

Abstracts for oral presentations  
presented at the  
Southern Division of the  
American Fisheries Society  
Spring 2016 Meeting

**Wheeling, West Virginia**

***Abstracts for all oral presentations***

***(listed by Symposium or Session)***

***(Symposium or Session title is listed after presentation title)***

Room	Banquet Room 1	Banquet Room 3	Conference Room 5	Conference Room 6
Sat. Feb.20	Student Best Papers Symposium	Crayfish Symposium	Big Rivers Tech. Session	Fish Mgmt. 1 Tech. Session
	Nicole Rankin, Moderator	Zachary Loughman, Moderator	Michael Kaller, Moderator	Stuart Welsh, Moderator
8:10 AM	Introductory Remarks			
8:20 AM	Introductory Remarks	Crayfish Symposium introduction		
8:30 AM	Reproductive Biology of Red Snapper, <i>Lutjanus Campechanus</i> , on Natural and Artificial Reefs in the Western Gulf of Mexico <i>Charles H. Downey</i>	An Analysis of Suspected Crayfish Invasions in Missouri: Evidence for the Prevalence of Short-Range Translocations and Support for Expanded Survey Efforts <i>Robert DiStefano</i>	Influences of Environmental Conditions on Distance Moved By Shovelnose Sturgeon in the Lower Mississippi River <i>Dylan A. Hann</i>	Predation of Invasive White Perch in Sooner Reservoir: Preliminary Results <i>Nathan Copeland</i>
8:50 AM	Using Relative Stock Density to Evaluate Alternative Management Regimes for Mississippi's Spotted Seatrout Stock <i>David A. Dippold</i>	Does the Native Geographic Origin of an Invader Affect Stream Structure and Function? <i>Nicole Graham</i>	A Synthesis of Methods for Sampling Shovelnose Sturgeon and the Realities for Sampling a Highly Altered System of the Great Plains <i>Josh Johnston</i>	Trends in Abundance of Northern Snakehead in Virginia Potomac River Tributaries <i>John Odenkirk</i>
9:10 AM	Transcriptome Discovery in Non-Model Species for the Development of Quantitative Gene Expression Assays: A Case Study of the Rochester Embayment Area of Concern <i>Cassidy Hahn</i>	The Crayfish Microbiome: Variation Due to Site, Body Region, and the Influence of Ectosymbionts <i>Bryan Brown</i>	Historic Arkansas River Flows in Spring and Summer 2015 Deposit Numerous Paddlefish in Metropolitan Tulsa, Oklahoma <i>Jason Schooley</i>	The Effects of Prior Satisfaction and Constraints on the Intention to Resume Fishing for Stocked Trout in Virginia <i>Vic DiCenzo</i>
9:30 AM	Brook Trout Preference of Terrestrial Versus Aquatic Prey Across Two Seasons in Appalachian Head-Water Streams <i>Erin Thayer</i>	Conservation Status of <i>Cambarus Cymatilis</i> : Natural History and Distribution <i>Roger Thoma</i>	Flood Pulse Effects on Multispecies Fishery Yields in the Lower Amazon <i>Leandro Castello</i>	Bridgewater Tailrace, NC: Historical and Contemporary Approaches to Managing a Quality Trout Fishery <i>Chris Wood</i>

Room	Banquet Room 1	Banquet Room 3	Conference Room 5	Conference Room 6
<b>Sat. Feb.20</b>	<b>Student Symposium Cont'd</b>	<b>Crayfish Symposium Cont'd</b>	<b>Big Rivers Tech. Session Cont'd</b>	<b>Fish Mgmt. 1 Tech. Session Cont'd</b>
9:50 AM	Age and Growth of Southern Flounder in the North-Central Gulf of Mexico <i>Morgan M. Corey</i>	Life History of <i>Cambarus Obeyensis</i> , an Endemic Crayfish of the Cumberland Plateau <i>Thomas Boersig III</i>	Demographics and Distribution of Asian Carp in the Lower Tennessee River and Cumberland River <i>Josey Ridgway</i>	Return of Stocked Brown Trout and Rainbow Trout to the Angler Creel at Apalachia Reservoir, NC <i>Amanda Bushon</i>
10:10 AM	<b>BREAK</b>	<b>BREAK</b>	<b>BREAK</b>	<b>BREAK</b>
		<b>Zachary Loughman, Moderator</b>	<b>Cory Trego, Moderator</b>	<b>Edward Olesh, Moderator</b>
10:30 AM	No presentation (Best Student Symposium begins again at 1pm)	Influence of Flow Regime, Geomorphology, and Habitat on Crayfish Assemblages of the Ozark Highlands <i>Allyson Yarra</i>	Movement of Triploid Grass Carp in the Regulated Pee Dee River, North Carolina <i>Lawrence Dorsey</i>	Costs of the U.S. Regulatory Environment on Baitfish and Sportfish Aquaculture <i>Jonathan van Senten</i>
10:50 AM	No presentation	Highway to Heaven? Roadsides As Preferred Habitat for Two Narrowly Endemic Crayfish <i>Cody Rhoden</i>	Are We Learning While Doing? Addressing Persistent Uncertainties in Ecosystem Responses to Modifications in River Discharge <i>William Pine III</i>	Thinking "inside the Box" to Direct American Eel Research Efforts in Florida <i>Kimberly Bonvechio</i>
11:10 AM	No presentation	Physical Habitat and Water Quality Correlates for <i>Cambarus Veteranus</i> in the Upper Guyandotte Basin of West Virginia <i>Zachary Loughman</i>	Human and Environmental Factors Affecting the Distribution of Arapaima in Amazon River Floodplain Lakes <i>Jordan Richard</i>	Patterns and Periodicity of Upstream Passage of American Eels at an Eel Ladder <i>Stuart A. Welsh</i>
11:30AM - 1:00PM	<b>LUNCH</b>	<b>LUNCH</b>	<b>LUNCH</b>	<b>LUNCH</b>

Room	Banquet Room 1	Banquet Room 3	Conference Room 5	Conference Room 6
<b>Sat. Feb.20</b>	<b>Best Student Paper Symp. Cont'd</b>	<b>Crayfish Symposium, Cont'd</b>	<b>Genetics Symposium</b>	<b>Fish Mgmt. 1 Tech. Session Cont'd</b>
	<b>Nicole Rankin, Moderator</b>	<b>Zachary Loughman, Moderator</b>	<b>Amy Welsh, Moderator</b>	<b>Ryan Braham, Moderator</b>
1:00 PM	Juvenile Atlantic Sturgeon Seasonal Movements and Outmigration in Four Georgia Rivers <i>Adam Fox</i>	The Crayfishes of Alabama Project: A Case Study of Why Faunal Surveys Still Matter <i>Christopher Taylor</i>	Identifying the Fundamental Unit of Management and Distinct Population Segments in Atlantic Sturgeon ( <i>Acipenser oxyrinchus</i> ) <i>Tim L. King</i>	Landscape and Flow Metrics Affecting the Distribution of a Federally-Threatened Fish: Improving Management, Model Fit, and Model Transferability <i>Shannon K. Brewer</i>
1:20 PM	Using Side-Scan Sonar to Assess the Atlantic Sturgeon Spawning Run in the Altamaha River <i>Edward Stowe</i>	Do Environmental Oxygen Requirements Vary with Molt Stage for Crayfish? <i>James Stoeckel</i>	Characterization of the Migratory Phenotype in Lake Sturgeon <i>Justine Whitaker</i>	Environmental and Biological Correlates of Seasonal Movement Patterns of Walleyes in a Hydropower Reservoir <i>Dustin M. Smith</i>
1:40 PM	Seasonal Movements and Annual Mortality Rates of Tripletail ( <i>Lobotes surinamensis</i> ) in the Southeast <i>Alex Cummins</i>	Potential Impacts of Invasive Virile Crayfish & Red Swamp Crayfish on Native Piedmont Crayfish: Insights from Laboratory Expts. <i>Sujan Henkanaththege</i>	Restoring the Connection Between Brook Trout Populations within an Appalachian Watershed <i>Darren Wood</i>	Population Characteristics of Channel Catfish in Cheat Lake, West Virginia <i>Corbin D. Hilling</i>
2:00 PM	Environmental DNA for Monitoring and Detection of Rare and Endangered Cavefish and Cave Crayfish in the Ozark Highlands <i>Ana Gabriel</i>	Applying Environmental DNA (eDNA) to Monitor Crayfish Populations <i>Eric Larson</i>	A Quest for Adaptive Variation Among Discreet Populations of Atlantic Sturgeon: Transitioning from Population Genetics to Population Genomics <i>Tim L. King</i>	Population Dynamics of Catfishes in Three Tennessee River Reservoirs and Developing Standardized Sampling Protocols <i>Cole Harty</i>
2:20 PM		A Complete Sequence of the Mitochondrial Genome of <i>Orconectes punctimanus</i> <i>Paul Cabe</i>	Using Microsatellite Loci to Identify Candy and Variegated Darter Hybrids <i>Isaac Gibson</i>	Naturalization of Largemouth Bass from Formulated to Live Diets, with Implications for Hatchery and Fisheries Management <i>Colin Dinken</i>
2:40 PM	<b>BREAK</b>	<b>BREAK</b>	<b>BREAK</b>	<b>BREAK</b>

Room	Banquet Room 1	Banquet Room 3	Conference Room 5	Conference Room 6
Sat. Feb.20	<b>GIS Symposium</b>	<b>Crayfish Symposium, Cont'd</b>	<b>Fish Health Symposium</b>	<b>Fish Mgmt. 1 Tech. Session, Cont'd</b>
	<b>Michael Strager, Moderator</b>	<b>Zachary Loughman, Moderator</b>	<b>Vicki Blazer, Moderator</b>	<b>Lila Warren, Moderator</b>
3:00 PM	"Advanced Surface Runoff Techniques for Watershed Modeling with GIS" <i>Michael P. Strager</i>	Crayfish Genetic Studies: Synthesis and Needs <i>Chester R. Figiel Jr.</i>	Gill Lice and Whirling Disease within North Carolina Trout Populations: Past, Current, and Future Efforts to Understand These Recently Discovered Threats <i>Jacob Rash</i>	Estimation of Largemouth Bass Survival in a Simulated Catch-and- Release Fishery <i>Kevin Keretz</i>
3:20 PM	Landscape Change and Hydrologic Alterations: Impacts on Water Resources Datasets and Modeling within West Virginia <i>Jacquelyn Strager</i>	Revealing the Elephant: The Past, Present, and Future of Species Delimitation in Crayfishes <i>Christopher Taylor</i>	Temporal Distribution of Cyanotoxins and Environmental Estrogens within the Upper and Middle Potomac River Drainage, USA <i>Ryan Braham</i>	Capture and Mortality Rates of Largemouth Bass at Guntersville and Wheeler Reservoirs, Alabama <i>Jeff Buckingham</i>
3:40 PM	Intensification of the Water Cycle: Implications for Appalachian Watersheds <i>Brandi Gardner</i>		Assessing the Exposure of Microcystin Cyanotoxin to Smallmouth Bass Via Diet Items in the South Branch of the Potomac River <i>Brandon Keplinger</i>	Restoring a Trophy Largemouth Fishery: Firing on All Cylinders <i>Dave Beasley</i>
4:00 PM			An Epizootic of Melanoma in Brown Bullhead <i>Ameiurus Nebulosus</i> in Lake Memphremagog, Vermont/Quebec <i>Cheyenne Simpson</i>	Evaluating the Effects of Threadfin Shad on Largemouth Bass Growth, Condition and Diets in Small Impoundments <i>Sean Lusk</i>

Room			Conference Room 5	Conference Room 6
Sat. Feb.20			<b>Fish Health Symposium Cont'd</b>	<b>Fish Mgmt. 1 Tech. Session, Cont'd</b>
			<b>Vicki Blazer, Moderator</b>	<b>Lila Warren, Moderator</b>
4:20 PM			Surface Area and Prevalence of "Blotchy Bass" Spots Change over Time in Smallmouth Bass ( <i>Micropterus dolomieu</i> ) <i>Kelsey Young</i>	Effects of Habitat Enhancement on Growth, Condition, and Habitat Use of Largemouth Bass <i>Chance Kirkeeng</i>
4:40 PM			Skin Lesions in Smallmouth Bass <i>Vicki Blazer</i>	Effects of Diet and Temperature on Growth Potential of Largemouth Bass in a Texas Impoundment <i>Chris Greene</i>

Room	Banquet Room 1	Banquet Room 3	Conference Room 5
<b>Sunday, Feb.21</b>	<b>Fish Communities Tech. Session</b>	<b>Brook Trout Symposium</b>	<b>Fish Mgmt 2 Technical Session</b>
	<b>Cassidy Hahn, Moderator</b>	<b>Eric Merriam, Moderator</b>	<b>Dustin Smith, Moderator</b>
8:30 AM	Lower Leon Creek (Bexar County, TX) Use Attainability Analysis <i>Shaun Donovan</i>	Assessing Previously Unknown Brook Trout Streams in Pennsylvania <i>Jon Niles</i>	A Multi-Scale Web-Based Fish Habitat Decision Support Tool <i>Jason Clingerman</i>
8:50 AM	Evaluating the Effects of Flood Pulses on Exploited Floodplain Fish Populations <i>Jesse Olsen</i>	Brook Trout Behavioral Thermoregulation Influenced By Brown Trout <i>Nathaniel P. Hitt</i>	Using Population Models to Evaluate Management Alternatives for Gulf-Strain Striped Bass <i>Alex Aspinwall</i>
9:10 AM	Unionid Mussel Survey and the Presence of Golden Orb, <i>Quadrula Aurea</i> , in the Lower Cibolo Creek, Texas <i>Shaun Donovan</i>	Multi-Scale Habitat Use By Brook and Brown Trout in a Restored Appalachian Stream <i>Cory T. Trego</i>	Riverine Habitat Conservation Planning By the Gulf Coastal Plains and Ozarks LCC <i>Mary Davis</i>
9:30 AM	Biotic Interactions and Habitat Drive Positive Co-Occurrence Between Facilitating and Beneficiary Stream Fishes <i>Brandon Peoples</i>	Brook and Brown Trout Movement in a Restored Appalachian Watershed <i>Benjamin Harris</i>	Response to Harmful Algae Blooms at USACE Reservoirs Located in the Upper Ohio River Basin <i>Rose Reilly</i>
9:50 AM	A Tale of Two Darters: Substrate Selection and Preference of Sympatric Sand Darters from the Elk River, WV <i>Patricia Thompson</i>	Genetic Assessment and Effects of Stocking on Wild Brook Trout Populations in South Carolina <i>Kasey Pregler</i>	The Decline of a Fluvial Fish: Species Distribution Models in a Fragmented Riverscape <i>Andrew T. Taylor</i>
10:10 AM	<b>BREAK</b>	<b>BREAK</b>	<b>BREAK</b>

Room	Banquet Room 1	Banquet Room 2	Conference Room 5
Sun. Feb. 21	<b>Fish Communities Tech. Session Cont'd</b>	<b>Brook Trout Symposium Cont'd</b>	<b>Fish Mgmt 2 Technical Session Cont'd</b>
	<b>Mark Scott, Moderator</b>	<b>Ross Andrew, Moderator</b>	<b>Erin Thayer, Moderator</b>
10:30 AM	The Effect of Stream Restoration on Fish Species Richness and Diversity in the Coastal Plains of West Tennessee <i>Mary Zaradich</i>	Using Local and Catchment-Level Variables to Explain Differences in Bia- Predicted Body Composition of Brook Trout in Headwater Streams of West Virginia <i>Ross Andrew</i>	Relative Abundance, Age, and Growth of Red Snapper: A Comparison Between Artificial and Natural Habitats in the Western Gulf of Mexico <i>Matthew K. Streich</i>
10:50 AM	Identifying Potential Cheaters in a Mutualistic Nest Association Among North American Minnows <i>Stephen Floyd Jr.</i>	Population Genomics of Brook Trout ( <i>Salvelinus fontinalis</i> ): A Quest for Adaptive Variation Among Populations Exhibiting Prodigious Genetic Differentiation at Neutral Loci <i>Tim L. King</i>	A Photogrammetric Method for in Situ Estimation of Body Length and Total Length of Benthic Fishes <i>Austin Rizzo</i>
11:10 AM	Fishes Associated with Low Levels of Suspended and Bed Sediment in the Broad River Basin of South Carolina <i>Mark Scott</i>		Scarce As Hen's Teeth: Abundance Estimation of an Imperiled Appalachian Minnow <i>Michael Moore</i>



Symposia

**"Advanced Surface Runoff Techniques for Watershed Modeling with GIS"** (Surface hydrological modeling for fisheries)

*Michael P Strager\*, West Virginia University, mstrager@wvuedu*

Analyzing spatial issues is a necessary component of watershed and fisheries management. Geographic Information Systems (GIS) is a useful tool to characterize spatial components of a stream, river or larger water body as well as the landscape, terrain attributes, and drainage patterns. Beyond characterization and data collection, watershed analysis includes using statistical modelling, hydrological principals and continuity equations, and terrain derivatives to provide insights to questions about water quality, quantity, aquatic habitat, restoration, and conservation. This presentation will outline and discuss these multifaceted aspects with specific examples used throughout the Mid-Atlantic Highlands. Examples include finding potentially affected streams from overland flow runoff, creating a spatially explicit runoff grid, and water quality modeling using loading equations from land cover for total nitrogen, phosphorus and suspended solids.

**Landscape Change and Hydrologic Alterations: Impacts on Water Resources Datasets and Modeling within West Virginia** (Surface hydrological modeling for fisheries)

*Jacquelyn Strager\*, West Virginia University, jmstrager@mailwvuedu*

Broad scale landscape changes have recently occurred across West Virginia and neighboring states, with associated impacts on hydrologic datasets and related GIS-based modeling. Widely used spatial datasets impacted by landscape level changes include the National Hydrography Dataset (NHD), Watershed Boundary Dataset (WBD), and the National Elevation Dataset (NED). The extent of recent landscape change in West Virginia will be described, with an emphasis on mountaintop removal surface mining. Examples of the impact of mountaintop mining on existing surface water datasets will be provided, along with a discussion of the need for increased NHD maintenance in WV. The ongoing development of the West Virginia StreamStats application using recently acquired LiDAR derived elevation data will be described, along with the related implications for applied fisheries research.

**Intensification of the Water Cycle: Implications for Appalachian Watersheds** (Surface hydrological modeling for fisheries)

*Nicolas Zegre\*, West Virginia University*

There is a general consensus that the global average surface air temperature will continue to increase over the next century forcing us to ask the question “*How will climate change impact*

*ecosystems and the services we derive from them?"* A potential consequence of climate warming is the intensification of the water cycle itself, having important implications for the frequency and intensity of tropical storms, floods, and droughts. The magnitude and scale of impacts will greatly depend on the response of hydrologic variables to climate warming, and on how ecosystem processes and services themselves are affected by changes in hydrology. In this talk we will explore the mechanisms and feedbacks involved in intensification of the water cycle, and discuss the implications of intensification on watershed responses.

**"Western Pennsylvania's Primary Burrowing Crayfish: Distributional Survey and Determination of Conservation Status"** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Rachel Scott\*, West Liberty University, rkscott@westliberty.edu, Zachary Dillard, West Liberty University, Nicole Sadecky, West Liberty University and Zachary Loughman, West Liberty University*

Dr. Arnold Ortmann, one of the nation's first crayfish biologists, conducted crayfish surveys in the late 1800's and early 1900's across western Pennsylvania. Unique for the time was Ortmann's inclusion of primary burrowing crayfishes. Primary burrowing crayfish utilize subterranean burrows for all facets of their ecology, and are rarely encountered outside their burrows. Urbanization, extractive industries, and the genesis of industry have all occurred across western Pennsylvania since Ortmann's initial surveys. We visited all of Ortmann's historic sites (70 sites) to determine if burrowing crayfish still occur throughout the region following the past century of environmental change. Furthermore, crayfish have been recognized recently as one of North America's most imperiled group of animals. Resultants of this, our efforts will lead to the determination of conservation baselines for each burrowing crayfish species occurring in the region. Ortmann determined that three species occurred in Western Pennsylvania, *Cambarus dubius*, *Cambarus thomai*, and *Cambarus monongalensis*. The project produced an excellent understanding of Western Pennsylvania's burrowing crayfish status, and was the first to focus on burrowing crayfish in Pennsylvania since Ortmann's efforts.

**An Analysis of Suspected Crayfish Invasions in Missouri: Evidence for the Prevalence of Short-Range Translocations and Support for Expanded Survey Efforts** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Robert DiStefano\*, Missouri Department of Conservation, Emily Imhoff, Thomas More College, Dusty Swedberg, Missouri Department of Conservation and Tom Boersig, Tennessee Technological University*

Reports of alien crayfish invasions are increasingly common and often associated with well-documented ecological effects including native crayfish biodiversity declines. Because most

regions in North America have not been surveyed to detect the presence and gauge the threat status of such invasions, management agencies lack information on the magnitude of problems in their respective jurisdictions. Our objectives were to catalog, confirm and summarize suspected crayfish invasions that were reported in one US state in recent years. Data were also examined for potential spatial patterns, prevalence of certain species as invaders and effects to native crayfishes. We collected reports of crayfish introductions/invasions from 1998-2014, and attempted to confirm them via sampling. We catalogued 34 reports and confirmed 31 as suspected invasions involving 6 invading species. White River Crawfish (*Procambarus acutus*) was easily the most frequent invader, and all invading species were native to at least part of Missouri. Most suspected invasions involved species that were legal for commercial sale in the state, but many also involved non-commercial species that are described as “narrow-range endemics”. Invading species were abundant, dominating crayfish communities, at several sites. Native species have apparently declined or been displaced at several locations. Our results suggest the potential for many existing, unreported crayfish invasions in North America, including those caused by shorter-range (eg, intrastate) translocations. Ecoregions featuring high crayfish diversity such as the southeastern US could be threatened with significant declines of native species with narrow ranges. Increased survey efforts in these regions are warranted to estimate threat levels and provide agencies with information to support management actions.

