PRESENTATION ABSTRACTS

Southern Division American Fisheries Society
Annual Meeting

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Intercontinental Hotel
San Juan, Puerto Rico

Hosted by the

Puerto Rico Chapter of the American Fisheries Society

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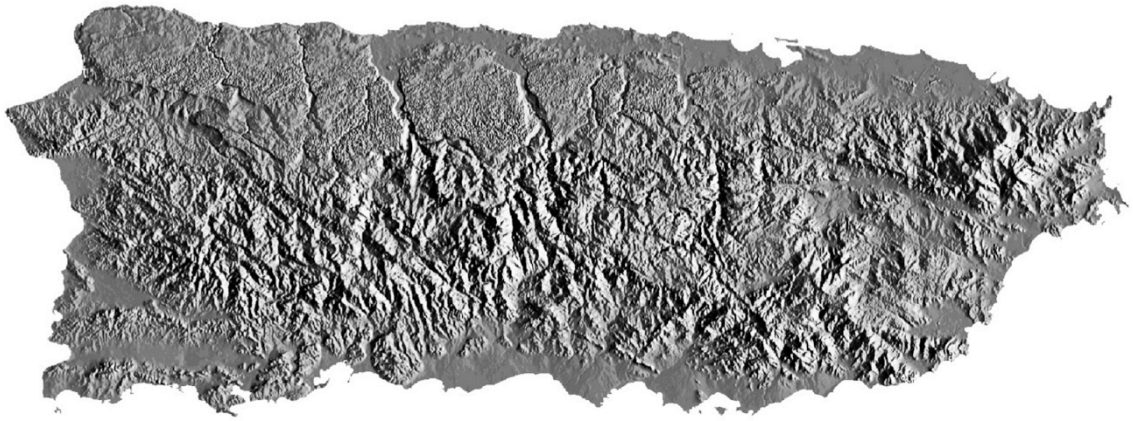
Note from the Meeting Team

It is our pleasure to provide you with the abstracts of the posters and oral presentations presented at the *2018 Southern Division American Fisheries Society Annual Meeting*. The abstracts are presented in the following order:

Please search this document by author, affiliation, or words in the title or text of an abstract.

Thank you to all the presenters who contributed to the success of this gathering by sharing their knowledge, expertise, accomplishments, and science with others.



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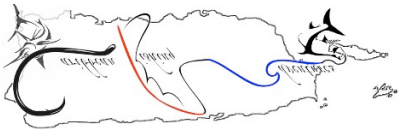

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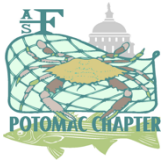

Victor Oliver, Artist

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Symposium Oral Presentation Abstracts

Assessment of Fish Habitat Associations in the Trinity River-Livingston Reservoir Ecosystem, Texas (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Michael Homer Jr, Texas Parks and Wildlife Department, michaelhomer@tpwd.texas.gov, Paul Fleming, Texas Parks and Wildlife Department, Sarah Robertson, Texas Parks and Wildlife Department and Archis Grubh, Texas Parks and Wildlife Department*

Rivers and reservoirs are physically connected, yet fisheries managers have traditionally focused on managing resources in these systems as separate biological entities Identification of appropriate scale for management requires identifying the spatial and temporal distribution of fishes to determine if fish assemblages are dependent on macrohabitat (eg, river, reservoir, or their interface) and/or microhabitats within them We describe similarity of fish assemblages among three large aquatic macrohabitats in Texas: the Livingston Reservoir, the Trinity River upstream of the reservoir, and the intervening river-reservoir interface (RRI) In addition, we quantified site-specific microhabitat characteristics to determine if fish assemblages were structured by localized habitat To account for large-scale geomorphological differences within each macrohabitat, they were stratified into five sampling zones: reservoir main lake, reservoir cove, RRI backwater, RRI main-channel, and river main-channel We collected a total of 815 individual samples from 86 randomly selected 100-m electrofishing transects Habitat features were also surveyed and quantified at each transects by using side-scan sonar Non-metric multidimensional scaling of the total data set (all 815 samples) displayed considerable variability among individual samples at all transects Variability in species composition and abundance at the microhabitat-scale generated incomplete separation between reservoir, river, and RRI macrohabitats in multivariate plots However, when samples for each transect were aggregated, there was complete separation between reservoir, river and RRI macrohabitats, indicating that the fish assemblages were clearly dissimilar By contrast, habitat quantification derived from side-scan sonar imagery, did not segregate by macrohabitat as was observed in the fish data While the fish assemblages in our samples were clearly dissimilar, site-specific habitat data failed to be a good predictor of that dissimilarity Among these macrohabitats, water flow regime was a logical factor for both structuring habitat and likely either attracting or repelling various fish species with flow-specific life-history adaptations Future iterations of this analysis will incorporate elements of the flow regime and concurrent water quality measurements We believe the addition of these elements may help to identify interactions between habitat and flow and provide additional contrast for segregation of microhabitats within the larger macrohabitats The results of this work will aid in determining relevant spatial scales for management activities and in identifying which species are likely to benefit

