly impacted by urbanization, road construction, and suburban housing construction. We collected fishes in both mainstem and tributaries habitats in the Pearl, Tchefuncte, Bogue Chitto, and Tangipahoa Rivers from early summer to early fall in 2007 and in 2008 with seines and backpack, barge, or boat electrofishing units. Habitat measurements such as depth, flow velocity, substrate type, canopy cover, and amount of woody debris were taken at the collection sites, and we were interested if the abundant minnow species in these streams exhibited any patterns of co-occurrence, and whether these patterns were related to stream habitat characteristics. We performed a principal component analysis (PCA) on the minnows collected during the study. We subsequently related the fishes to habitat characteristics with canonical correspondence analysis (CCA). The PCA identified four sets of species that exhibited clear associations in their abundance patterns among sites. The CCA indicated that most of the species were using similar habitats, although the golden shiner *Notemigonus crysoleucas* and weed shiner *Notropis texanus* were more abundant in streams with silt or clay substrates.

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