### **Does the Native Geographic Origin of an Invader Affect Stream Structure and Function?** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Nicole Graham\*, Arkansas Cooperative Fish and Wildlife Research Unit and Daniel Magoulick, Arkansas Cooperative Fish & Wildlife Research Unit*

The cold water crayfish, *Orconectes eupunctus*, is a vulnerable species endemic to the Spring River, Strawberry River, and Eleven Point River drainages of Arkansas and Missouri. The ringed crayfish, *O. neglectus*, was introduced to the Spring River drainage from the adjacent White River drainage and has since become established, leading to the apparent displacement of *O. eupunctus*. Recent research suggests that stream drying, a frequent disturbance in the Ozark Highlands, may play a role in the successful establishment of *O. neglectus*. In addition, experimental evidence provides that *O. eupunctus* and *O. neglectus* may be largely ecologically redundant with regard to their effect on stream structure and function. However, little is known about the relative effects of invaders from adjacent watersheds (ie, extralimnal) versus invaders from distant watersheds (ie, extraregional). This study aims to investigate the influence of an invader’s native geographic origin on stream structure and function. In order to address this question, we conducted a fully factorial mesocosm experiment to examine the effects of crayfish identity (ie, native crayfish, extralimnal crayfish, and extraregional crayfish) and simulated stream drying on response variables indicative of stream structure and function (ie, primary production and community

respiration, leaf breakdown, periphyton ash-free dry mass, macroinvertebrate abundance, and sediment levels) Male crayfish were collected from the Spring River (native *O eupunctus*) and White River drainages (extralimital *O neglectus*) of Arkansas and the Republican River drainage (extraregional *O neglectus*) of Kansas Multivariate analysis of variance (MANOVA) will be used to investigate the effects of drought and crayfish treatments on response variables and to examine the effects of drought and crayfish identity on crayfish growth and survival Analysis of variance (ANOVA) will be used to evaluate effects on individual response variables We hope to provide insight into the potential ecological impacts of invaders in relation to their geographic origin in order to benefit invasive species management

### **The Crayfish Microbiome: Variation Due to Site, Body Region, and the Influence of Ectosymbionts** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Bryan Brown\*, Virginia Tech, James Skelton, University of Florida and Robert Creed, Appalachian State University*

Recent years have seen intense interest develop in the microbiome of organisms However, while most microbiome work to date has focused on describing composition and compositional variability, more recent studies have begun to focus on topics like assembly of the microbiome and interactions between the microbiome and other organisms Of particular interest are questions like: 1) what factors control the structure of the microbiome community?, 2) do other symbionts affect the microbiome?, and 3) at what scale do microbiomes vary and why? We addressed each of these questions regarding the microbiome of the crayfish *Cambarus sciotensis*, the Teays River Crayfish Used both observational studies and field experiments and characterized the crayfish microbiome using amplicon sequencing of the 16s rRNA gene Among our most fascinating results were that: 1) location on the crayfish body had a strong influence over both taxonomic and functional composition of the microbiome, 2) the crayfish gill microbiome was characterized by a very distinct and restricted microbial assemblage, and 3) that branchiobdellidan symbionts of crayfish significantly changed microbiome structure on crayfish carapaces, but not on crayfish gills These results suggest control of the crayfish microbiome at multiple spatial scales and that interactions with other symbionts may be taxonomically and functionally important for the microbiome

### **Conservation Status of *Cambarus cymatilis*: Natural History and Distribution** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Roger Thoma\*, Midwest Biodiversity Institute*

H H Hobbs, Jr described *Cambarus cymatilis* in 1970 giving an urban lawn and rose garden in Chatsworth, GA as the type locality Hobbs (in The Crayfishes of Georgia) reported a

distribution primarily in the vicinity of Chatsworth, Georgia with one additional site in Bradley County, Tennessee This author visited Murray Co, GA in 2007 and failed to collect any specimens of *C cymatilis* In 2015 27 sites in Bradley Co, TN were visited Seven sites harbored the species Numbers ranges from one to 14 individuals with an average of 76 individuals collected per site Three of the collections consisted of ten or more individuals The most abundant colony covered an area of 480 m<sup>2</sup> and was estimated to harbor a population of between 750 to 1,150 individuals Population densities were greatest in areas lacking aquatic vegetation and water at the surface Burrows were found in hard surfaced grass fields (frequently Fescue) where water levels were 15 cm or more below the surface Burrows normally had two entrances and an enlarged chamber between them Occasional side burrow were observed *Cambarus extraneus* is confined to the South Chickamauga Creek watershed on the boarder of GA and TN Sampling efforts in Hamilton Co, TN (13 sites) in the summers of 2014 & '15 confirm the continued existence of the species in that portion of the basin Very few adult individuals were recorded All adults were recovered from beneath larger boulders while the numerous YOY were collected from aquatic vegetation and from leaf litter The species is not common even in the best habitat areas High sand bed load sediments are common in streams draining new housing project areas In addition, many streams in the basin have been modified, usually channelized with one long section of Friar Branch cement lined Stream restoration would greatly enhance the species' numbers

### **Life History of *Cambarus Obeyensis*, an Endemic Crayfish of the Cumberland Plateau** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Thomas Boersig III\**, *Tennessee Technological University, Hayden Mattingly, Tennessee Technological University and John Johansen, Austin Peay State University*

North American crayfish exhibit high imperilment rates and lack basic biological data needed for conservation, particularly life history information Although comprehensive, species-specific life history studies exist for less than 25% of crayfish within the genus *Cambarus*, published literature suggests considerable variation in life history strategies *Cambarus obeyensis* is endemic to the Cumberland Plateau with a global distribution of 86 km<sup>2</sup>, and no comprehensive life-history study exists for the species We determined life history variables of *C obeyensis* at two sites over two breeding seasons (March 2014 through June 2015) to inform conservation measures for the species Most individuals were <20 mm carapace length (CL), while reproductively active *C obeyensis* were >25 mm CL and 2+ years of age

Ovigerous females were present in spring collections, and few adult females took part in annual reproductive events Mean clutch size was 110 eggs and varied between sites and years, with no significant relationship between female carapace length and number of pleopodal eggs Mean egg diameter was 23 mm Although *C obeyensis* is abundant within its small range, life history attributes such as delayed maturity and low reproductive effort leave it vulnerable to anthropogenic disturbance Our study adds to the complex picture of crayfish

life-history strategies in the southeast United States, underscoring the importance of multi-year studies when collecting life history data, specifically as it relates to long-lived aquatic invertebrates

### **Influence of Flow Regime, Geomorphology, and Habitat on Crayfish Assemblages of the Ozark Highlands** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Allyson Yarra\*, University of Arkansas, ayarra@uark.edu and Daniel Magoulick, Arkansas Cooperative Fish & Wildlife Research Unit*

Crayfish are ecological dominants in many streams due to their multifaceted role as predators, prey, ecosystem engineers, and bioprocessors. Given the imperiled status and high level of endemism seen in numerous Ozark crayfish species, it is vital to understand the effects of stream drying on native crayfish. While the seasonal drying of intermittent streams in this region is a natural process, the pressures of human water use coupled with global climate change may induce additional stress on the region's sensitive aquatic biota in the future. Our objectives were to 1) determine crayfish occupancy and species densities in two hydrologic regimes (Groundwater Flashy and Intermittent Flashy streams) and 2) assess the relationship between hydrologic regime, crayfish occupancy, species density, and habitat (eg, current velocity, substrate composition, and water depth). Four riffle habitats were selected and eight 1m<sup>2</sup> areas were randomly selected per riffle in each of 10 Intermittent Flashy and 10 Groundwater Flashy streams. At each sampling location (32 per stream), crayfish were collected using the quantitative kicknet method and environmental variables were measured. Species occupancy varied among flow regimes. As determined by occupancy models in Program PRESENCE, *Orconectes neglectus*, *O. ozarke*, and *O. luteus* occupancy was positively associated with Groundwater Flashy regimes whereas *O. meeki* and *O. williamsi* occupancy was positively associated with Intermittent Flashy regimes. Total crayfish density differed significantly between the two years ( $p = 0.005$ ) but did not differ among flow regimes. MANOVA results indicated all environmental variables measured differed by both flow regime and year. The strength of relationships between individual species and environmental variables will be compared among flow regimes and years. Information gained from the establishment of flow-crayfish ecology relationships will be essential for guiding future management decisions of crayfish of greatest conservation need in the Ozark Highlands.

### **Highway to Heaven? Roadsides As Preferred Habitat for Two Narrowly Endemic Crayfish** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Cody Rhoden\*, Illinois Natural History Survey University of Illinois Urbana-Champaign, Chris Taylor, Illinois Natural History Survey and Bill Peterman, Ohio State University*

Roadside ditches can harbor beneficial and detrimental attributes for animal persistence. Past studies have revealed mostly negative effects on fauna that inhabit the roadside ditch.

However, we believe the microhabitat found in the roadside ditch could be preferential to two narrowly endemic habitat specialists. We tested this prediction by collecting habitat data for two primary burrowing crayfish species, *Fallicambarus harpi* and *Procambarus reimeri*, in the Ouachita Mountains Ecoregion of Arkansas. We analyzed the data with generalized linear mixed models. Our analysis revealed canopy cover and the presence of hydrophilic sedges to be important factors in predicting crayfish abundance across the landscape. Our findings show the microhabitat found in the roadside ditch can be beneficial to the persistence of two narrowly endemic habitat specialists.

**Physical Habitat and Water Quality Correlates for *Cambarus Veteranus* in the Upper Guyandotte Basin of West Virginia** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Zachary Loughman\**, West Liberty University, [zloughman@westliberty.edu](mailto:zloughman@westliberty.edu), *Nicole Sadecky*, West Liberty University, *Zachary Dillard*, West Liberty University, *Rachel Scott*, West Liberty University and *Stuart A Welsh*, USGS, WV Cooperative Fish and Wildlife Research Unit

In 2015 *Cambarus veteranus*, a narrow endemic crayfish native to the Upper Guyandotte River Basin (UGB) in West Virginia, was petitioned by the U.S. Fish and Wildlife Service to be federally listed as endangered. Following a public comment period, a status survey was recommended to determine if listing was warranted. During May and June 2015, surveys were performed across the UGB to determine the current distribution of the species. Seventy-one sites were sampled, including all historic streams, as well as semi-randomly selected streams, with at least one and as many as nine 125m reaches sampled per wadeable stream. At each site, physiochemical data were collected with a YSI data sonde. Also, water samples were collected to determine sulfate levels, and physical habitat was assessed with OEPA QHEI datasheets. *Cambarus veteranus* site presence/absence and associated site covariates were modelled using logistic regression to determine covariates affiliated with *C. veteranus* site presence. Survey results produced *C. veteranus* in both the Pinnacle Creek and Clear Fork/Laurel Fork watersheds at 10 sites; *C. veteranus* was not observed at the remaining 61 sites sampled. Models with conductivity followed by overall QHEI were selected as predictive for sites maintaining *C. veteranus*. Specifically, *C. veteranus* was associated with lower than average UGB conductivity (379 ms) and high (>80) QHEI score. All sites lacking *C. veteranus* either had higher conductivity, lower QHEI, or both higher conductivity and lower QHEI scores. Results indicated that favorable habitat is limited in the UGB, providing support for the listing of *C. veteranus*.

**The Crayfishes of Alabama Project: A Case Study of Why Faunal Surveys Still Matter** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Christopher Taylor\**, Illinois Natural History Survey, [ctaylor@inhsillinois.edu](mailto:ctaylor@inhsillinois.edu) and *Guenter Schuster*, Eastern Kentucky University

The state of Alabama in the southeastern United States may harbor the greatest diversity of crayfishes in the world for an area of its size. Since 2004 we have been conducting a comprehensive survey of aquatic and semi-aquatic habitats across Alabama for crayfishes. Over the past 12 years, we have documented new species, new distributional records, and new understandings of the ecological requirements of crayfishes in the state. This talk will highlight some of our findings in the context of future surveys in different regions of the United States. Funding for faunal surveys will also be addressed.

**Do Environmental Oxygen Requirements Vary with Molt Stage for Crayfish?** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*James Stoeckel\*, Auburn University, jimstoeckel@auburn.edu, Di Zuo, East China Normal University, Brian Helms, Auburn University and Katelyn Hatfield, Auburn University*

Dissolved oxygen (DO) requirements of aquatic species are some of the most basic parameters required to assess habitat suitability of impacted and restored aquatic systems. However, they can be surprisingly difficult to assess. It is increasingly realized that oxygen consumption patterns are highly variable not only across species, but within species as well. Oxygen requirements of freshwater crayfish species may be particularly difficult to assess because crayfish pass through multiple molting stages, which may affect gill function and respiratory efficiency. We measured respiration rates of crayfish 1 to 40 days after molting and calculated a regulation index (RI) to assess ability of crayfish to regulate oxygen consumption across normoxic to anoxic conditions. An RI of 1 indicates a constant oxygen consumption rate regardless of declining DO (oxygen regulator) whereas an RI of 0 indicates the ability to obtain oxygen declines linearly with declining ambient DO (oxygen conformer). Results thus far suggest that oxygen consumption rates, and the ability of crayfish to regulate oxygen consumption, varies with molt stage. Freshly molted crayfish exhibited a mean RI of  $0.50 \pm 0.06$  stdev. RI subsequently became highly variable during the intermolt stage with values ranging from nearly 1 to nearly 0. Respiration rates under normoxic (6 mg O<sub>2</sub>/L) and anoxic (2 mg O<sub>2</sub>/L) conditions decreased from early postmolt to intermolt stages. Taken together, data suggests that crayfish may be susceptible to a DO bottleneck during the molting process. Freshly molted crayfish have a higher demand for DO, but their ability to extract oxygen from the environment declines under low DO conditions. Intermolt crayfish have consistently lower demand for DO regardless of their variable ability to regulate oxygen consumption. Thus habitat suitability assessments should be based on oxygen requirements of freshly molted crayfish rather than that of fully hardened, intermolt crayfish.

**Potential Impacts of Invasive Virile Crayfish (*Orconectes virilis*) and Red Swamp Crayfish (*Procambarus clarkii*) on Native Piedmont Crayfish (*Cambarus* sp C): Insights from Laboratory Experiments** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)



*Sujan Henkanaththege*\*, Longwood University, *Patricia Hale*, Longwood University, *James Wilson*, Longwood University and *Zachary Loughman*, West Liberty University

Despite the extreme diversity of crayfish in Southeastern United States, many taxa are threatened with extinction due to their own invasive counterparts. Invasive crayfish alter native habitats causing community-level impacts, and population-level impacts due to competition, predation and transmitting diseases. We experimentally evaluated the potential impacts of invasive red swamp crayfish (*Procambarus clarkii*) and virile crayfish (*Orconectes virilis*) on native crayfish using Piedmont crayfish (*Cambarus* sp C) as a model species. We tested 1) species specific aggressive behavior with aggression assays, 2) competition for food with feeding assays, and 3) survival in sympatry with survival analysis. In general, both invasive species expressed much higher levels of aggression towards less aggressive native *Cambarus* sp C. The overall aggression score of invasive *O. virilis* ( $5950 \pm 1132$ ) was about twice that of native *Cambarus* sp C ( $3300 \pm 961$ ). The average overall aggression scores between invasive *P. clarkii* ( $4568 \pm 1108$ ) and native *Cambarus* sp C ( $3256 \pm 674$ ) were not statistically significant ( $W = 148$ ,  $p > 0.05$ ). During feeding assays, invasive *O. virilis* reached food faster in  $15331 (\pm 2571)$  seconds compared to relatively slow native *Cambarus* sp C ( $22862 \pm 2038$  seconds;  $W = 67$ ,  $p < 0.05$ ). In contrast, we did not detect a significant difference of time to reach food ( $W = 91$ ,  $p > 0.05$ ) between invasive *P. clarkii* ( $16400 \pm 2681$  seconds) and native *Cambarus* sp C ( $22294 \pm 2690$  seconds). During long-term survival experiments, proportional survival of native *Cambarus* sp C in sympatry with invasive *O. virilis* dropped by 56% over a 120-hour period while the overall survival of invasive *O. virilis* dropped only by 12% ( $X^2 = 718$ ;  $df = 1$ ;  $P = 0.0074$ ). However, we did not find a significant difference of the proportional survival between invasive *P. clarkii* and native *Cambarus* sp C ( $X^2 = 151$ ;  $df = 1$ ;  $P = 0.2185$ ). Collectively, these experiments show that the negative impacts of two invasive crayfish taxa tested against native *Cambarus* sp C were not consistent. Therefore it is critical to understand species-specific potential impacts of invasive crayfish on native taxa to better understand invading dynamics and potential impacts, and make novel and effective decisions in controlling invasive species.

### **Applying Environmental DNA (eDNA) to Monitor Crayfish Populations** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Eric Larson*\*, University of Illinois at Urbana-Champaign, *erlarson@illinois.edu*, *Matthew Dougherty*, Catholic Theological Union, *Mark Renshaw*, University of Notre Dame, *Crysta Gantz*, University of Notre Dame, *Scott Egan*, Rice University, *Daniel Erickson*, University of Notre Dame, *John Umek*, University of Nevada, *Sudeep Chandra*, University of Nevada and *David Lodge*, University of Notre Dame

Environmental DNA (eDNA) has emerged as a potentially sensitive tool for monitoring populations and communities of freshwater organisms, but much work remains to be done evaluating its utility across taxa and habitats. Benthic arthropods like crayfish may pose

unique challenges for eDNA monitoring, owing in part to exoskeletons that may limit exchange of DNA with surrounding water relative to the amphibians and fish for which eDNA has been most often applied. We report results of several recent studies evaluating eDNA for monitoring of crayfishes throughout North America. First, we tested the ability of eDNA to detect invasive rusty crayfish (*O. rusticus*) presence and represent abundance of this species in 12 lakes of Vilas County, Wisconsin. We successfully detected *O. rusticus* presence by eDNA down to low catch-per-unit effort (CPUE) from baited trapping of only 0.17 crayfish per trap, and the proportion of water samples yielding positive detections of *O. rusticus* increased with increasing CPUE. We were similarly successful in applying an eDNA assay to detect and monitor the invasive signal crayfish (*P. leniusculus*) in and around Lake Tahoe in California and Nevada, and to screen for this potential emerging invader throughout the Great Lakes region in cooperation with citizen scientists participating in zoo and aquarium summer science programs. Accordingly, we propose that eDNA holds high promise for monitoring both invasive and imperiled crayfishes at low population abundances, and conclude with brief discussion of potential applications to crayfishes of the southeastern United States.

#### **A Complete Sequence of the Mitochondrial Genome of *Orconectes punctimanus*** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Paul Cabe\*, Washington & Lee University*

Mitochondrial DNA sequences have been used extensively for studies of phylogeny, biogeography, and systematics in a vast array of taxa. In crayfish, the most widely used mitochondrial sequences are from the genes 16S ribosomal RNA, 12S ribosomal RNA, and cytochrome oxidase I. Other regions might perform well for certain questions, and entire mtDNA genome sequences might be very useful for phylogenetic studies, but these uses are curtailed by lack of sequence information. As part of an ongoing research project, we sequenced and annotated the full mtDNA genome of *Orconectes punctimanus* (Creaser 1933). This genome is 15,815 base pairs in length, and contains the expected complement of protein, tRNA, and rRNA genes. Gene order is identical to other Cambaridae mitochondrial genomes. This sequence can now be used to design PCR primers for any section, and is available for phylogenetic comparisons.

#### **Crayfish Genetic Studies: Synthesis and Needs** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Chester R Figiel Jr\*, Warm Springs Fish Technology Center, chester\_figiel@fwsgov*

I surveyed the peer-reviewed literature for studies on crayfish genetics over the last 20 years (1996 to 2015). My objectives were to determine overall trends in crayfish genetics related to population variability, systematics, technique development, and aquaculture and determine

whether there are research differences in studies in species groups, geographic location, or type of methods used. An extensive literature search yielded 188 peer-reviewed articles with genetic information published on 345 species: 178 species from North America; 128 species from Australia and Oceania; 23 from Mexico/Central America/South America; six from Europe; four from Asia; and zero from Madagascar. One hundred-fifteen of these species were listed by the IUCN as critically endangered, endangered, vulnerable, or as near threatened. Crayfish within each ecological group are represented in these published papers. Burrowing crayfish are well represented in these articles as are those crayfish living in lotic habitats; however, stygobitic species may be underrepresented. The synergistic effects of global climate change, emerging pathogens and habitat loss, population declines and species extinction are inevitable for many taxa. Given that nearly one-third of all crayfish species are assessed as threatened with extinction, it is increasingly important to prioritize and understand the taxonomy, genetic diversity, gene flow and population viability in this diverse taxa. Early intervention and management through genetic resource banking may provide an opportunity to ameliorate the short-term impacts and provide an opportunity for long-term conservation of many species. Understanding the genetics of founder populations in crayfish captive refugia programs and those in the wild is an important component for these conservation plans.

### **Revealing the Elephant: The Past, Present, and Future of Species Delimitation in Crayfishes** (Conservation, Ecology, and Taxonomy of Southeastern Crayfish)

*Christopher Taylor\**, Illinois Natural History Survey, [ctaylor@inhsillinois.edu](mailto:ctaylor@inhsillinois.edu), Bronwyn Williams, North Carolina Museum of Natural Sciences and Eric Larson, University of Illinois at Urbana-Champaign

Species discovery and delimitation in crayfishes historically has been based on variation in morphological characters. Classification of morphotaxa is grounded in the assumption that similarity of characters reflects relatedness. The incorporation of molecular data into studies of crayfish phylogeny and taxonomy has become commonplace in recent years. Results of many of these studies challenge the above assumption, and in some cases suggest drastically different relationships among sampled morphotaxa. Such non-congruent results have created a perceived dichotomy between morphological and molecular data. However, much of the dichotomy may be due to a lack of understanding of the mechanisms underlying morphological and molecular variation and therefore limitations in our interpretation of these results. This talk will summarize historical and current efforts to infer phylogeny within North American crayfishes, discuss how current knowledge may potentially impact other developing fields within astacology, and offer suggestions on how to potentially resolve the divergent phylogenetic signal given by morphology and molecules.

### **Assessing Previously Unknown Brook Trout Streams in Pennsylvania** (Brook Trout Conservation In the Face of Uncertain Futures)

*Jon Niles\*, Susquehanna University, nils@susquedu*

Since 2011 Susquehanna University has been a partner of the Pennsylvania Fish and Boat Commission's Unassessed Waters Initiative. This cooperative program between the PFBC and colleges and universities seeks to collect biological data on previously unsampled (unassessed) streams across Pennsylvania to determine their status as possible new Wild Trout streams. Prior to this program which began in 2010, only 8% of the 62,725 streams across Pennsylvania had been sampled for biological data by the PFBC. Since 2011, Susquehanna University faculty, staff and students have surveyed 617 previously unassessed waters as part of the program. Sample sites have been predominately across north central Pennsylvania in areas that under a variety of anthropogenic impacts. We found wild trout (brook and brown trout) in 52% of the streams (320 of the 617). A portion (17%) of sampled sites were found to be seasonally dry during the sampling. Brook trout were found in 293 (47%) of the streams. Results indicate that watershed size is an important predictor of finding wild trout in these previously unsampled streams.

**Brook Trout Behavioral Thermoregulation Influenced By Brown Trout** (Brook Trout Conservation In the Face of Uncertain Futures)

*Nathaniel P Hitt\*, US Geological Survey, nhitt@usgs.gov, Erin Snook, US Geological Survey and Danielle Massie, USGS Leetown Science Center*

Native brook trout are often limited by temperature and introduced brown trout, the relative importance of which is poorly understood but critical for conservation planning. We evaluated effects of brown trout on brook trout thermal habitat use in experimental streams across increasing temperatures (14-23 °C) with simulated groundwater upwelling zones providing thermal refugia (6-9 °C below ambient temperatures). We used a randomized substitution design to assemble allopatric and sympatric populations and recorded fish distributions, movement rates, and opercular ventilation rates (index of oxygen consumption) from visual observation and daily video samples across increasing temperatures for 6 replicated 4-day trials. Allopatric and sympatric trout populations increased their use of groundwater upwelling zones with elevated ambient temperatures, indicating the importance of groundwater as thermal refugia in warming streams. However, allopatric brook trout utilized a larger range of thermal habitats than sympatric brook trout which were primarily restricted to thermal refugia as ambient temperatures exceeded 20 °C. Allopatric brook trout also exhibited higher per-capita movement rates between thermal habitats than sympatric brook trout at all temperatures, whereas brown trout were similar to allopatric brook trout in this regard. Our results suggest that removal of brown trout may facilitate brook trout utilization of suboptimal stream temperatures in downstream reaches and may mitigate effects of stream warming depending in part on the spatial configuration of groundwater upwelling zones.

## **Multi-Scale Habitat Use By Brook and Brown Trout in a Restored Appalachian Stream** (Brook Trout Conservation In the Face of Uncertain Futures)

*Cory T Trego\*, West Virginia University and Eric R Merriam, West Virginia University*

Brook Trout *Salvelinus fontinalis* have experienced significant population declines throughout much of their native range, largely due to habitat loss. Increasing effort has been put toward restoring and preserving existing Brook Trout habitat in the face of continued anthropogenic stress (eg, climate and land use change). However, the ecological benefits of such efforts are rarely quantified. We assess multi-scale habitat use by Brook Trout and Brown Trout *Salmo trutta* in response to restoration activities designed to improve habitat suitability within Shavers Fork, West Virginia. Brook trout habitat suitability increased by an average of 53% one-year post restoration but decreased by 37% three years post restoration. Suitability within control reaches remained relative constant both one (11%) and three (28%) years post-restoration. Prior to restoration, Brook Trout were most dense in riffle habitats, while Brown Trout tended to occupy natural pools. Following restoration, all 3 trout species occupied constructed pool habitats; however, Brook Trout consistently occupied constructed habitats at densities 45× those of Brown Trout. Principal components analysis showed minimal overlap in microhabitat use between Brook and Brown Trout, with Brook Trout regularly occupying shallower habitats with higher velocities. Both species were consistently found <2m from suitable cover. Habitat restoration efforts at Shavers Fork initially resulted in greater brook trout habitat suitability, but these benefits appear to have declined over time. Both Brook Trout and Brown Trout utilize created habitat structures, but competition for microhabitat is minimal.