RWF 8 **On the Migration of the Freshwater Goby Post - Larvae, Sicydium Plumieri, in a Caribbean River** (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Ambar Torres Molinari, University of Puerto Rico, Rio Piedras Campus, Jorge Ortiz Zayas, University of Puerto Rico, Rio Piedras Campus and Omar Perez Reyes, University of Puerto Rico, Rio Piedras Campus*

Gobies are worldwide contributors to the overall diversity of freshwater and marine ecosystems, but their presence has been of particular interest in tropical streams However, the biology and behavior of numerous gobiid species, such as *Sicydium plumieri*, are only starting to be documented *S plumieri* inhabits the pools and eddies of tropical streams at high altitudes, where they spawn year round The larvae drift to

river mouths and spend a lunar month in the ocean Later, as post-larvae, they locate a source of freshwater and initiate an upstream migration through estuaries Locally known as cetí, the post-larvae are fished and popularly consumed as a delicacy in Puerto Rico Presumably, these migrations occur during the wet season, 1 to 2 days after the last quarter moon, and are triggered by high tides, lunar phases, and episodes of heavy rain Apart from these, other unknown physical and chemical water quality conditions may influence the migration of *S plumieri* Here we document migration of *S plumieri* and the physical -chemical conditions present in the Mameyes River, in Northeastern Puerto Rico Particularly, we measured salinity, dissolved oxygen, discharge, tidal elevation, temperature, and pH over a period of 4 days, before and during the last quarter moon phase of December 2017 and over a period of 6 hours on a migration event in January 2018 In addition, migrating post-larvae were counted and their length measured The data obtained in this study can contribute to river ecosystem management, the support of sustainable fishing practices, and, therefore, preserve this economic resource and prevent depletion of this species

Preliminary Biotic Data from Puerto Rico Streams Prior to Dam Removal and Modification (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Sean Locke, University of Puerto Rico at Mayagüez*

Like many oceanic islands, the freshwater fish fauna of Puerto Rico comprises a small number of diadromous species adapted to lotic habitats These fishes rely on connections between marine and fresh waters to complete their life cycles, and local fisheries also depend on their unimpeded migration between these habitats The freshwater reaches of the major streams of Puerto Rico are inhabited by ten native species belonging to two orders and four families Currently, the access of native fishes to a substantial extent of the island's riverine habitat is impeded by hundreds of dams constructed for storing irrigation or drinking water Upstream reaches, particularly lentic habitats, are dominated by ≈20 non-native fishes, some of which are intentionally stocked for sport fisheries In 2015, local and federal regulators identified reestablishment of river connectivity as a priority for the conservation of native freshwater species The main methods of re-establishing connectivity are removing dams or equipping them with biological passages Two pilot projects were identified as proof-of-concept for further potential riverine connectivity work across the island: First, removal of a low-head dam ≈2 km upstream from the mouth of the Río Grande de Arecibo, and second, the repair or replacement of a fishway at a dam ≈3 km upstream from the mouth of the Río Culebrinas In this talk I will present preliminary data gathered prior to planned restoration activities at pilot and control sites