## **Brook and Brown Trout Movement in a Restored Appalachian Watershed** (Brook Trout Conservation In the Face of Uncertain Futures)

*Benjamin Harris\*, West Virginia University*

Understanding the ecological response of organisms to global climate change and the efficacy of associated mitigation projects is of critical importance to those tasked with natural resource management. This study seeks to assess the response of native Brook trout *Salvelinus fontinalis* and exotic Brown trout *Salmo trutta* to restoration activities designed to increase thermal habitat suitability and improve access to historically severed tributaries within the Shavers Fork mainstem (554 km<sup>2</sup> drainage area) in eastern West Virginia. We implanted 23 Brook trout and 5 Brown trout with radio transmitters from June 1-3, 2015 and tracked the movements of 16 Brook trout and 4 Brown trout through August 15, 2015. Average total movement observed among Brook trout was 331 km (012 km – 821 km), compared with 098 km (045 km – 298 km) for Brown trout. Thirteen Brook trout moved out of the mainstem channel into tributaries (catchments <3 km<sup>2</sup>) in association with a specific high flow event, while four of five Brown trout remained in the mainstem channel and closely associated with

restored habitat structures. These results confirm the importance of connected fluvial systems in facilitating Brook trout dispersal and maintaining large-scale metapopulation structure. Our study suggests that native fish communities may benefit more from the removal of dispersal barriers than structural habitat improvement on main-stem rivers.

### **Genetic Assessment and Effects of Stocking on Wild Brook Trout Populations in South Carolina** (Brook Trout Conservation In the Face of Uncertain Futures)

*Kasey Pregler\*, Clemson University, kaseypregler@gmail.com, Yoichiro Kanno, Clemson University, Dan Rankin, South Carolina Department of Natural Resources, Jason A Coombs, University of Massachusetts Amherst and Andrew R Whiteley, University of Massachusetts Amherst*

Brook Trout (*Salvelinus fontinalis*) have declined greatly throughout its eastern historic range due to a combination of anthropogenic activities including habitat loss and fragmentation, and introduction of exotic species. In South Carolina, remnant wild populations persist in small and isolated headwater reaches of mountain streams, and have a record of current and historic stocking events from hatcheries across the east coast. Given their current small population size and prevalence of trout stocking practices, genetic diversity and integrity is among key scientific and management questions that need to be addressed for conserving South Carolina's wild Brook Trout populations. We investigated Brook Trout population genetics at 15 streams in South Carolina using 12 microsatellite loci based mostly on samples from young-of-the-year individuals, and compared these to samples taken from hatcheries that have a record of stocking in South Carolina. These 15 streams represent South Carolina's remaining Brook Trout populations. Our objectives were to identify genetic diversity within and among Brook Trout populations, and investigate the persistence of populations characterized with southern genetic signatures in South Carolina. Conservation and restoration of southern Appalachian Brook Trout genetic diversity is an important management goal in federal and state natural resources agencies. We aim to use this information to determine which existing South Carolina Brook Trout populations will best serve as source populations for future stream restoration efforts to preserve wild Brook Trout genetic integrity.

### **Using Local and Catchment-Level Variables to Explain Differences in Bia-Predicted Body Composition of Brook Trout in Headwater Streams of West Virginia** (Brook Trout Conservation In the Face of Uncertain Futures)

*Ross Andrew\*, West Virginia University, randrew4@mixwvuedu and KJ Hartman, West Virginia University*

Body condition is a driver of both individual and population characteristics such as behavior, survival, and reproduction. We used bioelectrical impedance analysis (BIA) along with mark-

recapture procedures on populations of Brook Trout to assess factors influencing body composition both spatially and temporally in headwater streams of West Virginia. We hypothesized proximate body composition (measured as percent dry mass) would vary across watershed characteristics such as elevation, geology, and drainage area and local stream characteristics such as proportion of pools, spawning area, and woody debris density. We used a multiple hypothesis approach and compared competing models using AIC scores. Candidate models with the most support included variables such as temperature, prey density, and network position. Across time, we found recaptured fish increasing in both length and weight, but changes in body composition were not always correlated with changes in size. Finally, body composition of adult trout in fall 2013 was not statistically correlated with juvenile abundance in fall 2014, suggesting evidence for environmental drivers of recruitment and spawning success in these streams.

**Population Genomics of Brook Trout (*Salvelinus fontinalis*): A Quest for Adaptive Variation Among Populations Exhibiting Prodigious Genetic Differentiation at Neutral Loci** (Brook Trout Conservation In the Face of Uncertain Futures)

*Tim L King\*, US Geological Survey, tking@usgs.gov, David C Kazyak, Integrated Statistics, Robin L Johnson, US Geological Survey, Matt Kulp, National Park Service, Casey Weathers, Pennsylvania State University, Jay Stauffer Jr, Pennsylvania State University and Barbara A Lubinski, US Geological Survey*

Resource managers must plan for an evolutionary future for trust species, as such, ecological and evolutionary processes—those that maintain genetic diversity and provide the raw material for evolution and adaptation of populations—must be explicitly identified. Contemporary genomic technology offers great promise for exploring the mechanistic basis of adaptive evolution in a model system. Brook trout (*Salvelinus fontinalis*) are rich in ecologically and evolutionarily interesting traits (eg, multiple life history forms; broad latitudinal and elevational distribution; and prodigious gene differentiation (neutral loci) at all spatial scales) that vary between interfertile individuals. Given that both neutral drift and natural selection govern the variance of traits among demographically distinct entities, we are employing a research framework that involves quantifying neutral (ie, differentiation due to genetic distance) and adaptive genetic variation (measured by mass gene expression profiling) among ecologically and evolutionarily distinct brook trout. As a first step, we have collaborated in an extensive survey of neutral allelic variation at 13 microsatellite DNA loci in over 22,000 brook trout sampled from 800 collections comprising the species' native range (and including five national parks). Traditional population genetic analyses identified prodigious levels of genetic differentiation at all spatial scales. Coalescence-based analyses also illuminated previously undetected demographic histories and evolutionary relationships among populations. We are now in the process of assembling and annotating a transcriptome (*de novo*) based on 17 billion RNA-Seq reads. We have initiated the transition from

population genetics (13 microsatellite markers screened across 84 chromosomes) to population genomics (screening thousands of markers across the genome) by employing genotype by sequence (GBS). This research has allowed the identification and contrasting of large numbers of neutral and non-neutral markers among collections interspersed across the species range, identification of evolutionary significant lineages, fine scale population structure, and enhanced resolution of family structures even in populations exhibiting little or no allelic diversity at microsatellite DNA loci. Moreover, a series of markers exhibiting the signal of directional natural selection hold the promise of allowing the identification of phenotypic plasticity and hardwired genetic differences which ultimately can be used for modeling adaptive resiliency at the population scale.

### **Identifying the Fundamental Unit of Management and Distinct Population Segments in Atlantic Sturgeon (*Acipenser oxyrinchus*) (The Use of Genetics in Fisheries Management and Conservation)**

*Tim L King\*, US Geological Survey, tking@usgs.gov, David C Kazyak, Integrated Statistics, Barbara A Lubinski, US Geological Survey, Lorraine Maceda, NYU School of Medicine, Jason Kahn, NOAA, Douglas L Peterson, University of Georgia, Matthew Balazik, Virginia Commonwealth University and Isaac Wirgin, New York University School of Medicine*

Effective programs for conserving at-risk species require the identification of unambiguous units of management that reflect evolutionarily important lineages. Characterizing and delimiting genetic divergence below the level of recognized taxonomic species remains an area of active debate; the fundamental issue being the imposition of demarcations on an evolutionary continuum. The issue of defining appropriate units of management becomes acute when taxa under consideration are threatened or endangered and protection relies on proof of distinction. We will present the results of a range-wide survey of 12 disomic nDNA markers in 380 young-of-the-year (YOY) and spawning adult Atlantic sturgeon (*Acipenser oxyrinchus*; 4N) sampled from nine river systems. Statistical analyses indicate that most, if not all, subpopulations are statistically differentiated ( $P < 0.05$ ) based on allelic frequencies, AMOVA,  $F_{ST}$  and allocation analyses and that the river system should be considered the fundamental unit of management. For example, the average accuracy of determining a sturgeon's collection of origin was 90.2%. In addition to the delineation of population structure throughout the range of Atlantic sturgeon, nDNA allowed the confirmation of the presence of a multiple reproducing populations within the Chesapeake Bay (eg, James, York, and Nanticoke rivers) and the Satilla River. Regional zones of genetic discontinuity were detected in the patterns of genetic variation across the range that likely delineate evolutionarily significant differentiation and adaptive potential for this species. These zones of genetic discontinuity, illustrated by high bootstrap support for nodes on the neighbor-joining tree of chord distance values, represented deeper levels of genetic differentiation, perhaps a higher degree of reproductive isolation than that usually attributable to population-



level differentiation. These zones of discontinuity delineate populations or groups of populations that likely warrant greater conservation considerations and designation as DPSs. Results suggest the designation of at least five DPSs named: 1) Gulf of Maine (St John R, Kennebec R), 2) New York Bight (Hudson R) 3) Chesapeake Bay (James R), 4) Carolina (Albemarle Sound), and 5) South Atlantic (Edisto, Savannah, Ogeechee, and Altamaha).

While a statistically significant, positive correlation exists between the measures of population differentiation ( $F_{ST}$ ) for nDNA and maternally inherited mitochondrial DNA (mtDNA), differences of opinion exist as to what constitutes a DPS for Atlantic sturgeon. Comparisons will be made with patterns observed with microsatellite DNA and mtDNA sequence variation.

### **Characterization of the Migratory Phenotype in Lake Sturgeon** (The Use of Genetics in Fisheries Management and Conservation)

*Justine Whitaker\*, West Virginia University, Amy Welsh, West Virginia University, Darryl Hondorp, USGS Great Lakes Science Center, James C Boase, US Fish and Wildlife Service, Charles Krueger, Michigan State University, Stuart A Welsh, USGS, WV Cooperative Fish and Wildlife Research Unit and George Merovich, Juniata College*

In the Lake St Clair system in the Great Lakes, lake sturgeon (*Acipenser fulvescens*) are partially migrant, with some individuals out-migrating to lakes and others residing in the river year-round. To characterize the migratory phenotype, we analyzed morphometrics, epigenetics, and genetic differentiation using neutral markers. For the morphometric analysis, photographs of 60 telemetered fish (35 residents, and 25 out-migrators) were used to analyze 17 morphological features. Principal component analysis (PCA) was used to show that there was no relationship between the morphometric measurements and migratory phenotypes. For the epigenetic analysis, differential methylation was measured using the methylation sensitive (MS)-AFLP protocol on 41 individuals, of which 22 were out-migrators and 19 were residents. An AMOVA performed for individual loci detected that the significantly different ( $P=0.01$ ) of the 89 restriction sites analyzed, 11 were found to be differentially methylated. It appears epigenetic changes were the only differences between the two phenotypes and may be the most useful tool for evaluating rapid adaptation in the presence of substantial gene flow.

### **Restoring the Connection Between Brook Trout Populations within an Appalachian Watershed** (The Use of Genetics in Fisheries Management and Conservation)

*Darren Wood\*, West Virginia University, dmwood@mix.wvu.edu, Amy Welsh, West Virginia University and J Todd Petty, West Virginia University*

Brook trout (*Salvelinus fontinalis*) are a species of concern within their native range due to a historical loss of habitat, overfishing, and stocking of non-native salmonids. Road culverts

have been recognized as an additional impediment to population persistence as movement between diverse habitat types has been identified as an alternative life-history strategy to maximize both growth and reproduction. Brook trout were genetically analyzed using a suite of 13 microsatellite loci above 7 culverts with varying levels of passability classified through a physical protocol. While most sites were not found to have losses in genetic diversity, populations above culverts with a high outlet drop were found to have significant population differentiation when compared to streams with passable culverts and streams without culverts. Additionally, restoration of two road culverts determined to be impassable, occurred on two second order streams: Beaver Creek in June 2011 and Lamothe Hollow in June 2013. Genetic assignment within one year of restoration identified five individuals at Beaver Creek (132%) and one individual at Lamothe Hollow (45%) to be first generation migrants. The results of this study emphasizes the importance of uninterrupted connections between populations and highlights the ongoing successes of such restoration projects.

**A Quest for Adaptive Variation Among Discreet Populations of Atlantic Sturgeon: Transitioning from Population Genetics to Population Genomics (The Use of Genetics in Fisheries Management and Conservation)**

*Tim L King\*, US Geological Survey, tking@usgs.gov, Robin L Johnson, US Geological Survey, Mike Eackles, US Geological Survey, Barbara A Lubinski, US Geological Survey, David C Kazyak, Integrated Statistics, Jason Kahn, NOAA, Mike Rasser, Bureau of Ocean Energy Management, Matthew Balazik, Virginia Commonwealth University and Isaac Wirgin, New York University School of Medicine*

USGS-Leetown Science Center (LSC) in conjunction with NOAA-Fisheries, BOEM, and NYUMC have genotyped in excess of 800 Atlantic Sturgeon sampled from the St Lawrence River, Canada to southern Georgia at 12 microsatellite DNA markers. This information has assisted resource managers by clarifying population structuring, identifying appropriate management units, and allowing assignment of individuals intercepted as bycatch or other anthropogenic activities to river or DPS of origin. As three putative metapopulations have been identified, fine-scale population resolution is required as well as the identification of adaptive features. To address this research need we have begun a transition from population genetics (12 microsatellite markers screened across 124 chromosomes) to population genomics (screen thousands of markers across the genome) by employing genotype by sequence (GBS). This research has allowed the identification and contrasting large numbers of neutral and non-neutral markers among collections interspersed across the species range to further assess functional (meta)population assemblages, identification of evolutionary significant lineages, and provided data for modeling adaptive resiliency. In addition, LSC has generated approximately 40X coverage of the Atlantic Sturgeon transcriptome in the form of 394,482 contigs (genome segments) using contemporary genomic sequencing (RNA-Seq). Variant detection in these contigs have yielded in excess of 1 million SNPs. We are currently

in the process of annotating the transcriptome; the most complete of any Acipenseridae species. This transcriptome will provide an important resource for future studies of physiological and immunological processes in this species, and help delineate adaptive differentiation which ultimately could promote resiliency in the context of environmental change.

### **Using Microsatellite Loci to Identify Candy and Variegated Darter Hybrids (The Use of Genetics in Fisheries Management and Conservation)**

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Candy Darters *Etheostoma osburni* and Variegated Darters *E. variatum* are both native to the streams of West Virginia and Virginia. The two allopatric species were historically divided by Kanawha Falls (Glen Ferris, WV). Habitat degradation has resulted in the reduction of range of Candy Darters, a Species of Concern in West Virginia and Virginia as well as a federal Species of Concern. Recently, Variegated Darters or putative hybrids have been collected at locations above Kanawha Falls. Individuals from the New, Gauley, and Greenbrier River drainages were genotyped to investigate potential hybridization. A suite of 5 microsatellite loci were used to genetically assess populations of fish. Individuals were compared to reference populations of Candy and Variegated Darters outside of the potential hybrid zone. Widespread hybridization was found throughout a population of Candy Darters. A geographic hybrid zone was estimated with the highest levels of introgression representing the kernel of the zone and the locations of F1 hybrids delineating the periphery. Introgressive hybridization between Candy and Variegated Darters threatens the genetic integrity and the survival of Candy Darters as a distinct species.

### **Gill Lice and Whirling Disease within North Carolina Trout Populations: Past, Current, and Future Efforts to Understand These Recently Discovered Threats (Fish Health)**

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Within its Public Mountain Trout Waters Program, the North Carolina Wildlife Resources Commission (NCWRC) manages approximately 8000 km and 800 ha of lotic and lentic

resources, respectively Brook Trout *Salvelinus fontinalis*, Rainbow Trout *Oncorhynchus mykiss*, and Brown Trout *Salmo trutta* populations comprise the majority of these resources, which are distributed across 26 counties of western North Carolina. In addition, a single population of self-sustaining Kokanee Salmon *Oncorhynchus nerka* exists within Nantahala Reservoir, Macon County. Since September 2014, NCWRC biologists have documented new biological threats to salmonids within the State. Gill lice (Copepoda:

Lernaeopodidae: *Salmincola*) have been found on Brook Trout and Rainbow Trout populations. Further taxonomic evaluations of copepod collections are ongoing; however, elsewhere within the United States, *S. edwardsii* and *S. californiensis* are known to parasitize salmonids of the genera of *Salvelinus* and *Oncorhynchus*, respectively. Additionally, whirling disease was confirmed in Rainbow Trout collected from Watauga River, Watauga County, in July 2015. Confirmation of each of these threats marked their initial discovery in North Carolina. Sampling for copepods and *Myxobolus cerebralis* (the parasite responsible for whirling disease) has continued since these initial observations. Furthermore, the NCWRC has worked to inform and engage the public regarding whirling disease and gill lice as biologists seek to learn more about the invasive organisms' distribution and effects to the State's salmonids. By increasing understanding within the State, the NCWRC can continue to work with other regional managers to trout health issues on a larger spatial scale.

### **Temporal Distribution of Cyanotoxins and Environmental Estrogens within the Upper and Middle Potomac River Drainage, USA (Fish Health)**

Ryan Braham\*, West Virginia University, [rbraham@mixwvuedu](mailto:rbraham@mixwvuedu), Vicki Blazer, US Geological Survey, Luke Iwanowicz, US Geological Survey, Jim Hedrick, West Virginia Division of Natural Resources and Patricia M Mazik, US Geological Survey

Significant fish die-offs across taxa were observed in the Potomac River basin in 2002 and 2005. An intensive investigation yielded multiple stressors; however, no definitive driver. Harmful algae blooms were first quantified in the lower Potomac River in 1983 with sporadic reports going back to 1930. The specific cause of these and subsequent blooms remain unclear; however, it is believed to be partially driven by low water years. Environmental estrogens have also been observed in the Potomac River drainage in recent years and are believed to play a role in the occurrence of endocrine disruption in fishes. Our research objective was to quantify microcystin (MC) toxins and environmental estrogens throughout the Potomac River drainage with the aim of determining if they may contribute to a reduction in overall fish health such as was observed during historic fish die-off events. Sites were sampled between July 2013 and December 2015. The primary focus of this sampling was to quantify the amount of MC toxin in the water column, as well as estimate the potential MC toxin which is bound in the pelagic and benthic cyanobacterial communities. A secondary focus was to compare the total MC and total estrogenicity in the water column. There was little difference in the total MC concentrations in the unfiltered vs. soluble water fractions.

Significant spikes were observed in all water fractions between June and September for total MC and total estrogenicity. Conversely, relative spikes in the total MC concentration in the periphyton were observed between October and April. Interestingly, a second spike in total estrogenicity was observed in early spring. Water temperature was positively correlated to the total MC and discharge was positively correlated to total estrogenicity. These results suggest that the overall contribution of MC toxin to the water column from either pelagic- or benthic-oriented cyanobacteria is relatively minimal. Although the individual concentrations of MC in the water column are a fraction of the WHO threshold guideline for in drinking water, there is little data on such a low level chronic exposure to aquatic organisms. They also highlight the presence of environmental estrogens in the water column at critical life stages for aquatic organisms. Our continuing research aims to better understand the drivers of benthic MC-producing cyanobacterial blooms, as well as the exploring the physiological effects of low-level MC exposure and environmental estrogens on fishes within the Potomac River basin.

### **Assessing the Exposure of Microcystin Cyanotoxin to Smallmouth Bass Via Diet Items in the South Branch of the Potomac River (Fish Health)**

*Brandon Keplinger\*, West Virginia Division of Natural Resources, brandonjkeplinger@wv.gov, Travis Metcalf, West Virginia Division of Natural Resources and Jim Hedrick, West Virginia Division of Natural Resources*

The South Branch of the Potomac (SBR) is a small, clear, low-to-moderate gradient river draining approximately 3,867 km<sup>2</sup> of the Chesapeake Bay Watershed. It is strongly influenced by agricultural landscape practices, riparian zone disturbance, and limestone geology. Recent assessments have revealed high biomasses of benthic cyanobacteria and the production of the cyanotoxins anatoxin-a and microcystin (MC). Fish kills and periods of suppressed fish health have raised concern about the potential impacts of cyanotoxins on Smallmouth Bass. A study was devised to determine the prevalence and extent of microcystin exposure to adult Smallmouth Bass liver tissue and diet items consumed. Collections were made from the SBR on a seasonal basis (winter through fall) during 2014 – 2015 using boat electrofishing gear. After having been lab identified to reasonably precise taxonomic levels, diet samples were recombined and, along with liver tissue samples, were packaged and frozen. Both liver and diet tissue samples were shipped to consultative private labs where Enzyme-linked Immunosorbent Assays (ELISA) were employed to determine microcystin quantity. Thus far, 48% of diets (N = 81) and 26% of liver tissue samples (N = 84) have tested positive for MC exposure. Diet samples possessing detectable quantities of MC were collected during each calendar season through both years. Frequencies of occurrence of MC exposed diet samples ranged from 10% (fall 2014) to 100% (fall 2015). Frequencies of MC exposed livers in Smallmouth Bass were greatest in summer surveys, ranging from 40% (2015) to 50% (2014). Crayfish amounted to 29% of all forage items (N = 185) observed in MC exposed diets. Additionally, 68% of all crayfish from analyzed samples (N=80) were identified from MC

exposed diets Maximum concentrations of MC for tissues tested were 0147 and 0087 ug/g for diet and liver tissues, respectively Of all Smallmouth Bass yielding MC contaminated liver or diet tissue, only 33% tested positive for MC exposure in both liver and diet tissue concomitantly Large invertebrates and small, benthic fish can act as pathways of MC exposure to predatory fish through consumption The frequency of Smallmouth Bass carrying MC burdens appears to fluctuate annually and seasonally and is likely dependent on the frequency and recentness of the consumption of contaminated diet items The frequency at which MC can be collected from adult Smallmouth Bass liver and diet tissues raises concerns pertaining to lethal or sublethal effects due to chronic exposure

### **An Epizootic of Melanoma in Brown Bullhead *Ameiurus Nebulosus* in Lake Memphremagog, Vermont/Quebec (Fish Health)**

*Cheyenne Simpson\*, Hood College, crsimpson@usgs.gov, Vicki Blazer, US Geological Survey, Cassidy Hahn, West Virginia University and Thomas Jones, Vermont Fish and Wildlife Department*

Reports of melanistic or hyperpigmented skin lesions have increased in many fish species worldwide In most cases, microscopically, these lesions consist of increased numbers of melanocytes (hyperplasia) within the epidermis Observations from anglers of raised black skin pigmentation on brown bullhead in Lake Memphremagog, Vermont raised concern of potential contamination Twenty-six percent of adult brown bullhead were affected in a survey conducted in 2014 Initial examination of these lesions demonstrated melanoma, rather than the more common hyperplastic lesions While melanomas have been previously reported in wild fishes, most occurrences have been spontaneous, affecting one or only a few individuals In 2015, a multiagency study of brown bullhead in Lake Memphremagog and a nearby reference lake were conducted to better document the gross observational and microscopic findings from these individuals Observations made during necropsy indicated raised melanomas of various sizes and involving multiple locations on the fish Metastases were observed in skeletal muscle, gills, ovaries and intestine in a few fish Histopathological analysis demonstrated neoplastic melanocytes in both the dermis and epidermis with invasion into other tissues Skin samples were collected from affected as well as reference fish for both contaminant and gene expression analyses The results, possible contributing factors and the significance of these analyses will be discussed

### **Surface Area and Prevalence of "Blotchy Bass" Spots Change over Time in Smallmouth Bass (*Micropterus dolomieu*) (Fish Health)**

*Kelsey Young\*, Lock Haven University*

Blotchy bass syndrome is the occurrence of black ink-like spots on the skin of *Micropterus* species Despite several decades of being aware of the spots, no studies have

formally monitored changes in spot prevalence on individual fish The objective of this study is to observe and quantify blotchy bass spots in smallmouth bass to determine if the spots change over time Thirty-one smallmouth bass (*Micropterus dolomieu*) were collected by angling from the West Branch Susquehanna River near Selinsgrove, PA, and transported to the Northeast Fishery Center at Lamar, PA Twenty fish exhibiting spots, the experimental group, and eleven fish showing no sign of spots, the control group, were mixed into five tanks fed by spring water To monitor changes in blotchy bass spots, we photographed each fish at biweekly or monthly intervals Photographs from the beginning and end dates were observed to determine quantitative changes in blotchy bass spots Five control fish did not add or lose surface area in blotchy bass spots Four control fish gained spots on each side Two control fish were found to have gained spots on the right side but did not gain spots on the left side Five experimental fish gained surface area of spots on each side Eleven smallmouth bass were found to have a loss of surface area of spots on both sides Four fish gained area of spots on one side and lost spots on one side This study does not indicate a clear pattern to the changing in area of blotchy bass spots

### **Skin Lesions in Smallmouth Bass (Fish Health)**

*Vicki Blazer\*, US Geological Survey, vblazer@usgs.gov, Heather Walsh, West Virginia University, Cheyenne Simpson, Hood College and Geoff Smith, Pennsylvania Fish and Boat Commission*

In recent years skin lesions of smallmouth bass and other species in the Chesapeake watershed have raised concerns These lesions include melanistic areas, slightly raised mucoid lesions and eroded areas of skin and muscle Reports of hyperpigmented, particularly melanistic, lesions in the skin of various fish species have increased worldwide These include observations in both largemouth and smallmouth bass from the Susquehanna and Potomac rivers In humans, the incidence of cutaneous melanomas has also increased in many countries over the past few decades Areas of melanistic skin from smallmouth bass collected in the Susquehanna river were evaluated microscopically and compared with normal skin Pieces of skin were fixed for histopathological analyses and stained with routine hematoxylin and eosin as well as special stains to compare skin sections To date, the melanistic areas observed have been non-raised black areas Microscopically, melanocytes that are normally in the dermis appear to either migrate to or proliferate in the epidermis The raised mucoid lesions range from hyperplasia of epithelial cells to papillomas, benign skin tumors Currently the cause of these is unknown, but potential risk factors will be discussed

### **Reproductive Biology of Red Snapper, *Lutjanus Campechanus*, on Natural and Artificial Reefs in the Western Gulf of Mexico (Student Best Papers and Posters Symposium)**

*Charles H Downey\*, Texas A&M University - Corpus Christi, Rachel Brewton, Texas A&M University - Corpus Christi, Jennifer J Wetz, Texas A&M University - Corpus Christi, Matthew J Ajemian, Florida Atlantic University, Harbor Branch Oceanographic Institute and Gregory W Stunz, Texas A&M University - Corpus Christi*

Energy exploration in the western Gulf of Mexico (Gulf) has resulted in the addition of numerous oil and gas production platforms which has added structurally complex habitat to an area otherwise comprised of primarily barren bottom. The impact of these artificial structures on fish populations is largely unknown, and there is ongoing debate about their functionality. Red Snapper is an ecologically and economically important sportfish in the Gulf and is a model species for testing the performance of artificial reefs, created by standing and reefed (toppled or cutoff) oil and gas platforms, due to its demonstrated reliance and fidelity to structurally complex habitat (both natural and artificial). Little is known about the reproductive characteristics of Red Snapper in the Gulf, and how these are influenced by natural and artificial habitats. Red Snapper (276-767 mm TL) were collected from standing rigs, reefed rigs, and natural hard-bottom in the western Gulf. Biological parameters (sex, total weight, gonad weight, TL) were recorded and ovaries were preserved for histological analysis. Sex ratios, gonadosomatic indices (GSI), reproductive stages, and somatic weights were compared among habitat types. Sex ratios were approximately 1:1 at natural habitats and standing rigs, with reefed rigs having a higher percentage of males (59.8%) than females (Chi-square,  $p < 0.05$ ). Preliminary GSI data suggest a similar spawning season and spawning condition among structure types ( $p > 0.05$ ). Differences in gonad weight among the three habitat types were assessed using body weight as a covariate. Red Snapper on reefed rigs had lower gonad weights than Red Snapper on standing rigs or natural banks (ANCOVA,  $p < 0.05$ ). Histological analyses of ovaries are ongoing and will lend additional information to clarify the impact of reef habitat type on Red Snapper reproduction in the western Gulf.

### **Using Relative Stock Density to Evaluate Alternative Management Regimes for Mississippi's Spotted Seatrout Stock** (Student Best Papers and Posters Symposium)

*David A Dippold\*, University of Southern Mississippi, daviddippold@eaglesusmedu, Robert T Leaf, University of Southern Mississippi, Mark S Peterson, University of Southern Mississippi and J Read Hendon, The University of Southern Mississippi*

Spotted Seatrout (*Cynoscion nebulosus*) is the most popular recreational inshore target in Mississippi's coastal waters. Although most marine stocks, like Spotted Seatrout, are managed to optimize yield, we explore management strategies that consider optimizing recreational fishing metrics related to the fishing experience. Relative Stock Density (RSD) is a recreational fishing metric that quantifies the length structure of a stock and is widely used in recreational freshwater fishery management because fish length is an important aspect of angler satisfaction. In this work we evaluate how alternative management regimes impact RSD metrics for Mississippi's Spotted Seatrout stock. We used age-based simulation models



that included demographic information derived from fisheries independent sampling and length-specific natural mortality estimates to determine the expected length frequency of the stock under a variety of management regimes Our analysis suggests that management regimes that reduced fishing mortality, increased minimum length limits, and employed slot limits can increase measures of RSD for the Mississippi Spotted Seatrout stock Specifically, in our simulations, the 305 to 457 mm (12 to 18 inch) slot limit resulted in populations comprised of greater relative proportions of Trophy and Memorable length individuals compared to the other management regimes considered, even at high levels of fishing mortality ( $F > 0.5 \text{ y}^{-1}$ ) We find that the local demographic properties, including individual growth dynamics and length-specific natural mortality may preclude the establishment of large proportions of trophy length ( $\geq 686 \text{ mm TL}$ , 27 inches) individuals in all management regimes examined for the Mississippi stock We note the utility of using RSD as a management tool as it can help inform the management of marine recreational fisheries relevant to angler satisfaction

**Transcriptome Discovery in Non-Model Species for the Development of Quantitative Gene Expression Assays: A Case Study of the Rochester Embayment Area of Concern** (Student Best Papers and Posters Symposium)

*Cassidy Hahn\**, West Virginia University, *Luke Iwanowicz*, US Geological Survey, *Robert Cornman*, US Geological Survey, *Patricia M Mazik*, US Geological Survey and *Vicki Blazer*, US Geological Survey

Contaminants of emerging concern (CECs) and legacy contaminants are frequently detected and quantified in environmental studies of aquatic ecosystems The biological effects of these complex chemicals mixtures on resident species of these systems, however remain largely unknown Frequently fish species used for biological monitoring of contaminant effects are model organisms, such as the fathead minnow, that do not inhabit these ecosystems and may not respond to chemical contaminants in a manner similar to that of native species Here, we employed high throughput methodologies to establish partial transcriptomes for three wild-caught, non-model species; smallmouth bass (*Micropterus dolomieu*), white sucker (*Catostomus commersonii*) and brown bullhead (*Ameiurus nebulosus*) Sequences from these transcriptome databases were utilized in the development of a custom nCounter CodeSet and quantitative real-time PCR (qPCR) primers for gene expression analyses of liver tissue Cross-species hybridization allowed the smallmouth bass nCounter CodeSet to be used for quantitative gene expression analysis of an additional non-model species, largemouth bass (*Micropterus salmoides*) Quantitative gene expression endpoints were used in an assessment of fish health at the Rochester Embayment Area of Concern Data on the integration and synthesis of these molecular markers with adverse outcomes at higher levels of biological organization will be presented

**Brook Trout Preference of Terrestrial Versus Aquatic Prey Across Two Seasons in Appalachian Head-Water Streams** (Student Best Papers and Posters Symposium)

*Erin Thayer\*, West Virginia University*

Previous research suggests Brook Trout (*Salvelinus fontinalis*) operate in violation of optimal foraging theory in that Brook Trout appear to feed preferential upon aquatic benthic invertebrates even in situations when terrestrial invertebrates have higher energy content and accessibility. This has led us to develop the hypothesis that Brook Trout prefer aquatic invertebrates to terrestrial invertebrates when ample amounts of both prey types are present; when aquatic production is low, Brook Trout switch to a more opportunistic feeding behavior resulting in higher amounts of terrestrial invertebrates present in their diets. A field study was designed to test this. We collected aquatic macroinvertebrates and Brook Trout stomach contents via kick nets and gastric lavage, respectively. Samples were collected in a hierarchical manner in order to capture the seasonal point at which Brook Trout prey-switching occurs. This entailed sampling at noon and dusk, in spring and summer across four head-water streams. The streams were paired by watershed size and within the pair, one stream contained high aquatic macroinvertebrate productivity and the other containing low productivity. The main results we focus on are: 1 How do different environmental variables (such as season, time of day, aquatic macroinvertebrate productivity) influence the amount of terrestrial invertebrates present in Brook Trout stomachs? 2 Do Brook Trout show a preference towards aquatic macroinvertebrates? 3 Does size (biomass) of prey items influence preference? 4 Does Brook Trout size influence preferences? We discuss these results in light of the persistence of Brook Trout populations in an ever-changing immediate environment and changing subsidies from the adjacent terrestrial ecosystem.

**Age and Growth of Southern Flounder in the North-Central Gulf of Mexico** (Student Best Papers and Posters Symposium)

*Morgan M Corey\*, University of Southern Mississippi, Samuel D Clardy, University of Southern Mississippi, Mark S Peterson, University of Southern Mississippi, Nancy J Brown-Peterson, University of Southern Mississippi and Robert T Leaf, University of Southern Mississippi*

Southern Flounder (*Paralichthys lethostigma*) is the most commonly harvested flatfish species in the north-central Gulf of Mexico (GOM) and supports a major recreational fishery (about 100,000 kg harvest per year) in Mississippi. Despite the economic value of this species and evidence for population decline in the GOM, critical life-history information is limited. The length-at-age relationship has been shown to vary spatially within the GOM and the growth dynamics of Southern Flounder in Mississippi's state-managed stock has not been previously described. The objective of this research is to determine otolith-derived age estimates and to describe the length-at-age relationship for Southern Flounder in the north-central GOM. Southern Flounder otoliths and measurements of total length (TL, mm) were collected from fish caught during September 2014 to December 2015. Otoliths ( $n = 313$ ) were sectioned following standard methods and age estimates were determined from otolith annuli.

counts and measured marginal increments. Our methods of age validation using measured marginal increments provided precise, biologically relevant estimates of age. A suite of length-at-age models were fit to the TL and age data and evaluated using Akaike information criteria (AIC). Model parameters were compared to previously reported parameter estimates using 95% confidence intervals. We found that the two-parameter von Bertalanffy growth model best described the data ( $L_{\infty} = 456 \pm 16$  mm,  $k = 103 \pm 0.13$ ). We also observed that female-specific model parameters differed from those published at other locations in the GOM, where  $L_{\infty}$  was lower and  $k$  was greater than parameter estimates from Texas and Louisiana. We anticipate that these results will be useful for informing state-level management of the Southern Flounder stock in the north-central GOM.

### **Juvenile Atlantic Sturgeon Seasonal Movements and Outmigration in Four Georgia Rivers** (Student Best Papers and Posters Symposium)

*Adam Fox\*, University of Georgia, agfox@uga.edu and Douglas Peterson, University of Georgia*

The Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a federally endangered anadromous fish found along the east coast of North America. Despite nearly two decades of Federal Protection, many populations have not recovered and many biologists now believe that poor recruitment may be responsible. Unfortunately, the lifecycle and habitat use of early juveniles is not well understood. The objectives of this study were to describe seasonal habitat use and timing of outmigration for age-1 Atlantic Sturgeon within three Georgia Rivers. During the summers of 2014-2015 we collected age-1 Atlantic Sturgeon in the Ogeechee, Altamaha, Satilla, and St Marys Rivers. A total of 34 fish were implanted with acoustic transmitters. Movements of these fish were monitored using a series of stationary receivers deployed below the heads of tide in each river system. Spatial analyses of the detection data revealed that juvenile sturgeon in all four rivers exhibited a similar pattern of seasonal habitat use; concentrating upriver during the summer and moving downstream into polyhaline habitats during the colder months. Of the 34 age-1 fish that received transmitters, 13 were confirmed to have outmigrated before the following spring. Most of these fish began leaving their natal rivers as temperatures declined in early winter, after which they were detected in several estuaries in both Georgia and South Carolina. These findings have important implications for future monitoring of Atlantic sturgeon recruitment and potential bycatch in several South Atlantic commercial fisheries.

### **Using Side-Scan Sonar to Assess the Atlantic Sturgeon Spawning Run in the Altamaha River** (Student Best Papers and Posters Symposium)

*Edward Stowe\*, University of Georgia and Douglas Peterson, University of Georgia*

**Abstract:** The use of side-scan sonar (SSS) imaging in fisheries research has expanded in recent years and is now being used in conjunction with traditional sampling methods to estimate fish population parameters for many species. Side-scan sonar technology has shown the greatest promise with fish like sturgeon given their large size and unique shape. During Fall, 2015, we conducted a pilot study in the upper Altamaha River system to evaluate the potential of using low-cost SSS to assess the annual spawning run of Atlantic sturgeon in that system. Our specific goals were to: (1) determine the spatial and temporal distribution of putative fall spawners; and (2) assess the potential of using an N-Mixture model to estimate the number of Atlantic sturgeon adults comprising the spawning run. In total, we surveyed over 475 km of river from September through November, with many sections of river sampled on multiple occasions. Here we provide the preliminary results of that investigation, including count data of likely sturgeon, as well as the temporal and spatial distribution of sturgeon. This preliminary investigation illustrates some of the challenges of using side-scan sonar for abundance estimation within large river systems during spawning season and highlights important factors that may predict the compatibility of using SSS to answer particular fisheries questions.

**Seasonal Movements and Annual Mortality Rates of Tripletail (*Lobotes surinamensis*) in the Southeast** (Student Best Papers and Posters Symposium)

*Alex Cummins\*, University of Georgia, Chris Kalinowsky, Georgia Department of Natural Resources and Matt Streich, Texas A&M University*

The Atlantic Tripletail *Lobotes surinamensis* supports a popular recreational fishery along the Atlantic coast of Georgia and Florida; however, effective management of this fishery has been hampered by a lack of data regarding the fisheries impacts on the population. The objective of this study was to determine the annual mortality rate for the Tripletail population inhabiting the Atlantic coast of Georgia and Florida. During the summers of 2009 through 2014, Tripletail were captured via hook and line sampling in Ossabaw Sound, Georgia. Prior to release, each fish received a surgically implanted acoustic transmitter. A total of 270 stationary receivers were used to monitor the movements of these tagged fish during their annual migrations between Ossabaw Sound, Georgia, and Jupiter, Florida. Over the 5 years of the study, we released a total of 59 tagged fish, yielding a total of more than 500,000 valid detections. Using spatial mark-recapture modeling and tag returns from local anglers, we calculated annual mortality rates of the population for each year of the study. Although these rates were higher than those for several other Atlantic coast sport fishes, additional population dynamics data will be needed to fully assess the sustainability of the current recreational fishery.

**Environmental DNA for Monitoring and Detection of Rare and Endangered Cavefish and Cave Crayfish in the Ozark Highlands** (Student Best Papers and Posters Symposium)

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Caves and karst subterranean aquifers are common in the Ozark Highlands ecoregion of northern Arkansas, southern Missouri, and northeastern Oklahoma. These groundwater habitats are home to a unique and important biodiversity, but many species are difficult to monitor and study due to the complexity and other challenges associated with sampling groundwater habitats. Many groundwater aquifers in this region are threatened by a variety of anthropogenic activities, including groundwater exploitation, pollution, and habitat degradation, which has resulted in conservation concerns for several endemic, troglomorphic species, including some listed as federally threatened. Surveys of these species have traditionally relied on visual census methods, which are often unreliable due to low detection and habitat disturbance. New monitoring methods employ the use of environmental DNA (eDNA). As organisms interact in their environment, trace genetic material (eDNA) is shed or excreted and can be detected in soil, sediment, and water samples. This noninvasive technique offers a cost-effective supplement to visual surveys. Here, we propose to develop an eDNA-based detection and monitoring approach for several threatened groundwater species, including *Troglichthys rosae* (the Ozark Cavefish) and the crayfishes *Cambarus tartarus*, *C. setosus*, and *C. aculabrum*. Preliminary studies have revealed the need for more stringent methods than by the amplification of eDNA using PCR as individual species of crayfish cannot be distinguished from one another. To overcome this, we have designed study parameters that will distinguish differences between eDNA samples based on melting curve analysis, pinpoint variations between species, and allow exclusion of false-positives. This study will benefit conservation and management efforts for these target species.

**Keywords:** environmental DNA; *Troglichthys rosae*; subterranean; conservation; Cambaridae

### **Determining Breathing Frequency of Arapaima Spp for Improved Fishery Management in the Amazon** (Student Best Papers and Posters Symposium)

Gretchen Stokes\*, Virginia Polytechnic Institute and State University, Leandro Castello, Virginia Polytechnic Institute and State University, Eduardo G Martins, University of Waterloo, Thiago Petersen, Instituto Piagacu and Jansen Zuanon, Instituto Nacional de Pesquisas da Amazônia

Arapaima (*Arapaima* spp) are obligate air-breathing fish endemic to the Amazon basin, and one of the world's most overexploited fish species. Arapaima conservation and management depend on census counts that use air-breathing frequency to estimate fish abundance and set harvest limits. However, these counts depend on breathing rate assumptions, which have never

previously been tested This study examines relationships between breathing frequency and environmental parameters (ie temperature, depth, dissolved oxygen) for radio-tagged arapaima (n=13) in an upland river and its floodplain (Lake Ayapuá, Amazonas, Brazil) Multiple linear regression was used to evaluate environmental correlates of breathing frequency Results show a significant negative relationship between breathing rate and water temperature (p-value = 0014) and a positive relationship with fish size (p-value = 0083) We observe average breathing frequency of 16 minutes for adult arapaima ( $T_L > 1$  m) and 145 minutes for juvenile arapaima ( $T_L < 1$  m) Current management uses assumptions of a 20-minute breathing rate; therefore this study suggests revisions be made to fisheries management protocols to account for area-specific temperatures and size of fish counted Our results will be used to inform better practices for censuses and improved management, thus helping to conserve populations of arapaima in the Amazon

### **"Western Pennsylvania's Primary Burrowing Crayfish: Distributional Survey and Determination of Conservation Status" (Posters)**

*Rachel Scott\*, West Liberty University, rkscott@westliberty.edu, Zachary Dillard, West Liberty University, Nicole Sadecky, West Liberty University and Zachary Loughman, West Liberty University*

Dr Arnold Ortmann, one of the nation's first crayfish biologists, conducted crayfish surveys in the late 1800's and early 1900's across western Pennsylvania Unique for the time was Ortmann's inclusion of primary burrowing crayfishes Primary burrowing crayfish utilize subterranean burrows for all facets of their ecology, and are rarely encountered outside their burrows Urbanization, extractive industries, and the genesis of industry have all occurred across western Pennsylvania since Ortmann's initial surveys We visited all of Ortmann's historic sites (70 sites) to determine if burrowing crayfish still occur throughout the region following the past century of environmental change Furthermore, crayfish have been recognized recently as one of North America's most imperiled group of animals Resultants of this, our efforts will lead to the determination of conservation baselines for each burrowing crayfish species occurring in the region Ortmann determined that three species occurred in Western Pennsylvania, *Cambarus dubius*, *Cambarus thomai*, and *Cambarus monongalensis* The project produced an excellent understanding of Western Pennsylvania's burrowing crayfish status, and was the first to focus on burrowing crayfish in Pennsylvania since Ortmann's efforts

Poster Presentations

### **Application of Fixed Intercept Catch Curves to Evaluate Released Ranches American Alligator (*Alligator mississippiensis*) Survival (Posters)**

*Kristy D Capelle\*, Louisiana State University Agricultural Center and Michael D Kaller, Louisiana State University Agricultural Center*

American Alligator (*Alligator mississippiensis*) ranching programs in Louisiana have been in effect since 1986 as a means to supplement natural alligator recruitment and populations throughout the state. Through these programs, ranchers are allowed to collect alligator eggs from private properties and must release a portion of the juvenile alligators back to the wild each year, once they reach a certain size class. In order to define how effective ranching programs are, survival of the ranch-raised alligators after release was estimated. Data from 1991 to present were incorporated into a variety of survival models in order to determine which model(s) displayed the best fit to the observed data. The initial model set included length at release, length at recapture (as measure of growth), time since release, and a random slope year of release variable to account for interval censoring. Next, environmental data, including precipitation and temperature, from alligator release areas were added into the models to investigate their influences on survival estimates. Alligator survival in response to additional environmental variables will continue to be evaluated to give a better understanding of the effects of climate change and extreme weather events on future management of American Alligators in Louisiana.