Fish Assemblages and Fisheries Resources in Puerto Rico's Riverine Estuaries (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Augustin C Engman, North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University, Thomas J Kwak, US Geological Survey, Jesse R Fischer, North Carolina Cooperative Fish and Wildlife Research Unit, North Carolina State University and Craig G Lilyestrom, Puerto Rico Department of Natural and Environmental Resources*

Tropical estuaries are diverse and productive environments with respect to their habitats, fish assemblages, and associated fisheries However, these ecosystems and the valuable fishes that they harbor are imperiled by multiple anthropogenic threats Despite the economic, social, and biodiversity value of tropical estuarine fish assemblages, they are poorly understood, especially on Caribbean islands where only one description of the fish assemblage of a single riverine estuary in Puerto Rico has been published in the primary literature We sampled the fish assemblages of four estuaries, which are broadly

representative of riverine estuaries in Puerto Rico, using a combination of passive (gill nets) and active (beach seine) gears In each estuary, we sampled at locations that spanned the salinity gradient, during both rainy and dry seasons We applied nonmetric multidimensional scaling (NMDS) and Pearson's rank-correlation analyses to characterize fish species composition and describe spatial and temporal variation of fish assemblage structure within and between estuaries Fish species richness among riverine estuaries varied from 18 to 29, and assemblage structure varied among rivers, but not by season or location within an estuary We identified common and widespread species and documented spatial variability in estuarine fish assemblage structure, including the abundance of recreationally valuable species such as Tarpon *Megalops atlanticus* and Common Snook *Centropomus undecimalis* Our results may benefit conservation and fisheries management efforts in lower river reaches and estuaries throughout the Caribbean, because they quantify typical fish assemblage structure and fisheries resources, identify drivers of variability, and provide insight into the distribution of natural resources in riverine estuaries

Ecological Impacts of Inter-Basin Water Transfers: Implications to Environmental Flows and River Passage for Aquatic Organisms Under Future Climate Scenarios in Puerto Rico (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Brent Murry, US Fish & Wildlife Service, Carla Restrepo, University of Puerto Rico, Beth Middleton, USGS, Jared Bowden, University of North Carolina Chapel Hill, Adam Terando, USGS and Miguel Garcia Bermudez, FWS Caribbean Landscape Conservation Cooperative*

Inter-basin water transfers are common throughout the world and are an effective means of moving critical water resources from water-abundant to water-deficient areas to support growing human populations There is a wealth of information on policies and politics of inter-basin water transfers, yet relatively little information is available concerning the ecological effects of such water transfers In Puerto Rico there are several projects that transfer water across basins to support agricultural, industrial, and residential uses One such transfer moves water from a heavily forested rural area receiving high precipitation to the San Juan metro area Here we ask what the thresholds of water withdrawal and addition before ecological impacts occur to the watersheds under current conditions and future climate scenarios We have identified several impacts that interrupt the natural flow regimes of groundwater and surface flows with potential significant effects Impacts include changes in the distribution and extent of riparian, depressional, and coastal wetlands; changes in the distribution of biodiversity, including native, endemic, and exotic species, along river and wetland gradients; interruption of life histories of migratory aquatic life, depletion or augmentation of coastal sediments, changes in nutrient, chemical, and microbiological variables; and changes in the flood regime Impacts are expected to worsen under projected climate scenarios, particularly if human demands for freshwater increase A multi-disciplinary team is needed to establish and update watershed water budgets across the island, establish protective environmental flows policies that account for multiple ecological objectives, and evaluate a suite of potential human populations and land use change scenarios to develop sustainable water management policies under future climate scenarios These estimates will be critical to manage the potentially divisive competition over human and ecological water needs

Reconnecting Illinois Waterways: Review of Dam Removal Projects and Benefits to Fish and River Ecosystems (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Stephen Pescitelli, Illinois Department of Natural Resources*