### **Community Concordance Between Fishes and Macroinvertebrates Among Adventitious and Ordinate Tributaries of a Major River System (Posters)**

*David G Argent\*, California University of Pennsylvania, argent@caluedu and William G Kimmel, California University of Pennsylvania*

We examined patterns of concordance between macroinvertebrate and fish communities among adventitious and ordinate tributaries of the Monongahela River in southwestern Pennsylvania in order to determine their efficacy as mutual surrogates for the assessment of ecosystem integrity. Fish, macroinvertebrates, and 19 water quality parameters were sampled from ten streams in each category. Collected data were analyzed by principal components analysis, redundancy analysis, and Ward's distance clustering matrices to determine degrees of community concordance and similarity. Fish and macroinvertebrate communities were assigned Index of Biotic Integrity and Hilsenhoff Biotic Index values respectively in order to compare stream ecosystem health as expressed by each index. Adventitious and ordinate macroinvertebrate communities largely clustered in like groups with adventitious tributaries dominated by the crustacean *Gammarus* sp, while the trichopteran, *Hydropsyche* sp was the dominant in ordinate streams. Adventitious communities were strongly influenced by elevated levels of total alkalinity and total suspended solids; ordinate communities by contrast to elevated total organic carbon and specific conductance. Fish communities, while ubiquitous in their taxonomic distribution among adventitious and ordinate tributaries, showed no significant relationship to water quality parameters. While fish communities often clustered with their nearest geographic neighbor, macroinvertebrate communities did not. Both

communities appeared to be driven by differences in local environmental conditions Concordance among adventitious and ordinate macroinvertebrate (HBI) and fish (IBI) community environmental quality scores was 5% and 35% respectively - suggesting that neither community serves as a surrogate for the other as an indicator of stream health in this basin

### **Does the Spiny Water Flea Dominate Communities in the Allegheny River? (Posters)**

*Luv Biswa\**, California University of Pennsylvania, *Derek Gray*, California University of Pennsylvania, *David G Argent*, California University of Pennsylvania and *William G Kimmel*, California University of Pennsylvania

The spiny water flea (*Bythotrephes longimanus*) was discovered in the Allegheny River for the first time in the summer of 2013 The present study was conducted to determine how abundant the spiny water flea is in comparison to native zooplankton We sampled twelve sites along the Allegheny River starting near the Kinzua Reservoir outflow and continuing down to Oil City, PA At each site three zooplankton samples were collected using a 30µm mesh net and samples were preserved in ethanol In the laboratory, zooplankton were sorted into different taxonomic categories To compare the zooplankton communities among stations we ran a principal components analysis (PCA) To determine the change in relative abundance of spiny water fleas as we moved downstream we performed a regression comparing length downstream from the Kinzua Dam to spiny water flea abundance Preliminary results suggest that the spiny water flea was abundant at sites 1-3, but did not dominate the communities at any of the sites The PCA demonstrated that there were differences in community composition among the sites, which were likely driven by differences in local conditions Overall, our results suggest that spiny water fleas are not a major component of zooplankton communities in the Allegheny River, but are potentially important predators at sites near the Kinzua Reservoir

### **Do Macroinvertebrate and Habitat Bioassessments Reflect Presence of Clinch Dace? (Posters)**

*Skylar L Wolf\**, Virginia Tech, *Michael J Moore*, Virginia Tech and *Donald J Orth*, Virginia Tech

Clinch Dace (*Chrosomus* sp cf *saylori*) are an undescribed species that, with the exception of two isolated Tennessee populations, are confined to two adjacent counties in Southwest Virginia Due to small localized distribution of populations and high habitat fragmentation, conservation of the species is a priority Specific threats stem from coal mines within the region that increase siltation, reduce riparian zones, and alter water quality in headwater streams that Clinch Dace inhabit Current research efforts focus on characterizing habitat and distribution of the species in order to guide future distribution exploration and



conservation efforts We examined relationships between Clinch Dace occupancy and stream characteristics in order to determine water quality and habitat preference as well as to identify potential sites suitable for future species translocation The Virginia Stream Condition Index (VSCI) and Rapid Bioassessment Protocol (RBP) are two methods of quantifying water and habitat quality in headwater streams We combined Clinch Dace collection records from Virginia Tech with VSCI and RBP data from VA Department of Mines and Mineral Energy, VA Department of Environmental Quality, and US Fish and Wildlife Service VSCI data consisted of 64 records collected at 52 stations in spring and 50 records at 42 stations in fall RBP data consisted of 70 records collected at 30 stations Both VSCI and RBP stations were classified as near or absent of Clinch Dace Stations were considered near if within 5 km of an upstream Clinch Dace record Comparisons were made using non-metric multidimensional scaling plots (NMDS) Mann-Whitney test were used to quantify significance of correlation of Clinch Dace presence with RBP and VSCI scores Results suggest that Clinch Dace presence corresponds with higher overall VSCI scores as well as certain individual VSCI metrics including percent Ephemeroptera, percent Plecoptera and Trichoptera excluding Hydropsychidae, and percent scrapers Clinch Dace sites were not distinguishable from other sites using RBP scores Results indicate that available monitoring records within the mined watersheds of the upper Clinch River tributaries are incomplete and that increasing monitoring stations in smaller streams is essential to conservation efforts

### **Genetic Differentiation of Brook Trout *Salvelinus fontinalis* on Laurel Hill: Implications for Conservation Management (Posters)**

*Julia Horiates\*, East Carolina University, Christopher Balakrishnan, East Carolina University, David G Argent, California University of Pennsylvania and William G Kimmel, California University of Pennsylvania*

The conservation status of Brook Trout (*Salvelinus fontinalis*) along its Appalachian range in North America is threatened by a number of factors including loss of habitat, water withdrawal, introduction of alien species, and climate change Restoration and enhancement efforts require precise information on the genetic diversity of resident populations in their respective drainages before translocations or stockings are undertaken We assessed genetic diversity among Brook Trout populations of four headwater streams draining the Northwest and Southeast slopes of the Laurel Hill in southwestern Pennsylvania This anticline harbors the southernmost populations of this species in the Commonwealth From fin clips obtained by electrofishing, we genotyped five microsatellite loci with an ABI 3100 sequencer following amplification by PCR GENEPOP analyses revealed polymorphism in all loci and significant differences (Fisher's exact test) between all stream population pairings Despite the spatial proximity of these populations, our analyses suggest long-term isolation of their respective streams These data support the need for identifying and conserving genetically

unique populations of Brook Trout, and careful planning of restoration efforts involving movement of fishes within and among drainage basins or the use of hatchery-reared stock

### **Isotopic Niche Overlap Between Silver Carp (*Hypophthalmichthys molitrix*) and Gizzard Shad (*Dorosoma cepedianum*) (Posters)**

*Dalton Lebeda\**, Murray State University, *dlebeda@murraystate.edu* and *Michael Flinn*, Murray State University

Kentucky Lake is the largest impoundment east of the Mississippi River and is located on the Tennessee River in western Kentucky. The reservoir has a diverse fishery that includes large populations of native planktivorous Gizzard Shad (*Dorosoma cepedianum*) and Threadfin Shad (*D. petenense*). Silver Carp (*Hypophthalmichthys molitrix*) are an invasive planktivorous fish species that invaded Kentucky Lake in 2004 and have successfully established a reproducing population. Silver Carp and Gizzard Shad have been shown to feed on similar food items that include both phytoplankton and zooplankton. Therefore, diet overlap between Silver Carp and Gizzard Shad is a major concern to biologists, commercial fishermen, and recreational fishermen due to the potential for competition with commercial and sportfish populations. We used stable isotope analyses to determine trophic position and potential for competition between Silver Carp and Gizzard Shad in Kentucky Lake. Samples of fish and endmembers were collected at two embayment sites and one channel site. Preliminary results suggest that Silver Carp and Gizzard Shad are filling similar isotopic niches within Kentucky Lake. As populations of Silver Carp increase, the potential for competition with native fish species may increase and potentially result in ecosystem effects.

### **Characterization of a Novel Hepadnavirus in the White Sucker (*Catostomus commersonii*) from the Great Lakes Region of the USA (Posters)**

*Cassidy Hahn\**, West Virginia University, *Luke Iwanowicz*, US Geological Survey, *Robert Cornman*, US Geological Survey, *Carla M Conway*, US Geological Survey, *James Winton*, US Geological Survey and *Vicki Blazer*, US Geological Survey

The white sucker *Catostomus commersonii* is a freshwater teleost often utilized as a resident sentinel. Here, we sequenced the full genome of a hepatitis B-like virus that infects white suckers from the Great Lakes Region of the USA. Dideoxysequencing confirmed the white sucker hepatitis B virus (WSHBV) has a circular genome (3542 bp) with the prototypical codon organization of hepadnaviruses. Electron microscopy demonstrated that complete virions of approximately 40 nm were present in the plasma of infected fish. Compared to avi- and orthohepadnaviruses, sequence conservation of the core, polymerase and surface proteins was low and ranged from 16-27% at the amino acid level. An X protein homologue common to the orthohepadnaviruses was not present. The WSHBV genome included an atypical, presumptively non-coding region absent in previously described hepadnaviruses. Phylogenetic

analyses confirmed WSHBV as distinct from previously documented hepadnaviruses. The level of divergence in protein sequences between WSHBV, other hepadnaviruses, and the identification of an HBV-like sequence in an African cichlid provide evidence that a novel genus of the family *Hepadnaviridae* may need to be established that includes these hepatitis B-like viruses in fishes. Viral transcription was observed in 95% (16 of 169) of white suckers evaluated. The prevalence of hepatic tumors in these fish was 49%, of which only 24% were positive for both virus and hepatic tumors. These results are not sufficient to draw inferences regarding the association of WSHBV and carcinogenesis in white sucker.

### **Survival of Upper Piedmont Stream Fishes Implanted with a Passive Integrated Transponder Tag (Posters)**

*Josh Cary, Clemson University, Jessica Holbrook, Clemson University, Thomas Austin, Clemson University, Seog Hyun Kim, Clemson University, Kasey Pregler, Clemson University and Yoichiro Kanno\*, Clemson University, ykanno@clemson.edu*

We studied weekly and bi-monthly survival of select non-game fishes in upper Piedmont streams of South Carolina implanted with an 8-mm passive integrated transponder (PIT) tag. Weekly survival and tag retention rates of individuals (> 45 mm TL) kept in stream cages were > 97 % across species (Bluehead Chub *Nocomis biguttatus*, Creek Chub *Semotilus atromaculatus*, Yellowfin Shiner *Notropis lutipinnis*, Mottled Sculpin *Cottus bairdii*, and Striped Jumprock *Moxostoma valenciennesi*) and these rates did not differ from control cages where individuals were kept for a week without being implanted with a PIT tag. Bi-monthly survival was inferred by conducting a mark-recapture study based on tagging > 1,500 individuals of Bluehead Chub, Creek Chub, Mottled Sculpin and Striped Jumprock in two 400-m stream sections. A Bayesian state-space analysis of Cormack-Jolly-Seber models indicated that survival and detection probabilities differed among species and sites. Additional data collection is ongoing to understand demographic response and synchrony of these species. Our initial results indicate that PIT tags can be successfully applied to study population dynamics of small-bodied non-game fish species.

### **Ecological Interactions Between Invasive Rusty Crayfish (*Orconectes rusticus*) and Native Piedmont Crayfish (*Cambarus* sp C) (Posters)**

*James Wilson\*, Longwood University, Patricia Hale, Longwood University, David Conner, Longwood University, Connor Perry, Longwood University, Zachary Loughman, West Liberty University and Sujana Henkanaththege, Longwood University*

Virginia is home to a large diversity of crayfish species, most of which are native. Despite the high diversity, invasive crayfish may pose a serious threat to the existence of native crayfish. Rusty crayfish (*Orconectes rusticus*) is one of the three invasive crayfish species reported in Virginia with devastating impacts on native species elsewhere. The knowledge on ecological

interactions between native and invasive taxa is a critical element in implementing control and management of invasive species. Ecological interactions between invasive rusty crayfish and native crayfish in Virginia are not well understood. We studied the aggressive behavior, competition for food and long-term survival under sympatric conditions between invasive rusty crayfish and native Piedmont crayfish (*Cambarus* sp. C). Preliminary observations suggest that invasive rusty crayfish is competitively superior to native Piedmont crayfish. However, larger Piedmont crayfish show competitive superiority over smaller rusty crayfish, suggesting size-specific impacts. With this species-specific information, conservation practitioners may be able to better understand ecological interactions between invasive rusty crayfish and native crayfish and may help plan novel management actions to mitigate invasive crayfish impacts.

### **Frequency-Dependent Female Mating Preference in *Poecilia* (Posters)**

*Jack Frankel\*, Howard University, jfrankel@howardedu and Andre Porter, Howard University*

Heterogeneity enhances long-term population survival and may be maintained through the retention of rare or uncommon phenotypes via selective mating strategies. Utilizing a frequency-dependent selection mating strategy, females would be expected to exhibit an affinity towards groupings of males comprised of multiple phenotypes, as compared to groupings showing no phenotypic diversity. Employing several color morphs of the guppy (*Poecilia reticulata*, Poeciliidae), this study was designed to investigate whether *P. reticulata* females would preferentially seek out heterogeneous groupings of males. Adult female guppies were exposed simultaneously to two groups of males; one comprised of only a single color morph ( $n = 5$ ) and the other of two color morphs ( $n = 5$ ). For the latter group, the ratio of males exhibiting these colorations was changed incrementally over multiple trials, beginning and ending with homogeneous populations (5:0, 4:1, 3:2, 2:3, 1:4, 0:5). Experiments were conducted employing a long configuration, 76 L aquarium, partitioned at both ends with clear Plexiglas to house the male groups. Individual females were placed into an acclimation column located in the center compartment of the experimental tank. Subsequent to a 5 minute acclimation period, each female was released. Courting behaviors and population affinities (i.e. female location relative to the male compartments) were recorded every 5 seconds over a 5 minute observation period. Utilizing chi-square analysis, females did not exhibit a preference for male groupings exhibiting either the 4:1 or 1:4 color ratios, nor did they exhibit a preference for homogeneous groupings (5:0 or 0:5). However, they did show an affinity for the male groupings of 3:2 and 2:3 ( $p < 0.05$ ).

### **Growth Patterns of Channel Catfish in the Susquehanna River (Posters)**

*Daniel Isenberg\*, Susquehanna University, Jon Niles, West Virginia University and Geoff Smith, Pennsylvania Fish and Boat Commission*

Channel Catfish (*Ictalurus punctatus*) is a common species in aquaculture and recreational fisheries in North America. They naturally occur from northern Mexico to southern Canada, with a large portion of research on the species taking place in the central to southern Mississippi River basin. However, in Pennsylvania, little is known about population characteristics of Channel Catfish, including age and growth. Typically, northern populations of Channel Catfish show a tendency to have slower growth rates, while southern populations show a tendency for faster growth rates. This study seeks to determine how the growth patterns of Channel Catfish shift throughout the length of the Susquehanna River. We attempted to create natural-state growth models for two reaches of the Susquehanna River in central Pennsylvania. These growth models will allow resource agencies to better manage Channel Catfish populations.

### **Distribution and Conservation Status of Western Pennsylvania's Burrowing Crayfish (Posters)**

*Rachel Scott\*, West Liberty University, rkscott@westliberty.edu, Zachary Dillard, West Liberty University, Nicole Sadecky, West Liberty University, David Lieb, Western Pennsylvania Conservancy and Pennsylvania Fish and Boat Commission and Zachary Loughman, West Liberty University*

Astacological efforts in Pennsylvania have increased over the past decade. With most surveys focused on epigeal species in eastern and central Pennsylvania, Western Pennsylvania's (WPa) fauna has not received the same level of effort, although the majority of the state's crayfish diversity is found in this region. In particular, the distribution and conservation standing of WPa burrowing crayfish represents the greatest void in knowledge regarding the state's crayfishes. In order to rectify this situation, burrowing crayfish surveys were initiated across WPa in 2014/2015 using Ortmann's historic records to guide our efforts. Ortmann's sites were georeferenced, coordinates determined, and then the sites were sampled. In addition to sampling Ortmann's sites, new sampling locations were visited to aid in determining the conservation status of WPA's burrowing crayfish. Ortmann documented *Cambarus dubius*, *Cambarus monongalensis*, and *Cambarus thomai* in western Pennsylvania. All three species were found during our surveys, with each species allied to a physiographic region. *Cambarus dubius* occurred east of Chestnut Ridge in the Allegheny Mountain physiographic province in seeps and roadside ditches (RSD). *Cambarus monongalensis* was common in forested seeps, RSD, and depressional wetlands south and east of the Monongahela/Ohio River in the unglaciated Appalachian plateau, and was the only species found within Pittsburgh city limits. *Cambarus thomai* was the most widespread species, and occurred in wetlands and RSD within the unglaciated Appalachian Plateau physiographic province. Our survey showed a negative correlation between burrowing crayfish sites presence and urbanization, although results indicate that all three species are currently stable in Pennsylvania.

## **A Night of Devastation: Natural and Life History Observations of an En-Masse Single Night Collection of *Fallicambarus Devastator* (Texas Prairie Crayfish) (Posters)**

*Zachary Dillard\*, West Liberty University, zwdillard@westlibertyedu, Nicole Sadecky, West Liberty University, Rachel Scott, West Liberty University, Luke Sadecky, West Liberty University and Zachary Loughman, West Liberty University*

Due to their fossorial tendencies, primary burrowing crayfish are the most difficult behavioral group of crayfish to study in-situ. In this study we elucidated both natural and life history aspects and intraspecific behaviors from a collection of 111 individual *Fallicambarus devastator* collected in Angelina County, Texas, on the night of 15 May 2015. Significant amounts of precipitation occurred during the days prior to 15 May 2015, resulting in the majority of burrows at our study site being flooded on the day of collection. All animals were observed either traversing the landscape, or at the portal of their burrow; captures occurred in both situations. Behaviors observed included excavation, respiration, feeding, and interspecific interactions. The majority of animals observed were adults, with juveniles noticeably absent on the surface. Life history observations included evidence of synchronous alteration to reproductive form in males, as well as sexually-dependent chelae morphometric ratios. *Fallicambarus devastator* meristically displayed sexual dimorphism between form I male and female chelae, with form I chelae having longer propodus length and greater palm widths, compared to the squamous and shorter chelae of females. Understanding the significance of studying these animals in favorable conditions conducive to observing natural behaviors is of paramount importance to the quality of future primary burrowing crayfish research, and exemplified by this single event.

## **Status Survey Results and Distribution of *Cambarus Veteranus* Across the Upper Guyandotte Basin of West Virginia (Posters)**

*Nicole Sadecky\*, West Liberty University, Zachary Dillard, West Liberty University, Rachel Scott, West Liberty University and Zachary Loughman, West Liberty University*

*Cambarus veteranus* (Guyandotte River Crayfish) is endemic to West Virginia's Upper Guyandotte basin (UGB) and currently petitioned for federal listing as endangered by the U.S. Fish and Wildlife Service. At the turn of the last century, *C. veteranus* was documented occurring throughout the UGB. Basin wide surveys completed in 2009 only found the species in Pinnacle Creek, indicating *C. veteranus* had experienced extensive population decline. During May and June 2015, surveys were performed across the UGB to determine the current distribution of the species. Seventy one sites were sampled, including all historic as well as semi-randomly selected streams, with at least one and as many as nine 125m reaches sampled per wadeable stream. Surveys determined that Pinnacle Creek populations persist along a minimum of 48 stream kilometers. *Cambarus veteranus* was absent at both the confluence with the Guyandotte, and headwaters of Pinnacle Creek. Animals also were procured for the

first time from the Clear Fork/Laurel Fork watershed, with *C veteranus* limited to a minimum of 217 km there in *Cambarus veteranus* were not encountered in any other historic locations including Still Run and Huff, Barker, Briar, Indian, Little Indian, or Turkey Creek At present, *C veteranus* is known to occur within a minimum of 265 stream kilometers in two subwatersheds in the UGB, and given this limited distribution and apparent population decline, is deserving of federal protection

### **Crayfish Diversity and Distribution of Tomlinson Run State Park, Hancock County, West Virginia (Posters)**

*Clarissa Damis\*, West Liberty University, Nicole Sadecky, West Liberty University, David Foltz II, Civil & Environmental Consultants, Inc, Cynthia Cyprych, Civil & Environmental Consultants, Inc and Zachary Loughman, West Liberty University*

In 2015, a survey of the epigeal crayfish of Tomlinson Run State Park was conducted The 1,398 acre park is located in Hancock County in the northern most portion of West Virginia's northern panhandle A preliminary habitat survey was conducted to map all reaches of intermittent and perennial streams as well as any wetlands, seeps, ponds, and lakes that may also house crayfish Following the survey for habitat, 30 stations, each 100m long, were randomly selected using ArcGIS for both intermittent and perennial stream reaches Sites were sampled by performing ten seine hauls in best available habitat throughout the reach and scored using an Ohio EPA QHEI (Qualitative habitat evaluation index) to obtain qualitative habitat data Ponds and lakes were trapped for crayfish using crayfish/ minnow traps baited with cat food Any burrows found in wetlands and seeps were excavated In order to minimize impacts within the park, all crayfish were identified to species upon capture and released following sampling at each station In total, 471 crayfish were collected during the survey out of which four species were identified, including *Cambarus carinirostris*, *Cambarus monogalensis*, *Cambarus robustus*, and *Orconectes obscurus* No statistically significant relations between QHEI score vs CPUE (catch per unit effort) were shown, but *O obscurus* demonstrated a slightly positive correlation with increased score while *C carinirostris* demonstrated a slightly negative correlation to increased score Sixty trapping days for ponds and lakes only produced a single *O obscurus* *Cambarus monogalensis* was collected from three large forested seeps Only *C carinirostris* were collected from intermittent stations with overall CPUE of 012 crayfish per haul CPUE scores for perennial stations indicated 143 crayfish per haul, but when split by species, *C carinirostris* had lower CPUE (039) compared to *O obscurus* (095) *Cambarus robustus* had the lowest CPUE (009) and was the rarest species encountered in Tomlinson Run State Park

### **Fish Assemblages As Indicators of Agricultural Land Use Impacts in the Nolichucky River Watershed of Tennessee (Posters)**

*J Brian Alford\*, The University of Tennessee, jalfor12@utk.edu, Joyce Coombs, The University of Tennessee, Justin Wolbert, The University of Tennessee and Hayley Gotwald, The University of Tennessee*

We assessed the extent of current land use intensity (% of watershed area) and change from 2000 to 2015 in the Nolichucky River watershed and how spatiotemporal variability of land use influenced fish assemblages. During summer 2014-2015, we sampled fishes using TVA backpack electrofishing methods at riffle-run habitats in different stream size categories (5 tributary sites and 11 main stem sites). Site classification was based on levels of observed riparian land use impacts (quartiles from US EPA rapid habitat assessment scores) and included least-impacted ( $n=7$ ), moderately-impacted ( $n=4$ ), and most-impacted ( $n=5$ ) sites. Canonical correspondence analysis and Sum F tests ( $F > 420$ ;  $P < 0.01$ ) revealed that fish assemblages were different based on site impairment classifications (344 samples, 50 species, 8,610 fish), and that elevation and temperature correlated the strongest with assemblage structure (CCA axis 1), followed by % current forest land cover, total dissolved solids, and specific conductivity (CCA axis 2). Results of blocked indicator species analysis suggested that *Notropis rubricroceus* was a strong indicator of the least-impacted condition (indicator values [IV] = 35;  $P < 0.01$ ). *Nothonotus acuticeps* was a strong indicator of the moderately-impacted condition (IV = 32;  $P < 0.01$ ), while *Cottus carolinae*, *Etheostoma zonale*, and *E. simoterum* were indicative of the most-impacted condition (IV = 26-29;  $P < 0.02$ ). Additionally, abundances of fish with relatively more “equilibrium” functional and life history traits were indicative of least-impacted sites, while those with more “opportunistic” traits were indicative of most-impacted sites. Agricultural land use had stronger influences on tributary fish assemblages rather than on main stem assemblages, especially since *N. rubricroceus* was never captured at most-impacted or moderately-impacted tributary sites. Fishes with traits such as cavity-spawning and lithophilic egg laying strategies, preferences for pools and aquatic vegetation were impacted most by agriculture, likely as a result of greater suspended sediments.

### **Evidence of Long Range Movement By Small-Bodied Great Plains Cyprinids (Posters)**

*Gene Wilde\*, Texas Tech University, genewilde@ttu.edu and Aaron Urbanczyk, Texas Tech University*

We used Visible Implant Elastomere tags to mark three species of Great Plains fishes of conservation concern: Arkansas River Shiner *Notropis girardi* ( $N = 1505$ ), Peppered Chub *Macrhybopsis tetranema* ( $N = 757$ ), and Plains Minnow *Hybognathus placitus* ( $N = 5462$ ) during spring of 2013 and 2014. Tagged fishes ranged in total length, across species, from 27 to 120 mm. We recaptured 131 fish from 0 to 213 km upstream from the release site, over a period of 1 to 343 days post-release. Most (66%) of these recaptures were of Peppered Chub in 2014, at the release site, shortly after their release. Arkansas River Shiner and Plains Minnow were recaptured upstream from the release site at locations 13-, 52-, and 214-km.



upstream Both species were recaptured 13- and 52-km upstream in the year they were tagged and released and were recaptured at 214-km upstream in the year following release One Peppered chub was recaptured 52-km upstream shortly following release None was at liberty long enough to be expected to arrive at the upstream-most site We modeled the distances traveled by tagged fish and estimate, across species, an average daily upstream movement of 04 km per day The three study species are members of a reproductive guild that broadcast spawns semi-buoyant ova that are displaced downstream by the current It generally is believed that juveniles and adults migrate upstream, but there is no definitive evidence that these species do migrate Our study provides the first direct evidence that these small-bodied species are able to move upstream over long distances at a rate, on average, of 04 km per day To put this into perspective, this represents an upstream movement of nearly 5000 body lengths per day

### **Maximum Daily Consumption of Blue Catfish *Ictalurus Furcatus* (Posters)**

*Hae Kim\*, Virginia Tech, haekim@vtedu*

Daily maximum consumption of Blue Catfish (*Ictalurus furcatus*) will be determined in the laboratory over the temperature ranges of 5-25 °C Introduced to Virginia's tidal rivers during the 1970's, these fish have quickly established themselves as a top predator Predation on threatened species such as American Shad (*Alosa sapidissima*) and Blue Crabs (*Callinectes sapidus*) has been observed in these fish To quantify the maximum daily consumption, fish will be fed gizzard shad (*Dorosoma cepedianum*) and blue crabs (*Callinectes sapidus*) *ad libitum* over a period of 24 hours From this experiment, it is possible to extrapolate the data into abundance models to quantify the absolute maximum consumption of the catfish in these tidal systems

### **Using the Position of Digestive Contents to Map Chlorinated Hydrocarbon (CHC) Movement through the Smooth Dogfish (*Mustelus canis*) (Posters)**

*Tyler Plum\*, West Virginia University, Eric B May, University of Maryland Eastern Shore and Jhamyllia Rice, University of Maryland Eastern Shore*

Many studies have found that organic pesticides, especially chlorinated hydrocarbons, are absorbed by organisms through bioaccumulation in most marine ecosystems, usually in food chain bioaccumulation and magnification Sharks are one example of a commercially and recreationally valuable organism that could be affected by these contaminants, as they are at a greater threat from bio accumulation, being top level predators However, literature on contaminant exposure in sharks is severely lacking It is therefore important to understand how these chlorinated hydrocarbons are absorbed from their diet, and how they move as digestion occurs To test this, we sampled a number of smooth dogfish, *Mustelus canis*, and attempted to correlate the results of gut content position analyses at the time of death to

chlorinated hydrocarbon concentrations in the liver Chlorinated hydrocarbon concentrations were expected to spike at different points in digestion, and by comparing the results of multiple shark diet analyses, which were sacrificed at varying stages of digestion, to their liver concentrations, it was assumed a conceptual map of how these chemicals are absorbed during digestion could be created Assuming elasmobranch digestion was similar to teleost digestion, it was hypothesized that liver concentrations would be highest when large volumes of content are found within the sharks spiral valve, or lower intestine, which usually have high nutrient absorption In reality, no chlorinated hydrocarbons were found in any of the liver samples, a highly unexpected event It is assumed that either 1) chlorinated hydrocarbons are absorbed at a continuous rate from the liver into the bodily tissues (ie muscle), leaving them virtually absent from the liver, or 2) that the sharks are not absorbing chlorinated hydrocarbons into their body or liver because they are excreted as waste at a rate that does not allow adequate time for absorption

### **Captive Propagation of Imperiled Cyprinid Fishes (Posters)**

*Aaron Urbanczyk\*, Texas Tech University, aaronurbanczyk@ttuedu and Gene Wilde, Texas Tech University*

We have propagated a number of species of Great Plains minnows, using a combination of strip spawning in the laboratory and semi-natural spawning in the field Study species are primarily broadcast spawning species, but also include at least one demersal spawning species Here, we present preliminary results of laboratory experiments designed to assess whether fish can be spawned more than one time during the spawning season (yes) and whether there is a diminution in ova/fry production over time We also have spawned fish in the wild in small enclosures, although these results are much more preliminary Overall, we have found that most species of Great Plains minnows can readily be propagated using slight modifications of standard fish culture techniques

### **Enemy at the Gates: Distributions of Painted Crayfishes (*Orconectes palmeri* subspecies) Are Encroaching on Range Restricted and Habitat Sensitive Louisiana Crayfish Species (Posters)**

*William R Budnick\*, Louisiana State University Agricultural Center, Christopher P Bonvillain, Nicholls State University, Michael D Kaller, Louisiana State University Agricultural Center and Samantha N Lott, Louisiana State University Agricultural Center*

Louisiana hosts 39 native crayfish species and has the lowest crayfish diversity among the Gulf States Although no invasive crayfish species are known in Louisiana, our studies in the central Louisiana river basins (central Red, Mermentau, Lower Ouachita, Calcasieu, Vermillion-Teche and Atchafalaya River basins) have discovered an occurrence of *Orconectes palmeri* subspecies (*O p palmeri* and *O p longimanus*) and other

unidentified *Orconectes* species in basins outside of state historical distribution records. Based on new collection data, it appears the ranges of these *O palmeri* subspecies are approaching boundaries of two *Orconectes* species (*O maletae* and *O hathawayi*) which are endemic to Louisiana and severely restricted in distribution (central Red River and upper Vermillion-Teche streams, respectively). Studies in Flint River basin streams in Georgia have reported that *O palmeri* is competitive and can displace established crayfish species. In a region of Louisiana that is undergoing constant land use and connectivity change due to silviculture, crop monoculture, stream diversion, and exceptional flooding, it is very possible that human-facilitated dispersal of *O palmeri* into ranges of endemic and rare *Orconectes* species can occur. Additionally concerning, it is currently unknown whether any *O palmeri* subspecies are actively dispersing through basin stream networks (ie, expanding their ranges). Therefore, surveys to elucidate spatial distributions and ecological relationships of both groups of *Orconectes* species will be needed to assess the interspecific competition risk posed by *O palmeri* in Louisiana streams occupied by endemic and rare populations.

#### **Population Characteristics of Yellow Perch in Dead Lakes, Florida (Posters)**

*Andy Strickland\*, Florida Fish and Wildlife Conservation Commission and Scott Bisping, Florida Fish and Wildlife Conservation Commission*

Yellow Perch are an important recreational and commercial sportfish throughout the United States. In Florida, Yellow Perch exist only in limited populations within the Apalachicola River watershed. We conducted a one-year study to assess the life history and population characteristics of Yellow Perch in the Dead Lakes, Florida. We collected 271 Yellow Perch ranging from 72 to 343 mm TL, via boat electrofishing from West Arm and Stone Mill Creek regions of the Dead Lakes. Yellow Perch ranged from 0–6 years in age; a majority of the catch consisted of Age–0 (483%) and Age–2 (328%) fish. Length at age data was fitted to a Von Bertalanffy growth curve ( $L_{inf} = 3391$ ,  $K = 0.521$ ,  $T_0 = -0.481$ ). A weighted catch curve was used to estimate total annual mortality ( $A$ ) at 65%. The overall mean  $W_r$  was 70 and showed no statistical difference between length groups (ANOVA,  $P = 0.49$ ; Stock–Memorable). The low condition ( $W_r$ ) and high mortality estimates are consistent with other southeast populations. Stomach contents were identified and showed a diet consisting primarily of invertebrates. Our study suggests that Yellow Perch in the Dead Lakes are a fast growing population with limited abundance and a long growing season.

#### **Size Structure, Age, Growth and Spawning Periodicity of Silver Carp *Hypophthalmichthys Molitrix* in Kentucky Lake, Kentucky (Posters)**

*Allison DeRose\*, Murray State University and Timothy Spier, Murray State University*

Invasive species are a growing threat to aquatic ecosystems in the United States. Invasive species can compete with native species, alter habitats and reduce ecosystem function. A recent invader, Silver Carp *Hypophthalmichthys molitrix*, has successfully infiltrated much of the Mississippi River Basin and has established reproducing populations within the Illinois, Mississippi, Missouri and Tennessee Rivers. In 2004 Silver Carp were reported within Kentucky Lake, a large reservoir located on the Tennessee River in Western Kentucky. Although Silver Carp have been present in Kentucky Lake for over a decade, very little is known about the population, which makes it difficult to predict the potential impact of Silver Carp on native species as well as the future trajectory of the population. Information regarding population dynamics (ie, recruitment, growth and mortality) is important for managers as well as commercial and recreational fishermen. Our first objective was to describe population dynamics of the Silver Carp population within Kentucky Lake, focusing on size structure, age structure and growth rates. Our second objective was to determine when Silver Carp spawn within Kentucky Lake by analyzing mean monthly gonadosomatic index (GSI). Silver Carp were collected from Kentucky Lake using a variety of sampling methods including gill nets, boat electrofishing, cast nets and commercial fishing. Preliminary data suggest that the Silver Carp population within Kentucky Lake is composed of one or two significant year-classes. These data are critical for modeling the future trajectory of the Silver Carp population within Kentucky Lake.

### **Trophic Interactions of Introduced Flathead Catfish within a Chesapeake Bay Tributary (Posters)**

Jason Emmel\*, Virginia Tech, jsnemmel@vt.edu

Flathead catfish (*Pylodictis olivaris*) is a large piscivore native to much of the Mississippi River and lower Laurentian Great Lakes basins. Deliberate stocking and unauthorized introduction have expanded their range to water bodies throughout the United States, including coastal tributaries to the mid-Atlantic and Chesapeake Bay. Because of their fast growth rates, large adult sizes, and mostly piscivorous feeding habits, nonindigenous populations of Flathead catfish can exert considerable negative impacts on native fish communities. Fisheries managers are concerned that Flathead catfish may prey heavily on already depleted stocks of alosine species -- Blueback herring *Alosa aestivalis*, Alewife *Alosa pseudoharengus*, and American shad *Alosa sapidissima* in Chesapeake Bay tributaries. In spring of 2015, we collected gut content samples from 331 Flathead catfish in the lower James River, Virginia to quantify diet composition. Flathead diets were comprised entirely of fish. Alosine species contributed substantially to Flathead diets, with 166 percent occurrence; over half of the alosines in Flathead guts were imperiled Blueback herring (98%). The remainder of the diets consisted predominantly of Gizzard shad and White perch; the numbers of which are not currently a management concern. Our findings are of particular importance to

the ongoing management of native alosines, and will help inform future management of Flathead catfish throughout their nonindigenous range

## Oral Presentations

### **Lower Leon Creek (Bexar County, TX) Use Attainability Analysis** (Freshwater Communities)

*Shaun Donovan\*, San Antonio River Authority, sdonovan@sara-tx.org*

Lower Leon Creek is a perennial water body west of San Antonio, TX, with a high Aquatic Life Use Designation (ALU). This major tributary to the San Antonio River flows for 32 miles and is comprised of six hydrologically unique assessment units (AU). A Use Attainability Analysis (UAA) was initiated in 2012 to evaluate and further define the appropriate ALU and associated dissolved oxygen (DO) criteria. To assess the ALU, 24-hr DO profiles were performed at ten stations with at least one in each AU; biological (nekton and benthic macroinvertebrate) and habitat assessments were performed at seven sites with all but one AU represented. Dissolved oxygen criteria ( $\geq 50$  mg/L 24-hr Min,  $\geq 30$  mg/L 24-hr Avg) were supported throughout the basin with the exception of the upper 50 miles of the segment, AU 1906\_06. Biological and benthic macroinvertebrate Index of Biotic Integrity (IBI) scores did not meet the high criteria for the same AU suggesting an inappropriate ALU designation for this portion of the creek. Flow measurements taken during the two year study period suggest that AU 1906\_06 does not have perennial flow, and would be more appropriately described as intermittent with perennial pools. The San Antonio River Authority recommends re-defining the boundary line between the Lower Leon Creek and Upper Leon Creek and classifying the Upper Leon Creek as intermittent with perennial pools.

### **Unionid Mussel Survey and the Presence of Golden Orb, *Quadrula Aurea*, in the Lower Cibolo Creek, Texas** (Freshwater Communities)

*Shaun Donovan\*, San Antonio River Authority, sdonovan@sara-tx.org and Larry Larralde, San Antonio River Authority*

The Texas Parks and Wildlife Department (TPWD) currently lists 15 species of Unionid mussels as threatened, three of which are historically found in the San Antonio River basin, golden orb (*Quadrula aurea*), Texas pimpleback (*Quadrula petrina*) and Texas fatmucket (*Lampsilis bracteata*). In 2011, a 12-month finding by the US Fish and Wildlife Service warranted listing five Texas Unionid species, including the three aforementioned, on the Endangered Species Act candidate species list. In response to these listings, the San Antonio River Authority initiated a holistic mussel survey in 2013 to identify mussel populations throughout the San Antonio River basin. The initial effort focused on the Lower Cibolo Creek, a 119 km spring fed creek that drains  $\sim 1,502$  km<sup>2</sup> southeast of San Antonio, TX. Previous studies suggested that *Q. aurea* was no longer found in the Lower Cibolo Creek and

the overall Unionid density was very low. Quantitative and qualitative surveys were conducted and 81 Unionid individuals were found representing five species; yellow sandshell, *L. teres* (n=38), *Q. aurea* (n=32), pistolgrip, *Q. verrucosa* (n=7), paper pondshell, *Utterbackia imbecillis* (n=3) and Louisiana fatmucket, *L. hydiana* (n=1). Sites sampled were inclusive of all mesohabitats present and covered 8,250 m<sup>2</sup>, resulting in an overall species density of 0.0098 individuals/m<sup>2</sup>. Sampling efforts are underway throughout the remainder of the San Antonio River Basin and will include all major tributaries as well as smaller creeks and streams in the watershed.

### **Biotic Interactions and Habitat Drive Positive Co-Occurrence Between Facilitating and Beneficiary Stream Fishes (Freshwater Communities)**

Brandon Peoples\*, Purdue University, [bpeople@purdue.edu](mailto:bpeople@purdue.edu) and Emmanuel A. Frimpong, Virginia Polytechnic Institute and State University

The role of biotic interactions in determining species distributions is difficult to decouple from abiotic factors. Most research to date has focused on negative biotic interactions, but the importance of positive interactions such as mutualism and facilitation at large scales is less understood. We used a two-species occupancy modelling approach to decouple the relative effects of abiotic factors and biotic interactions between a habitat-modifying North American stream fish (*Nocomis leptocephalus*) and two of its nearly-obligate beneficiary species (*Chrosomus oreas* and *Clinostomus funduloides*). We sampled fishes using backpack electrofishing in the summers of 2012-2014 at 61 sites on tributaries to the New River basin of NC, VA, and WV, USA. We gathered 10 habitat covariates from the National Hydrography Dataset and from instream measurements. We reduced dimensionality in habitat variables, corrected them for spatial autocorrelation and selected two eigenvectors as habitat covariates. We then used an information theoretic approach to compare two-species occupancy models representing hypotheses specifying the importance of only habitat, only biotic interactions, or combinations of both. The best model for each species combination specified the importance of biotic interactions. For both associate species, probabilities that associates would occur in the absence of their host were considerably lower than probabilities of co-occurrence. Species interaction factors indicated positive patterns of co-occurrence between hosts and associates. Models suggested that habitat variables mediated host-associate interactions for *C. oreas* but not for *C. funduloides*. This study provides some of the first large-scale quantitative evidence of positive co-occurrence among vertebrates, and demonstrates the importance of abiotic context for mediating interspecific interactions. Two-species occupancy modelling may be superior to traditional co-occurrence analyses for parsing out the relative importance of biotic interactions and habitat variables for determining species distributions. However, experiments and small-scale behavioural observations will also be necessary to confirm mechanisms.

### **A Tale of Two Darters: Substrate Selection and Preference of Sympatric Sand Darters from the Elk River, WV (Freshwater Communities)**

Patricia Thompson\*, West Virginia University, [pnthompson@mixwvuedu](mailto:pnthompson@mixwvuedu), Stuart Welsh, USGS, WV Cooperative Fish and Wildlife Research Unit and Austin Rizzo, West Virginia University

*Ammocrypta pellucida* (Eastern Sand Darter) and *A. clara* (Western Sand Darter) are the only sympatric sister species of *Ammocrypta*, and the Elk River in West Virginia is one of the few remaining places where both species occur. They are slender, sand-dwelling fish that were once broadly distributed, but have since undergone range-wide population declines, presumably owing to habitat loss. Habitat use studies have been conducted for *A. pellucida*, but literature on *A. clara* remains sparse, and is an essential element for the conservation of the species. Substrate selection was evaluated by conducting 15 laboratory trials in four aquaria. Two aquaria contained six *A. clara* in each, while the other two held a combination of both species, three *A. pellucida* and three *A. clara*. The sand darters were given the choice to bury into five equally available and randomly positioned substrates: fine sand (0.12-0.25 mm), medium sand (0.25-0.5 mm), coarse sand (0.5-1.0 mm), very coarse sand (1.0-2.0 mm), and granule gravel (2.0-4.0 mm). *Ammocrypta clara* primarily buried in coarse (33 %) and medium sand (28 %), followed by fine (20 %) and very coarse (19 %) sand. *Ammocrypta clara* selected coarse and very coarse sand more frequently than *A. pellucida*, while *A. pellucida* selected fine and medium sand more often than *A. clara*. Our results indicate there are substrate selection differences between the two species, though further corroboration with field surveys is needed to elucidate the variation in habitat use.

### **The Effect of Stream Restoration on Fish Species Richness and Diversity in the Coastal Plains of West Tennessee (Freshwater Communities)**

Mary Zaradich\*, University of Tennessee at Martin, [marczara@ututmedu](mailto:marczara@ututmedu), Logan Perkins, University of Tennessee at Martin, Jeffrey Fore, The Nature Conservancy, Tennessee Chapter and Tom Blanchard, University of Tennessee at Martin

Most coastal plain streams in Tennessee have been channelized causing physical stream habitat and fish community degradation. Stream restoration has been implemented to restore stream habitats and fish communities. Little is known about fish community and physical habitat response to these efforts. The goal of this project was to determine the effects of stream restoration on physical habitats and species diversity and richness of fishes in three coastal plain streams in west Tennessee. Physical instream habitat data and fishes were collected from three treatments (reference, channelized, and restored) annually during the summers of 2013-2015. Reference treatments (n=3) were those considered least-disturbed and channelized treatments (n=3) were located upstream of restored treatments (n=3). We used ANOVA to assess differences in species richness and Shannon-Weiner diversity among treatments. Species richness did not differ among treatments ( $F=0.459$ ,  $P=0.638$ ). Species diversity differed among all treatments ( $F=16.71$ ,  $P<0.001$ ). Post-hoc tests revealed species diversity significantly differed among all treatments ( $P\leq 0.0224$ ) and was highest in reference streams and lowest in

channelized streams Linear regression indicated a moderately positive relationship between standard deviation of depth and species diversity ( $P=0.052$ ,  $r^2=0.161$ ) No other habitat features were significantly related to species diversity Stream restoration in coastal plains can increase species diversity relative to more disturbed, channelized systems and this is likely due to greater heterogeneity of depth in restored streams However, species diversity at reference sites was significantly higher than restored reaches which indicates channel restoration may not result in full recovery in the short-term (<5 years)

### **Identifying Potential Cheaters in a Mutualistic Nest Association Among North American Minnows (Freshwater Communities)**

*Stephen Floyd Jr\*, Virginia Polytechnic Institute and State University, spfloyd@vtedu, Brandon Peoples, Virginia Polytechnic Institute and State University and Emmanuel A Frimpong, Virginia Polytechnic Institute and State University*

The relative costs and benefits determine the outcomes in fitness terms of biotic interactions; if the net outcome is beneficial for all participants, the interaction is considered mutualistic Mutualisms are common in natural systems and often contain cheaters (individuals exploiting benefits without contributing to the cost) Cheaters often coevolve with mutualists, however, their effect on mutualisms is poorly understood Understanding how cheating influences fitness outcomes of these interactions will help elucidate how mutualisms structure populations and communities, and consequently help in developing conservation strategies for mutualism-dependent species Nest association, a reproductive interaction in which one species spawns in the nest of a host species, is often mutualistic Using multivariate analysis, we assessed a time series of gonadosomatic index (GSI) values to detect patterns in the reproductive timing of the bluehead chub *Nocomis leptocephalus* (the host) and its nest associates in a Virginia stream Additionally, we used a nonparametric Spearman's  $\rho$  test to compare reproductive condition among the host and six associate species We conducted complementary field observations to document the onset of *Nocomis* nesting, spawning events, and other reproductive behaviors We hypothesized that associates whose GSI does not track *Nocomis* closely, but are observed frequently visiting nests, may be doing so only to forage for eggs The GSI of all putative obligate associate species were positively correlated with the GSI of *Nocomis*, whereas putative facultative associates were negatively correlated with *Nocomis* GSI Within groups (i.e., obligate, facultative), GSIs of all species were significantly correlated with the GSI of other group members All facultative associates spawned prior to the onset of *Nocomis* spawning In particular, the central stoneroller *Campostoma anomalum* spawned before *Nocomis* and was documented on all *Nocomis* nests We conclude that central stonerollers could be cheaters in this study system

### **Fishes Associated with Low Levels of Suspended and Bed Sediment in the Broad River Basin of South Carolina (Freshwater Communities)**



*Mark Scott\*, South Carolina Department of Natural Resources, ScottM@dnrscgov, Kevin Kubach, South Carolina Department of Natural Resources, Kerry Castle, South Carolina Department of Natural Resources, Drew Gelder, South Carolina Department of Natural Resources and Kenson Kanczuzewski, South Carolina Department of Natural Resources*

The Broad River and its tributaries make up the largest watershed within the Santee River Basin located on the south Atlantic coast. The Broad River Basin, which terminates at the confluence with the Congaree River in Columbia, South Carolina, is almost entirely situated within the Piedmont physiographic province. Piedmont streams are often characterized by transport-limited conditions, high turbidity, sandy mobile bottoms and shoals, and unstable banks. Conditions such as these typically cannot support specific designated uses of the waterbody owing to impaired biotic conditions. Unfortunately, the data needed to quantify complex relationships between fluvial sediment and in-stream habitat are scarce in SC Piedmont rivers and a discernible data gap exists in the Broad River Basin. Our objective here was to assess associations between sediment flux, grain size, and the stream fish assemblage. We collected over 800 suspended-sediment samples, and 700 bed material samples over a 24 month period from June 2012 to June 2014. In-stream habitat was assessed at each field site and 55 fish sampling surveys were carried out with standard backpack electrofishing methods. We examined fish assemblage structure with respect to sediment load and bed material character using ordination. Fish species representing sensitive groups such as benthic and water column-dwelling members of the families *Catostomidae* (suckers), *Cyprinidae* (minnows) and *Percidae* (darters) showed negative responses to higher suspended sediment levels and positively responded to increasing bed particle size (d50 and d90). We highlight a suite of species that may be useful indicators of sedimentation in the basin and note potential counterparts in other Piedmont surface waters.

### **Predation of Invasive White Perch in Sooner Reservoir: Preliminary Results (Fisheries Management)**

*Nathan Copeland\*, Oklahoma Department of Wildlife Conservation, natecopeland@odwcokgov, Ashley Nealis, Oklahoma Department of Wildlife Conservation and Bill Wentroth, Oklahoma Department of Wildlife Conservation*

White perch, *Morone americana*, were first documented in Sooner Reservoir in 2006 by the Oklahoma Department of Wildlife Conservation (ODWC) and the species has been deemed a nonindigenous aquatic species in Oklahoma, due to the impact the species has on the established fishery. Previous studies have shown that white perch impact sport fish age-0 year classes and recruitment through competition and predation. The catch rate trends at Sooner Reservoir for largemouth bass, *Micropterus salmoides*; white bass, *Morone chrysops*; channel catfish, *Ictalurus punctatus*; and hybrid striped bass, *Morone saxatilis x Morone chrysops*, have decreased as the catch rates of white perch have increased since 2007. In 2011,

ODWC began to stock saugeye, *Sander vitreus x Sander Canadensis*, in Sooner Reservoir as a possible answer to the increasing abundance of white perch. Diet samples were collected from saugeye, largemouth bass, hybrid striped bass, channel catfish, and blue catfish, *Ictalurus furcatus*, via monthly electrofishing and gill net samples. Preliminary diet analysis shows that saugeye consumed the highest number of white perch and ranked highest in foraging success for white perch. However, largemouth bass returned the highest foraging success for the prey categories: unidentifiable fish and *Morone spp*. The top four prey items from the preliminary diet analysis have been unidentifiable fish, vegetation, invertebrates and white perch. The vegetation prey category ranked highly because it has been the main prey item for channel catfish. Upon completion of the diet analysis, the possibility of manipulating one or more of the sport fish species as a biological control for white perch through stocking rates and/or harvest recommendations will be evaluated.

### **Trends in Abundance of Northern Snakehead in Virginia Potomac River Tributaries** (Fisheries Management)

*John Odenkirk\*, Virginia Department of Game and Inland Fisheries, johnodenkirk@dgifvirginiagov and Mike Isel, Virginia Department of Game and Inland Fisheries*

A Northern Snakehead *Channa argus* population was documented in the Potomac River system in 2004. We estimated relative abundance (electrofishing fish/hour) for 12 years for a series of core creeks within the original area of colonization and for nine years for Aquia Creek – colonized about three years later. Population estimates were also calculated for adult Northern Snakehead in Little Hunting Creek. Relative abundance of Northern Snakehead ceased to increase, and ANOVA was unable to discern any significant differences in relative abundance in recent years suggesting population growth slowed or perhaps stabilized. Population estimates (12-21 fish/ha) declined each year 2013-2015 supporting the assertion that Northern Snakehead density stabilized and possibly declined.

### **The Effects of Prior Satisfaction and Constraints on the Intention to Resume Fishing for Stocked Trout in Virginia** (Fisheries Management)

*Vic DiCenzo\*, Virginia Tech and Steve L McMullin, Virginia Tech*

Stocked trout anglers in Virginia are less satisfied than anglers fishing for other species. Additionally, the sale of licenses required to fish for stocked trout declined 31% between 2006 and 2013. In 2014, we surveyed 1,100 lapsed trout anglers (individuals who had purchased licenses twice between September 1, 2011 and August 31, 2013 but did not purchase one between September 1, 2013 and August 31, 2014). We then used a structural equation model to evaluate the effects of prior satisfaction and constraints on lapsed anglers' intention to fish for stocked trout again. Measurement models confirmed that commonly used

indicators for satisfaction and constraints were appropriate for each construct. With the structural model, we found a direct and positive relation between non-catch-related factors (eg, being outdoors, enjoying a relaxing experience, experiencing a natural setting) and lapsed anglers' intention to fish in the future. Constraints did not mediate the effect of prior satisfaction on future participation. However, structural constraints were positively related to future participation, suggesting that individuals who had more time and family commitments were more likely to negotiate those constraints and participate in the future.