Dams have had severe negative impacts on aquatic ecosystems, and are a primary factor in the loss of fish and mussel species diversity in North America In Northeastern Illinois, dams have been shown to cause reduced diversity and productivity of fishes, mussels and other macroinvertebrates within the dam impoundments Dams have also blocked re-colonization of fish species lost due to droughts, floods, and past water problems, a prevalent occurrence in the highly populated area around Chicago To date, a total of 30 dam projects have been completed in Northeastern Illinois, including 27 removals and three fish passage structures A detailed review of five removal projects will be discussed, including a description of the project and evaluation of fish community response following dam removal Fish typically moved in rapidly following dam removal with an average three-fold increase in species richness in the former dam pool area, compared to pre-removal conditions Mean total abundance was six times higher in the former pool following dam removal Index of Biotic Integrity increased by 40% and was dependent on the overall quality of the stream system We also documented re-colonization of fish species in the stream segments upstream of the dam pools, including re-establishment of tributary spawning runs by riverine suckers and other fish species; in one case, two weeks after dam removal No effects in the areas downstream of the dams were observed Although we have documented the use of passage structures by a number of fish species, they were less effective than dam removal and degraded conditions within the dam pool remained unchanged All three fish passage projects have also experienced serious maintenance problems

Looking Beyond the River: Conserving Water through Innovative Agricultural Practices (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Jessica Graham, Southeast Aquatic Resources Partnership and Vance Crain, SARP - Southeast Aquatic Resources Partnership*

The Southeast Aquatic Resources Partnership (SARP) has been working across the Southeast US to conserve aquatic habitats and the species that depend on them SARP works with partners to conserve aquatic resources through watershed based planning and actions This requires us to look beyond the stream to identify the source of the problem as well as opportunities to collaborate on practices that ultimately improve our rivers and streams In the Southeast, over 95% of the land is privately owned with over half of that area in some sort of agricultural industry SARP's partners have thus focused collaborative opportunities on private land and primarily agricultural land Some of the Best Management Practices (BMPs) are no surprising to many biologists such as cattle exclusion fencing, alternative water sources, riparian buffer restoration While other BMPs are not as well known or understood such as sod-based rotation, variable rate irrigation, and center pivot retrofits Applying these practices together can lead to a 30-50% reductions in water use, reduction in erodibility of soil, and up to a 50% reduction in the amount of nutrients applied to a single field These reductions have profound implications for nearby waterways as well as shallow aquifer systems This presentation will highlight current and future work by SARP's partners to implement upland BMPs that benefit our rivers and streams

RWF 9 **Overview of the USFWS US Caribbean Fish and Aquatic Conservation Program** (Restoring Water Flows-Riparian Connectivity in Action for Fisheries Conservation)

Alexandra Galindo, US Fish and Wildlife Service, alexandra_galindo@fws.gov and Ivan Llerandi Román, US Fish and Wildlife Service*

The US Caribbean freshwater ecosystems face many anthropogenic threats severely degrading the condition of aquatic ecosystems and their resources In order to avoid the degradation of these ecosystems and address the aquatic issues in Puerto Rico and US Virgin Islands, the US Caribbean Fish and Aquatic Conservation program (FAC) was formally established in 2016 The US Caribbean FAC program focuses

its efforts on actions leading to the conservation, restoration and enhancement of aquatic habitats in coordination with several partners The program's initiatives are mainly intended to benefit focal native species by augmenting the species abundance, the amount of habitat available, maintaining stable populations and habitat suitability On-going efforts to minimize threats to aquatic ecosystems include the removal of physical barriers (eg dams), replacement and/or modification of culverts and other stream crossing structures, construction of fish ladders, rehabilitation of stream banks, development of conservation strategies for high priority species to maintain stable populations, control of invasive species, and public outreach to educate the people in the importance of aquatic resources and our conservation mission So far, the Caribbean Ecological Services Field Office (CESFO) have developed three aquatic restoration projects aiming to address aquatic needs in focal watersheds of Puerto Rico in collaboration with the Service's Coastal Program and Science Application division, the Caribbean Landscape Conservation Cooperative (CLCC), and other partners The projects focus on improving river connectivity for the benefit of native aquatic fauna as well as public health and safety The program is essential for the development of management strategies specifically to improve the decision making process regarding aquatic habitat conservation

Ecological Response to Implemented Environmental Flow Standards in Texas (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Jeremy D Maikoetter, Texas State University, Cody A Craig, Texas State University, David Ruppel, Texas State University and Timothy H Bonner, Texas State University*