### **Bridgewater Tailrace, NC: Historical and Contemporary Approaches to Managing a Quality Trout Fishery (Fisheries Management)**

*Chris Wood\*, North Carolina Wildlife Resources Commission, chriswood@ncwildlife.org, David Goodfred, North Carolina Wildlife Resources Commission, Jacob Rash, North Carolina Wildlife Resources Commission and Douglas Besler, North Carolina Wildlife Resources Commission*

Bridgewater Tailrace is a 29-km waterway extending from Lake James to Lake Rhodhiss in western North Carolina. An 18-km reach is classified as Special Regulation Trout Waters by the North Carolina Wildlife Resources Commission (NCWRC) and managed as a put-grow-and-take trout fishery. This reach was stocked each spring from 1996–2008 with 25,000–50,000 fingerling (25–75 mm total length) Brown Trout *Salmo trutta* in an effort to establish a high-quality tailrace fishery. Early results suggested stocking efforts were successful; however, subsequent evaluations from 2003–2009 demonstrated recruitment of stocked fish was highly variable and negatively correlated to water temperature. Recent upgrades to Bridgewater Hydro Station led to a new stocking approach by NCWRC that may ameliorate historical issues. In 2012, the NCWRC initiated a five-year study to evaluate annual stockings of 10,000 advanced fingerling (200–255 mm total length) Brown Trout. Fish were marked with coded wire tags and stocked during late fall after the threat of elevated water temperatures. Preliminary results from 2012–2015 suggest the fishery is improving: catch-per-unit-effort (CPUE; fish/hour) increased and percent contribution of stocked fish is high and consistent among survey years. Four year classes of stocked Brown Trout occur within the fishery; however, age structures indicate elevated mortality between ages one and two. Additionally, CPUE of stocked age-one Brown Trout declined between spring and fall samples within a single year, suggesting elevated temperatures during late summer and early fall continue to impede recruitment into the fishery.

### **Return of Stocked Brown Trout and Rainbow Trout to the Angler Creel at Apalachia Reservoir, NC (Fisheries Management)**

*Amanda Bushon\*, North Carolina Wildlife Resources Commission, Jacob Rash, North Carolina Wildlife Resources Commission, Powell Wheeler, North Carolina Wildlife Resources Commission and David Yow, North Carolina Wildlife Resources Commission*

Apalachia Reservoir is a 445-ha impoundment in western North Carolina that contains suitable trout habitat year-round and Blueback Herring *Alosa aestivalis*, an abundant cold-water forage base. As such, the impoundment was a good candidate for experimental put-grow-and-take trout stockings, with the potential to produce a trophy trout fishery. The objective of this study was to evaluate the return of experimentally stocked trout to the angler creel and determine the appropriate size and species of trout to utilize within Apalachia Reservoir. Beginning in December 2012, the North Carolina Wildlife Resources Commission began stocking Brown Trout *Salmo trutta* and Rainbow Trout *Oncorhynchus mykiss* at two different sizes, 255 and 356 mm mean total length. All trout were marked with visible implant elastomer and coded wire tags prior to stocking to differentiate year and size classes. To determine the return of stocked trout to the angler creel, a non-uniform probability creel survey was conducted on pre-assigned days from 1 December 2014 through 31 November 2015. Game cameras were placed at each of the two boat ramps on Apalachia Reservoir to determine boat-angling effort, while catch and harvest statistics were determined through angler interviews. Cameras successfully measured boating effort without dedicating staff time to angler count circuits, improving efficiency and precision of the angler survey. Preliminary results suggest that trout stocking at Apalachia Reservoir has created a popular fishery and Brown Trout appear to be reaching larger sizes at faster rates than Rainbow Trout.

### **Costs of the US Regulatory Environment on Baitfish and Sportfish Aquaculture (Fisheries Management)**

*Jonathan van Senten\*, University of Arkansas at Pine Bluff*

A survey of US baitfish and sportfish producers was conducted in 2014-2015, to collect data on direct and indirect regulatory costs, and any changes implemented on farms to remain compliant with regulations. The questionnaire was distributed to producers in 13 states: Alabama, Arkansas, Florida, Illinois, Kansas, Louisiana, New York, North Carolina, Ohio, Pennsylvania, Texas, Virginia, and Wisconsin; these states represented 80% of the US production value of baitfish and sportfish. The overall response rate for the study was 31% of farms, equivalent to 74% of the US production value of baitfish and sportfish. The number of regulations that farms must comply with ranged from a low of 1 to as many as 40 regulations per farm. Some regulations require frequent renewal. While the average number of renewals nationally was 13 per farm, some farms had as many as 203 renewals each year. Overall, 48% of farms had to process more than 5 permits/licenses/renewals each year. More than 79% of the permits and licenses were state, not federal regulations, and there was a high degree of variability from state to state. The overall cost of regulations to the baitfish/sportfish industry was estimated to be \$12 million. Per farm, the average cost posed by regulations was \$150,000 each year, with an average cost per acre due to regulations of \$3,000, which was greater than per-acre profits. When regulatory costs were divided into specific categories, the cost of the permits and licenses themselves composed only 1% of the total regulatory costs.

The primary factors that contributed to the overall cost of compliance with regulations included: 1) time spent to apply for and renew permits and licenses; 2) changes that were made on farm to comply with regulations; and 3) lost or foregone sales due to difficulties related to the complexity of regulations in various states. Study results captured only the costs on farms. However, the degree of redundancy in the overall regulatory environment among and within states likely increases costs to state agencies that often struggle to absorb new but often unfunded regulatory mandates. Simulations examined scenarios likely to occur from implementation of the proposed Commercial Aquaculture Health Program Standards (CAHPS) federal model that would provide a uniform set of fish health regulations that could be adopted by states. Results showed potential for CAHPS to result in improved effectiveness of fish health regulations across the US at a lower cost to aquaculture farms.

### **Thinking “inside the Box” to Direct American Eel Research Efforts in Florida** (Fisheries Management)

*Kimberly Bonvechio\*, Florida Fish and Wildlife Conservation Commission, KimBonvechio@MyFWC.com, Andy Strickland, Florida Fish and Wildlife Conservation Commission, Cheree Steward, Florida Fish and Wildlife Conservation Commission, Brandon Barthel, Florida Fish and Wildlife Conservation Commission, Jessica Carroll, Florida Fish and Wildlife Conservation Commission and Justin Hill, Florida Fish and Wildlife Conservation Commission*

The American Eel stock has been determined by the Atlantic States Marine Fisheries Commission to be in a state of decline. Implicated in this decline are factors such as habitat loss and degradation, hydroelectric turbine mortality, commercial harvest, climate change, and disease. Florida Fish and Wildlife Conservation Commission researchers are teaming up with fisheries projects across the state to gather information about Florida's American Eels. Since February 2014, biological, age, condition, and *Anguillicoides crassus* parasite infection data have been obtained for 303 American Eels collected in 36 systems. Genetic fin clip samples were also obtained from fish in the Apalachicola River, which empties into the Gulf of Mexico, and St Johns River, which empties into the Atlantic Ocean, to compare population structure between the two coasts. Fish ranged from 10 to 80 cm in total length and 0 to 12 yrs of age. Active parasite infection rates were highly variable among regions, from 0 % in the south and western areas of the State to 15% in the panhandle and 54% in the St Johns River basin. Fish health indices varied by region, and in the St Johns River, also by season and distance from the river mouth. Upon completion of data collection in June 2016, information will be summarized and used to direct future research and conservation efforts for American Eel in Florida.

### **Patterns and Periodicity of Upstream Passage of American Eels at an Eel Ladder** (Fisheries Management)

*Stuart A Welsh\*, USGS, WV Cooperative Fish and Wildlife Research Unit and Joni Aldinger, West Virginia University*

The American Eel (*Anguilla rostrata*) is a migratory species of ecological and economic importance, as well as a species of conservation concern. While studies have examined upstream migration of nocturnal yellow-phase American Eels, little is known about the diel periodicity of upstream migration. For example, although American Eels are active during low light conditions, few studies have examined the periodicity and chronology of upstream movements relative to time of night. Using American Eel passage data (2008-2014) from an eel ladder on the Shenandoah River, we found chronological patterns in the timing of upstream migration. Periodicity of movements closely followed a 24-hour cycle of activity for each passage event with most movement occurring nocturnally. Multimodal models were supported by the data, where most passage distribution modes represented nocturnal movements, but modes at or near the transition between periods of twilight and night were also common. Further research will focus on the association of movement patterns with environmental variables, including lunar illumination and river discharge.

#### **Landscape and Flow Metrics Affecting the Distribution of a Federally-Threatened Fish: Improving Management, Model Fit, and Model Transferability (Fisheries Management)**

*Shannon K Brewer\*, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Thomas Worthington, Oklahoma Cooperative Fish and Wildlife Research Unit, Tianjiao Zhang, OSU, Aaron Mittelstet, OSU and Daniel Logue, OSU*

Truncated distributions of pelagophilic fish have been observed across the Great Plains of North America, with water use and landscape fragmentation implicated as contributing factors. Developing conservation strategies for these species is hindered by the existence of multiple competing flow regime hypotheses related to species persistence. The main objective of this study was to compare predicted distributions of one pelagophil, the Arkansas River Shiner, constructed using different flow regime metrics. Further we investigated different approaches for improving transferability of the species distribution model (SDM). We compared mean annual flow with three flow metrics calculated to examine flows during the spawning period: the 75<sup>th</sup> percentile of daily flow, the number of zero-flow days, and the number of days above 55<sup>th</sup> percentile flows. Building on an earlier SDM, we added the covariates well water use, point-source discharges, and non-native species presence to a structured variable framework. We assessed the effects on model transferability and fit of reducing multicollinearity using Spearman's rank correlations, variance inflation factors, and principal component analysis, as well as altering the regularization coefficient ( $\beta$ ). The 75<sup>th</sup> percentile of daily flow was the most important flow metric related to structuring the species' distribution. The number of wells and point source discharges were also highly ranked. At the default level of  $\beta$ , model transferability was improved using all methods to reduce collinearity; however, at higher levels of  $\beta$ , the correlation method performed best.

Using  $\beta = 5$  provided the best model transferability, while retaining the majority of variables that contributed 95% to the model. This study provides a workflow for improving model transferability and also presents water-management options that may be considered to improve the conservation status of pelagophils.

### **Environmental and Biological Correlates of Seasonal Movement Patterns of Walleyes in a Hydropower Reservoir (Fisheries Management)**

*Dustin M Smith\*, West Virginia Division of Natural Resources, Stuart A Welsh, US Geological Survey, Nate D Taylor, West Virginia Division of Natural Resources and Corbin D Hilling, Virginia Tech*

Cheat Lake, a hydropower reservoir in northern West Virginia, was historically impacted by acid mine drainage. Although the native Walleye (*Sander vitreus*) population was extirpated as a result, a reintroduced Walleye fishery has seen recent improvements owing to management efforts and improving water quality. Although water quality has improved, potential impacts still exist from water level fluctuations and episodic pH depressions. Despite an improving Walleye fishery, little is known about the movement ecology and seasonal distribution of Cheat Lake Walleyes. To assess Walleye movements and distribution in Cheat Lake, we utilized an acoustic telemetry monitoring array supplemented with manual tracking efforts. Fifty adult Walleyes were implanted with acoustic transmitters and monitored from 2012-2015. Acoustic telemetry detection data were analyzed using generalized linear mixed models to test the effects of environmental and biological correlates on seasonal movements and distribution. Results suggest that movements and distribution vary seasonally and to some extent between male and female fish. Spawning related movements were primarily correlated with changes in water temperature and also differed between males and females. Movements during non-spawning periods were influenced by incoming river discharge and water temperature changes. Results from this study suggest that water temperature, river discharge, and to some extent fish sex are the most important predictors of Walleye movements and distribution in Cheat Lake. Although lake elevations did not appear to directly affect fish movement, timing of Walleye spawning usually coincided with periods of maximum lake fluctuation potential. Given the timing and location of spawning and potential for maximum lake level fluctuation, spawning success could be impacted from habitat loss or egg exposure. Increased knowledge of Walleye movement ecology and seasonal Walleye distribution should allow for improved management decisions that will aid in the continued recovery of the Cheat Lake Walleye fishery.

### **Population Characteristics of Channel Catfish in Cheat Lake, West Virginia (Fisheries Management)**

*Corbin D Hilling\*, Virginia Tech, Stuart A Welsh, USGS, WV Cooperative Fish and Wildlife Research Unit and Dustin M Smith, West Virginia University*

Acidification has historically impaired Cheat Lake's fish community, but recent mitigation efforts within the Cheat River watershed have improved water quality and species richness. Presently, Channel Catfish are abundant and attain desirable sizes for anglers, but information on the population is limited. We evaluated the population characteristics of Cheat Lake's Channel Catfish population to provide managers with information to aid management decisions. Our objectives were to estimate size and age structure, condition, mortality and growth of the population using fishery independent data. A sample of 155 Channel Catfish was collected from Cheat Lake from 5 August to 4 December 2014, a subsample of which was aged ( $n = 148$ ) using lapillus otoliths. Size structure was evaluated using proportional stock density and a length frequency histogram. We estimated body condition using the relative weight index, summarized using five-cell length categories. Annual mortality was estimated using weighted catch-curve regression to lessen the influence of older, less abundant age classes. We compared mean length at age to published growth standards. Also, four growth models (von Bertalanffy, logistic, Gompertz and power) were fit to length at age data and compared using an information theoretic approach. Total lengths of individuals in the sample ranged from 154–721 mm and ages ranged from 2–19 years. Based on data from this study, Cheat Lake's Channel Catfish population features an abundance of quality length fish, average to above average condition, low mortality and fast growth. The von Bertalanffy growth model was  $AIC_c$ -selected as the best approximating model, and the power and Gompertz models also had considerable support, while the logistic model had little support. This study provides baseline data for management of Cheat Lake's Channel Catfish population. Further, this study fills a knowledge gap in the scientific literature on Channel Catfish, as few published studies have examined the population ecology of Channel Catfish in the Central Appalachian region.

### **Population Dynamics of Catfishes in Three Tennessee River Reservoirs and Developing Standardized Sampling Protocols (Fisheries Management)**

*Cole Harty\*, Tennessee Cooperative Fishery Research Unit, [charty@tntech.edu](mailto:charty@tntech.edu) and Phillip Bettoli, Tennessee Cooperative Fishery Research Unit*

Catfish are important components of sport and commercial fisheries in several Tennessee reservoirs. In 2011, catfish were the second most pursued recreational species in the state behind black bass and accounted for nearly five million days of fishing. Sport fishing effort directed at catfish accounted for approximately 16% of all fishing pressure in Chickamauga Lake in 2014, when more than 165,000 Blue Catfish *Ictalurus furcatus* and Channel Catfish *I. punctatus* were harvested. Catfish in Tennessee have received scant attention because catfish were not classified as a sport fish, and Sport Fish Restoration Funds were not available to study and manage them, until 2007. The lack of knowledge regarding catfish populations in Tennessee reservoirs and how to effectively sample them presents many research opportunities. A primary focus of this research is to develop unbiased and standardized catfish



sampling protocols when using tandem hoop nets, low-frequency electrofishing, trotlines, or a combination of these three approaches. In a pilot study during the summer of 2014, tandem hoop nets were deployed in Kentucky Lake (24 series), Chickamauga Lake (16 series), and Fort Loudoun Lake (16 series) and over 450 Channel Catfish were collected. Sampling effort was nearly tripled (160 series) in 2015 and more than 3,400 Channel Catfish were collected across several seasons. Additionally, length, weight, and age data has been collected from over 400 Blue Catfish. Future goals are to mathematically model the response of catfish populations to different management scenarios, and to assess the potential for growth and recruitment overfishing in Tennessee reservoirs.

### **Naturalization of Largemouth Bass from Formulated to Live Diets, with Implications for Hatchery and Fisheries Management** (Fisheries Management)

*Colin Dinken\*, Mississippi State University, Kevin Keretz, Mississippi State University, Hal Schramm, US Geological Survey and Peter Allen, Mississippi State University*

Research to identify factors affecting survival of Largemouth Bass *Micropterus salmoides* often require large numbers of relatively homogenous fish that cannot be obtained from the wild, thereby necessitating the intensive culture of research specimens. Further, management agencies are interested in rearing Largemouth Bass to larger sizes via intensive culture and formulated diets. Previous studies of Largemouth Bass have shown that fish reared on formulated diets higher in carbohydrates than live diets may develop livers with higher lipid content and potentially differ in both physiological responses and survival compared to wild fish. The objective of this study was to determine the duration of time fish need to be fed live diets before they are physiologically similar to wild fish. Therefore, Largemouth Bass were reared from 50 to 290 mm on a formulated diet and transitioned to a diet of live forage. A suite of physiological and anatomical metrics indicate fish reared on formulated diets approximate wild fish within 4 to 6 weeks of feeding live forage.

### **Estimation of Largemouth Bass Survival in a Simulated Catch-and-Release Fishery** (Fisheries Management)

*Kevin Keretz\*, Mississippi State University, Colin Dinken, Mississippi State University, Peter Allen, Mississippi State University and Hal Schramm, US Geological Survey*

### **Estimation of Largemouth Bass Survival in a simulated Catch-and-Release Fishery**

**Kevin R Keretz<sup>1</sup>, Colin P Dinken<sup>1</sup>, Peter J Allen<sup>1</sup>, Harold L Schramm, Jr<sup>2</sup>**

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**Abstract** Largemouth Bass *Micropterus salmoides* are a frequently sought after fish species by recreational anglers in the United States, and information about the mortality of angler-caught Largemouth Bass is critical to their effective management. Mortality of tournament-caught fish varies widely and is positively related to water temperature. The mortality of caught-and-immediately-released largemouth bass is considered to be low, but temperature effects have not been considered. We measured the survival of Largemouth Bass subjected to simulated angling followed by immediate release and simulated tournament conditions across a range of temperatures at which recreational fishing occurs (17, 21, 25, 29 and 33°C). At each temperature, we also tested the effect of live well (LW) temperature manipulations ( $\Delta T$ ) of -4, 0, and + 4°C. LW dissolved oxygen concentration was maintained above 5 mg/L in all trials. No fish subjected to simulated angler capture and immediate release died during 5-day retention at any temperature. None of the Largemouth Bass acclimated to 33°C and subjected to simulated tournament handling survived following the  $\Delta T = + 4^\circ\text{C}$  LW treatment; observed survival was 60% for fish subjected to the  $\Delta T = -4^\circ\text{C}$  LW treatment, and 70% for fish subjected to the  $0^\circ\text{C}$  LW treatment. Five-day survival of fish subjected to simulated tournament procedures was  $> 80\%$  at acclimation temperatures of  $\leq 29^\circ\text{C}$ . Results suggest that the survival of caught and immediately released largemouth bass is high across a range of water temperatures; however, decreased survival can be expected in largemouth bass subjected to tournament handling as ambient temperatures approach 33°C.

### **Capture and Mortality Rates of Largemouth Bass at Guntersville and Wheeler Reservoirs, Alabama** (Fisheries Management)

*Jeff Buckingham\*, Auburn University and Matthew Catalano, Auburn University*

Catch-and-release angling for Largemouth Bass (*Micropterus salmoides*) has substantially increased since the 1980s, yet few studies have assessed the population-level consequences of these activities. Guntersville and Wheeler Reservoirs, Alabama, are nationally known Largemouth Bass fishing destinations with high levels of angling effort and high rates of voluntary release ( $>85\%$ ). We used a variable reward tagging study to estimate rates of capture, release, mortality, and angler reporting of tagged Largemouth Bass at these reservoirs. Separate estimates were obtained for non-tournament release, tournament release, and harvest fisheries to evaluate the relative magnitude of potential population impacts among these fishery sectors. Preliminary results of the study suggest that 47% of Largemouth Bass at Guntersville and 36% at Wheeler Reservoir are captured by anglers annually. Harvest rates were 4% at Guntersville and 2% at Wheeler. Competitive tournaments captured 11% of Largemouth Bass at Guntersville and 15% at Wheeler. An estimated 9% of the Largemouth Bass died due to angling at Lake Guntersville versus 6% at Lake Wheeler. Harvest

contributed the most to this number at Guntersville whereas tournament mortality contributed the most at Wheeler Tag reporting rates were lower for fish caught in competitive tournaments than that for non-tournament captures Our results could improve management strategies at heavily fished reservoirs with high rates of voluntary release

**Restoring a Trophy Largemouth Fishery: Firing on All Cylinders** (Fisheries Management)

*Dave Beasley\*, SOLitude Lake Management, dbeasley@solitudelakecom and Aaron Cushing, SOLitude Lake Management*

For years, a long established private fishing club in central Virginia watched as the health and condition of their largemouth bass decreased from season to season Finally in the fall of 2009 they reached out to a private management company to help restore the health of their 85 acre lake and improve their bass fishing Following an initial electrofishing, water quality, and habitat assessment in 2010, a fisheries management plan was developed to help improve the catch rates of trophy-sized fish Limiting factors were identified and meetings were held with club members to determine a strategy based on budget Over a six year period, more than 3,000 slot bass have been removed and a pattern has emerged with decreasing CPUE correlating with an increase in the quality of bass caught Following a low of 16 trophy catches in 2009/2010, a record high of 48 were caught in the 2014/2015 fishing season Using a variety of management techniques including vegetation control, fertilizing, habitat improvement, predator harvest, bluegill stocking, and nuisance wildlife trapping, the health of the lake and the fishery continue to improve

**Evaluating the Effects of Threadfin Shad on Largemouth Bass Growth, Condition and Diets in Small Impoundments** (Fisheries Management)

*Sean Lusk\*, Auburn University and Matthew Catalano, Auburn University*

Threadfin shad are commonly stocked into small impoundments to increase the growth and condition of largemouth bass, ultimately to enhance recreational fishing However, the effects of threadfin shad on largemouth bass recruitment, growth, and condition are not fully understood To date, much threadfin shad research has focused on large reservoirs with few studies conducted on small impoundments With over 250,000 small impoundments in Alabama alone, understanding the role of threadfin shad in these systems is paramount to providing best management advice We evaluated the impacts of threadfin shad on largemouth bass growth, condition and diets at five recently-stocked and 29 established small impoundments in central Alabama Results from this study suggest that threadfin shad may be associated with higher largemouth bass growth and condition although variability in the observed effects of threadfin shad makes generalizations difficult This study will provide a

better understanding of interactions between threadfin shad and largemouth bass and provide managers with insight on how to better manage small impoundments

### **Effects of Habitat Enhancement on Growth, Condition, and Habitat Use of Largemouth Bass (Fisheries Management)**

*Chance Kirkeeng\*, South Dakota State University, Jason Breeggemann, South Dakota State University, Brian Graeb, South Dakota State University, Katie Bertrand, South Dakota State University, Troy Grovenburg, South Dakota State University and Bob Lusk, Pond Boss Magazine*

Reservoir aging and the resulting loss of structural habitat can limit productivity, in particular growth rates, of fishes such as Largemouth Bass in North America. Habitat enhancement using artificial structure could provide the necessary resources to more efficiently transfer energy to Largemouth Bass and thereby increase population growth rate. We evaluated the effects of habitat enhancement on Largemouth Bass in a 60-year-old reservoir. We used radio telemetry to quantify annual and seasonal home range sizes, habitat use, and daily movement of Largemouth Bass before and after a large-scale artificial habitat addition (ie, artificial habitat was added to cover approximately 10% of the shoreline area). Initial growth and condition data shows upward trends coinciding with the time of habitat enhancement. Prior to the habitat addition, home ranges during the growing season averaged nearly 8 hectares with a maximum of 25 hectares and annual home ranges averaged 9 hectares with a maximum of 28 hectares. Additionally, daily movement rates averaged around 30 meters per hour with some Largemouth Bass moving as far as 225km in 24 hours. Our results one year post-habitat showed that Largemouth Bass are attracted to the artificial habitat and using space rarely used prior to the habitat addition. Home range sizes and daily movements remained similar to the pre-habitat period, but the locations where the Largemouth Bass are focusing has shifted to around the artificial habitat. Our results indicated that Largemouth Bass quickly responded to habitat restoration, but that more habitat may be needed to improve population growth rates of Largemouth Bass.

### **Effects of Diet and Temperature on Growth Potential of Largemouth Bass in a Texas Impoundment (Fisheries Management)**

*Chris Greene\*, South Dakota State University, Jason Breeggemann, South Dakota State University, Brian DS Graeb, South Dakota State University and Bob Lusk, Pond Boss Magazine*

Quantity and quality of food resources along with temperature can affect growth rates of Largemouth Bass. We were interested in the effects that different various diet scenarios and temperatures had on growth potential of Largemouth Bass in a Texas impoundment. Our objectives were to quantify seasonal changes in Largemouth Bass diets over three years and

model growth potential of Largemouth Bass under various diet and temperature scenarios using bioenergetics modeling In spring and early summer, crayfish were the dominant prey item in Largemouth Bass diets, while during summer, fall, and winter months, diets changed to piscivory consisting of mostly Gizzard Shad, Threadfin Shad, and Bluegill Other diet items observed throughout the study include turtles, snakes, frogs, and invertebrates Growth potential of Largemouth Bass was maximized on a diet consisting mainly of Shad species Our models will disentangle the effects of diet versus temperature on growth potential of Largemouth Bass and provide fisheries managers with insight into how best to manage forage and temperature in a changing climate

### **Human and Environmental Factors Affecting the Distribution of Arapaima in Amazon River Floodplain Lakes (Large Rivers)**

*Jordan Richard\*, Virginia Tech*

Understanding habitat selection across the life span of fishes is a critical component of sustainable fisheries management strategies However, few studies have characterized the relationship between fine-scale environmental influences (microhabitat) and tropical floodplain fish distributions The goals of this study were to (1) examine the effects of microhabitat variability (ie, water quality, habitat structure, lake morphology) on the presence of arapaima Arapaima spp in floodplain lakes, (2) determine the extent to which these relationships differ across life stages, and (3) compare the relative influence of human and environmental factors affecting arapaima distribution Dry season arapaima microhabitat measurements were collected from 13 floodplain lake environments in six fishing communities of the lower Amazon River near the municipality of Santarém, Pará, Brazil Arapaima expressed distinct and significant relationships between microhabitat variables and predicted probability of presence The general pattern observed was that arapaima selected deeper ( $p < 0.0001$ ), more turbid ( $p = 0.028$ ) habitats within floodplain lakes, and smaller arapaima selected habitats nearly twice as close to floating macrophyte beds than larger, older arapaima Predicted probability of arapaima presence differed strongly and significantly between fishing communities, indicating that community-based management strategies play an important role in sustaining arapaima populations This study reveals that microhabitat factors can govern population distributions for large-bodied fish in river floodplains and suggests that incorporation of environmental data into current community-based management models could enhance sustainability and restoration efforts for critical fisheries populations through identification of key habitats

### **Influences of Environmental Conditions on Distance Moved By Shovelnose Sturgeon in the Lower Mississippi River (Large Rivers)**

*Dylan A Hann\*, Mississippi State University, dah409@msstate.edu and Hal Schramm, US Geological Survey*

Shovelnose Sturgeon *Scaphirhynchus platorynchus* are native to the large rivers of the Mississippi River basin and have been described as both highly migratory and sedentary by previous studies, though movements are not well documented in the lower Mississippi River. Distance between weekly time steps and environmental variables were recorded for 32 individual Shovelnose Sturgeon throughout a 27-km reach of the lower Mississippi River. We recorded 221 locations of Shovelnose Sturgeon during a six month period over a wide range of river stages and water temperatures. More than 75% traveled more than 1 km between weekly relocations. We used AIC model selection with linear mixed models to determine influences on distance moved by fish. River stage and surface current velocity were found to influence distance traveled by fish; change in river stage, water temperature, and depth were not influential. Distance traveled increased with surface current velocities and declining river stage. These results provide information about conditions when Shovelnose Sturgeon are likely to increase movement and may be used to infer habitats occupied when fish are mobile and sedentary.

### **A Synthesis of Methods for Sampling Shovelnose Sturgeon and the Realities for Sampling a Highly Altered System of the Great Plains (Large Rivers)**

*Josh Johnston\**, Oklahoma Department of Wildlife Conservation, [joshjohnston@odwcok.gov](mailto:joshjohnston@odwcok.gov)  
and Shannon K Brewer, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit

Shovelnose Sturgeon is the smallest and most abundant sturgeon in North America. However, numbers have declined over the past century as a result of over-harvest, habitat fragmentation, and pollution. In response, many states have developed standardized sampling procedures and management plans for the species. Our objective was to provide a comprehensive review of sampling gears used to capture Shovelnose Sturgeon throughout their range and then report on the effectiveness of some of these gears for capturing sturgeon in rivers of the Great Plains. We completed a systematic review of several databases using key search terms to synthesize gear choices and the types of rivers and habitats where these gears were used. Twenty search terms were used across four large databases to ensure inclusive results. Many variables were recorded, including stream order, month and discharge while sampling, and dominant substrate, as these variables can influence the effectiveness of gears. Several of these gears were used in preliminary sampling for Shovelnose Sturgeon in Oklahoma. Many gears that proved successful in other systems failed to capture few or any fish in this region. We relied on sight fishing, snorkeling during winter, and herding fish into nets to capture Shovelnose Sturgeon in our applied sampling trials. Our literature review will serve as a reference for investigator's choosing appropriate gears for establishing a new monitoring plan(s) or updating sampling protocols for sturgeon. Results from our field work suggest non-standard gears and techniques are most effective for capture of Shovelnose Sturgeon in altered Great Plains rivers.

## **Historic Arkansas River Flows in Spring and Summer 2015 Deposit Numerous Paddlefish in Metropolitan Tulsa, Oklahoma (Large Rivers)**

*Jason Schooley\*, Oklahoma Department of Wildlife Conservation,  
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Rivers and reservoirs throughout much of the United States swelled and overflowed in spring and summer 2015 as much of the nation received record amounts of rainfall. The Arkansas River exceeded discharge levels of 100,000 cfs for 77 consecutive days at Ft Smith, Arkansas; the combined product of consistent metering-out of Oklahoma flood-control reservoirs throughout the watershed. Tulsa, Oklahoma residents experienced bank-full conditions in the Arkansas River amidst economic and political proposals to install multiple low-water dams. As any potadromous fish species would do, many American paddlefish (*Polyodon spathula*) from unknown downstream origins made unusually long spawning migrations before being halted at Zink low-water dam in midtown Tulsa. An initial angler observation of several hundred paddlefish aggregated below the dam led to a unique opportunity for public awareness on the essential migratory corridors of native paddlefish, shovelnose sturgeon (*Scaphirhynchus platyrhynchus*), and American eel (*Anguilla rostrata*). Thus began a cascade of events over the course of several months garnering the attention of numerous local, national, and social media outlets. Highlights discussed include: collaborative noodling for genetic samples, water quality (hospice?) monitoring, opportunistic poachers with high restitution fines, fish rescue/relocation to accommodate multi-million dollar construction projects, and presumptive resolutions.

## **Demographics and Distribution of Asian Carp in the Lower Tennessee River and Cumberland River (Large Rivers)**

*Josey Ridgway\*, Tennessee Cooperative Fishery Research Unit, jridgway@tntech.edu and  
Phillip Bettoli, Tennessee Cooperative Fishery Research Unit*

The invasive Bighead Carp *Hypophthalmichthys nobilis* and Silver Carp *H. molitrix* (collectively referred to as Asian carp) were introduced to the US in the 1970s to control algae blooms and improve water quality in aquaculture ponds and wastewater systems with little regard to potential impacts on native fishes. The range of Asian carps in the Mississippi River system continues to expand. These two invasive species have the ability to radically alter ecosystem function when they become established and there is much concern regarding the biotic integrity of Tennessee waters as Asian carp numbers grow. In the lower Tennessee River and Cumberland River systems of Kentucky and Tennessee, Asian carp were systematically sampled seasonally in 2015 using a multi-gear approach. A total of 6,283-m of experimental gill nets fished overnight captured 101 adult Silver Carp and 2 Bighead Carp. Hoop nets (n = 96) with 3-day soak times captured 2 Silver Carp and 2 Bighead Carp. Twenty-four hours of boat mounted electrofishing collected 118 adult and 212

young-of-year (YOY) Silver Carp Cast nets (n = 600 throws) captured 64 YOY Silver Carp Some YOY Silver Carp were collected 180 and 110 river kilometers upstream of Kentucky Dam and Lake Barkley Dam, respectively, and are presumed to be the first evidence of natural reproduction in Kentucky Lake and Lake Barkley Continued research will describe population dynamics, recruitment mechanisms, and the leading edge of Asian carp in the Tennessee and Cumberland rivers

### **Movement of Triploid Grass Carp in the Regulated Pee Dee River, North Carolina (Large Rivers)**

*Lawrence Dorsey\*, North Carolina Wildlife Resources Commission*

Hydrilla (*Hydrilla verticillata*) was discovered in the Pee Dee River, North Carolina just below the Lake Tillery Dam in 2010 Triploid grass carp (*Ctenopharyngodon idella*) were selected as the most effective treatment method for this system However, the North Carolina Wildlife Resources Commission (Commission) has not previously permitted triploid grass carp stockings in riverine environments The Pee Dee River between Lake Tillery Dam and Blewett Falls Dam is regulated by releases from the Lake Tillery Dam but also receives flow from several tributaries including the Rocky River and the Little River In order to determine the movements of triploid grass carp in a partially regulated river, Commission staff deployed ten VR-2 acoustic receivers in the section between the two dams, and two receivers below Blewett Falls Dam to monitor for escapement Triploid grass carp (n =24) were implanted with sonic tags that allowed one year of operational battery life and released in June of 2014 at the Red Hill Boating Access Area approximately 20 km downstream of the Lake Tillery Dam Movement data was captured by the acoustic receivers from the stocking date until June 1, 2015 No grass carp were detected below the Blewett Falls Dam even though there were at least 68 days during the study period where water spilled over the dam increasing the potential for downstream movement However, only three fish passed the upstream receivers where the majority of the hydrilla in this system occurred These three fish moved back downstream within 48 hours after their upstream migration Only seven fish were detected after two weeks post-stocking suggesting that either short-term mortality was high and / or that there were not enough receivers present to document these fish in all portions of the study area

### **Are We Learning While Doing? Addressing Persistent Uncertainties in Ecosystem Responses to Modifications in River Discharge (Large Rivers)**

*William Pine III\*, University of Florida, billpine@uf.edu*

While intuitively “leaving a little water in the river for the fish” is appealing, in reality modifications in riverine flows can cause large changes in fish and invertebrate habitats, species composition, and species interactions As water resources become limited



understanding how aquatic organisms and ecosystems respond to specific types of water withdrawals and changes in river discharge characteristics are questions that fisheries managers will increasingly be tasked with assessing. I will present case histories from river basins in the western and eastern US that I have been working in that offer strongly contrasting frameworks for identifying and addressing key uncertainties in ecosystem responses to flow modifications. I feel that ecosystem responses to flow modifications in the southeastern US are highly uncertain and these uncertainties limit opportunities for informed decision making. To address this I think that modifications to river discharge characteristics should be viewed as large-scale experiments capable of providing information to inform critical policy decisions related to water allocation that have far reaching ecological, economic, and sociological implications.

### **A Photogrammetric Method for in Situ Estimation of Body Length and Total Length of Benthic Fishes** (Fisheries Techniques)

*Austin Rizzo\*, West Virginia University, aarizzo@mixwvuedu, Stuart Welsh, USGS, WV Cooperative Fish and Wildlife Research Unit and Patricia Thompson, West Virginia University*

Length measurements are an integral part of age/length data used for fish population studies. For those species that are rare, threatened, or endangered, using a nonintrusive method to obtain measurements may be imperative in allowing for continued study of the organism. We used measurements from photographs, ie, photogrammetric techniques, to obtain length measurements of the federally-listed Diamond Darter. We also evaluated the photogrammetric technique on two surrogate darter species, where total length (TL) and body length (BL) were obtained from direct and photogrammetric measurements. For photogrammetry, digital photographs from the dorsal view of each individual were taken using a waterproof camera paired with two parallel lasers. Photogrammetric measurements of TL and BL were conducted with ImageJ software. Agreement between direct and photogrammetric measurements was examined with concordance correlation coefficients (CCCs). Precision and accuracy of measurements were evaluated using Pearson's correlation coefficient and the bias correction factor, respectively. The CCCs for TL and BL were similarly high for both surrogate species, indicating that the photogrammetric technique is an effective method for measuring benthic darter species.

### **Scarce As Hen's Teeth: Abundance Estimation of an Imperiled Appalachian Minnow** (Fisheries Techniques)

*Michael Moore\*, Virginia Tech and Don Orth, Virginia Tech*

Clinch Dace (*Chrosomus* sp cf *saylori*), a newly discovered species of minnow, are listed as a Tier 1 species of conservation concern in Virginia. Estimates of Clinch Dace abundance and

density are needed to prioritize populations for specific conservation action I generated estimates of population extent based 206 site visits from four independent fish surveys within the Clinch Dace's putative range since 2007 I used Royle-Nichols occupancy models to test hypotheses on factors that influence Clinch Dace abundance while accounting for spatial autocorrelation among sites Next, I used mark-recapture techniques to estimate densities in five occupied streams A linear regression model generated from these data allowed me to transform all single-pass electrofishing data into population estimates for Clinch Dace in occupied streams where single pass electrofishing has occurred Estimates of total census and genetic population size were combined for an estimate of total abundance in Virginia Clinch Dace occur at low densities in 312 km out of the approximately 351 km of 2<sup>nd</sup> and 3<sup>rd</sup> order streams in Russell and Tazewell Counties in Virginia Individual population census size estimates ranged from 11 to 1699 individuals Estimates of combined census population size for 10 of 16 populations was just 6,046 adult individuals Clinch Dace populations are small, isolated, and likely lacking in genetic diversity No estimates of population trends are available, but these first estimates can provide a start Swift conservation action is needed to protect most Clinch Dace populations in Virginia

### **A Multi-Scale Web-Based Fish Habitat Decision Support Tool (Fish Management 2)**

*Jason Clingerman\*, Downstream Strategies Inc, jclingerman@downstreamstrategies.com, J Todd Petty, West Virginia University, Fritz Boettner, Downstream Strategies Inc, Michael P Strager, West Virginia University and Frank Orr, Critigen*

The technological advancements of the 21st century have revolutionized environmental science and now more than ever, planners and decision makers have access to an enormous breadth and depth of revelatory data Pair this reality with the ever present climate of limited funding and resources, and the task of maximizing the ecological “bang for your buck” of each aquatic habitat project can seem impossibly daunting We believe that it should be easier to implement wise management and to that end we constructed an approach that synthesizes complex, peer-reviewed science into an intuitive, map-based process designed to underpin the enterprise of putting science to work The Fish Habitat Decision Support Tool (FHDST) is the first implementation of this framework

The FHDST platform provides resource managers and the general public access to data, models, and prioritization tools within several fish habitat assessments across the Great Plains, Midwest, and Atlantic Coast The mapping and analysis capabilities are akin to a lightweight GIS, but are useable within any web browser Datasets central to any decision making effort are included, such as landscape variables (both natural and anthropogenic), socioeconomic information, and predictive model results Model results, which vary geographically, describe natural habitat quality, biological stress, and predicted habitat condition for distinct aquatic endpoints These data can be explored at several scales through thematic mapping, but also with two custom analytical methods: ranking and futuring

Ranking catchments by multiple variables puts in the hands of a planner the ability to tease out complex differences within a HUC8 watershed such as which portions of a study area are likely to contain a species, but are also subject to high stress. Futuring takes this analysis even further by modeling the local and downstream effects of improvements to or loss of habitat. Together, data visualization, ranking, and futuring form the spine of a methodological framework for coordinated natural resource planning that can result in informed decision making and sustainable leveraging of finite resources.

### **Relative Abundance, Age, and Growth of Red Snapper: A Comparison Between Artificial and Natural Habitats in the Western Gulf of Mexico (Fish Management 2)**

*Matthew K Streich\*, Texas A&M University-Corpus Christi, matthewstreich@tamuccedu, Matthew J Ajemian, Texas A&M University - Corpus Christi, Jennifer J Wetz, Texas A&M University-Corpus Christi and Gregory W Stunz, Texas A&M University - Corpus Christi*

Artificial reef creation is a popular management tool commonly used to enhance fish populations and create additional recreational opportunities. Despite the popularity of these programs, the effects of this new structured habitat on fish populations is not fully understood. Specifically, few fisheries-independent surveys have examined the ecological performance of fish inhabiting man-made reefs. Furthermore, few studies have compared performance of artificial habitats with nearby natural habitats. The goal of our study was to evaluate relative abundance, age structure, and growth of Red Snapper among three different habitat types (standing oil and gas platforms, artificial reefs, and natural banks) in the western Gulf of Mexico. From May 2013 - January 2015, we conducted 140 vertical line sets and captured 1538 Red Snapper ranging in size from 251 to 855 mm TL. Ages determined for 801 of these fish ranged from 2-30 years. No differences were detected in Red Snapper CPUE among the three habitats. However, a comparison of TL and TW distributions suggested that natural banks supported a greater proportion of large fish than artificial reefs or standing platforms (K-S test,  $p < 0.001$ ). Mean TW-at-age regressions for the most common age groups (ages 4-7) suggested that Red Snapper grew faster at artificial reefs and standing platforms than natural bank habitats (ANCOVA,  $p < 0.05$ ). Mean age was positively correlated with capture depth ( $r = 0.73$ ) suggesting spatial variation in age composition. These results have important implications for artificial reef development and Red Snapper management in the GOM. Further use of standardized, fishery-independent surveys and additional biological data will aid in understanding the role artificial structures play in maintaining the Red Snapper population.

### **Using Population Models to Evaluate Management Alternatives for Gulf-Strain Striped Bass (Fish Management 2)**

*Alex Aspinwall\*, Auburn University*

## Using Population Models to Evaluate Management Alternatives for Gulf-Strain Striped Bass

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Interstate management of Gulf-strain Striped Bass (*Morone saxatilis*) has involved a thirty-year cooperative effort involving Federal and State agencies in Georgia, Florida and Alabama (Gulf Striped Bass Technical Committee) The Committee has recently focused on developing an adaptive framework for conserving and restoring Gulf striped bass in the Apalachicola, Chattahoochee, Flint River (ACF) system To evaluate the consequences and tradeoffs among management activities, population models are being constructed to inform management decisions We constructed a stochastic matrix model with varying recruitment and stocking rates to simulate effects of management alternatives on Gulf Striped bass population objectives We used an age-classified matrix model that incorporated stock fecundity estimates and survival estimates to project population growth rate In addition, we evaluated how combinations of management alternatives (Harvest regulations, Stocking rates, *Hydrilla* control) influenced population growth rate Annual survival and mortality rates were estimated from catch curve analysis and fecundity was estimated and predicted using regression analysis of fish length versus egg number from hatchery brood fish data Stocking rates and stocked-fish survival rates were estimated from census data Results of the model will be used to update data provided by the Committee for informing decisions related to selection of management alternatives In addition, the results can be applied to other populations of Striped Bass in the Gulf Region

## **Riverine Habitat Conservation Planning By the Gulf Coastal Plains and Ozarks LCC (Fish Management 2)**

*Mary Davis\*, Southeast Aquatic Resources Partnership, Todd Jones-Farrand, US Fish and Wildlife Service and Jessica Graham, Southeast Aquatic Resources Partnership*

The Gulf Coastal Plains and Ozarks Landscape Conservation Cooperative (GCPO LCC) is assessing the condition of their riverine habitats as part of their regional conservation planning process The objective of this project was to revise the proposed riverine species and landscape endpoints for the conservation plan The endpoints are based on representative species of the major river habitats in the region Population endpoints for each species will provide the conservation targets for assessing the success of conservation actions Landscape endpoints identify the watershed and reach-level conditions necessary to meet the population targets To obtain these endpoints, fish assemblage data from state agencies were used to refine a river classification and identify the extent of habitats occupied by the representative

species in the region. A multiscale habitat suitability index model was then developed to help identify the landscape and reach scale conditions required for each representative species. The conditions identified for each species were compiled into the landscape endpoints for each major river habitat. These ecological conditions will be used to specify the desired ecological condition, assess the current condition of riverine habitats, and prioritize areas for conservation action. The challenge in applying the species and landscape endpoints to conservation planning will be the availability of the appropriate regional data. Information gaps and recommended steps for the GCPO LCC will be discussed.

### **Response to Harmful Algae Blooms at USACE Reservoirs Located in the Upper Ohio River Basin (Fish Management 2)**

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The borders of the US Army Corps of Engineers, Pittsburgh District (District) are defined by the Upper Ohio River Basin. There are 16 reservoirs and 23 navigation projects in the District which are authorized for the statutory purposes of flood control, low-flow augmentation, water quality, water supply, navigation, fish & wildlife protection, and recreation.

The District's water quality mission is authorized by project specific congressional language, Executive Orders, and Federal laws, which direct the operation and management of District reservoirs to improve water quality. More than 88% of the summer storage in these reservoirs is exclusively dedicated to water quality, 8,000 lineal miles of stream in the upper Ohio River Basin are controlled by reservoir operations, and 1,0325 miles of 21 different major streams are directly influenced by reservoir releases. Activities that impact regional water resources therefore impact Corps' resources and projects and the benefits they provide. To assure optimum operation of projects for authorized purposes, the District has been monitoring water quality in the Basin since the mid 1970's.

The District is responsible for managing the land, water, and natural resource at their facilities and also the health and safety of those who visit them. While summer season blue-green algae (BGA) blooms have occurred regularly at some projects since they were constructed, harmful blue-green algae blooms (HABs) have only been documented since 2012. BGA are naturally occurring in fresh water ecosystems, but when produced in high numbers they can produce toxins that can adversely affect humans and other animals with exposure. In response, the District implemented a HAB Plan to reduce human health risk associated with exposure to BGA at projects located in states that do not have HAB response protocol.

A summary of the District HAB Plan and its effectiveness, a comparison of historical nutrient and algae data for projects that have and have not had reported HABs, and recommendations

to better understand and possibly reduce the frequency and/or intensity of HABs at projects will be presented

### **The Decline of a Fluvial Fish: Species Distribution Models in a Fragmented Riverscape** (Fish Management 2)

*Andrew T Taylor\*, Oklahoma State University and James M Long, US Geological Survey*

The diverse fluvial fish fauna of the southeastern US faces increasing imperilment, yet contributing factors are often poorly understood or confounded. The fluvial-specialist Shoal Bass (*Micropterus cataractae*) has experienced continual declines within its narrow native range, and fragmentation may drive localized range loss. Our objective was to identify landscape and riverscape factors contributing to recent range losses of the Shoal Bass. We developed presence-only species distribution models (SDMs) in Maxent reflecting two distributions: 1) the potential distribution based on natural landscape factors and, 2) the currently restricted distribution based on natural landscape factors as well as presence of non-native congeners, land use, and three different intensities of riverscape fragmentation. SDMs had strong predictive performance, as receiver operating characteristic (ROC) area under the curve (AUC) values averaged 0.87–0.94 and 10-fold cross-validation omission rates averaged 0.01–0.03. Results revealed that Shoal Bass potentially occurred throughout most of the larger streams within their native range; however, current restricted SDMs indicated 14%–36% range loss from the potential distribution based on stream segment lengths, with range loss increasing with fragmentation intensity. Also as fragmentation intensity increased, the response curves relating presence of non-native congeners to presence of Shoal Bass went from a 1:1 linear trend to a curvilinear response indicating negative effects to presence of Shoal Bass at non-native congener probability of presence  $\geq 0.75$ . Variable contributions suggested that variables like presence of non-native congeners, percent forest cover within 300 m stream buffer, and free-flowing fragment length were important in estimating the restricted range of the Shoal Bass; thus, response curves of these variables should help guide future Shoal Bass conservation efforts. Applying similar SDM approaches for other imperiled fluvial fishes should facilitate large-scale predictive conservation planning.