Validating environmental flow standards is necessary to ensure that standards are adequate as intended in maintaining stream communities and to enable changes to the standards Purpose of this study is to validate instream flow standards implemented on the Brazos, Guadalupe, and San Antonio Rivers utilizing fish and macroinvertebrate communities While seasonal flow standards consisting of small and large flow pulses had little to no effect on existing communities, a large catastrophic flood across central Texas during the study period provided a unique opportunity to study fish and macroinvertebrate responses to a high flow event Fishes and macroinvertebrates were classified into flow and habitat guilds for analysis, and the communities from fourteen sites across the three river basins were compared across implemented flow tiers (eg, subsistence, base, 1 per season, 1 per year), pre-flood and post-flood Sites were grouped into similar reaches based on geography Riffle and run habitats were sampled for swift water specialists and diet (gut fullness) and condition factor (HSI) was investigated Riffle habitats were sampled for macroinvertebrates Fish communities showed a shift toward the historical fluvial fish community and a decrease in the more tolerant slack water species in the lower Brazos River basin The middle Brazos, upper Guadalupe, and San Antonio basins showed minimal to no changes in density and slack water fish relative abundance, while swift water fish abundance increased Macroinvertebrates within upper reaches of the Guadalupe and San Antonio river basins remained similar in density and composition, while the middle Brazos and lower Guadalupe and San Antonio river basins showed changes in density and macroinvertebrate community structure Our findings suggest that environmental flow standards might need to be more regionalized (eg, by basin, stream order) and the ecological value of small to high flow events in maintaining community is not well understood

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Water Levels and Flow Patterns That Benefit Growth and Recruitment of Lotic and Lentic Fishes
(Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

John Dattilo, Oklahoma Cooperative Fish and Wildlife Research Unit, Oklahoma State University and Shannon Brewer, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit*

Reservoir construction for human-use services alters connected riverine flow patterns and influences fish production We sampled two pelagic fishes, Freshwater Drum *Aplodinotus grunniens* and Gizzard Shad *Dorosoma cepedianu*, from two rivers and two reservoirs and related seasonal and annual hydrology patterns to the recruitment and growth of each species River and reservoir populations of Freshwater Drum reached similar ages (32 and 31, respectively) Likewise, longevity of Gizzard Shad between the two systems was also similar (7 and 8 years, respectively) However, both species grew larger in the rivers compared to reservoir residents Recruitment of Freshwater Drum in reservoirs was negatively related to water retention time suggesting moving water through the reservoir was beneficial Riverine recruitment of Freshwater Drum populations was negatively related to the annual number of flow reversals and positively related to prespawn discharge Unlike Freshwater Drum, there was no relationship between flow metrics and Gizzard Shad recruitment in reservoirs However, recruitment of riverine Gizzard Shad was positively related to high flow pulses during the prespawn and spawning seasons The growth of both species in reservoirs was positively related to the number of days each year that water levels were above the conservation pool Growth of Freshwater Drum was also negatively related to minimum reservoir summer water levels Growth of both Freshwater Drum and Gizzard Shad occupying lotic systems was positively related to May and July discharge, respectively In general, growth and recruitment of the reservoir populations was related more to annual water patterns, whereas riverine fishes responded more to seasonal flow patterns This information is useful if agencies are interested in developing holistic river-reservoir water-allocation plans

Effects of Hydrology on the Population Trajectory of Blue Suckers Cycleptus Elongatus (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Joseph Dyer, Oklahoma State University and Shannon Brewer, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit*

Blue Sucker (*Cycleptus elongatus*) is one of several big river obligate species of concern in North America, and are likely susceptible to altered flow regimes In this study, we used empirical estimates of population parameters to develop an age-structured model of the Blue Sucker population below a hydropower dam in the Red River, Oklahoma We estimated mortality, age at maturity, and potential fecundity of the Blue Sucker population from Blue Suckers captured in the Red River We used acoustic telemetry data from the study area to explore the effects of hydrology on spawning migration and simulate the effects of drought on the population We did not have data to inform egg or age-0 survival, so we estimated these values using parameter optimization and sensitivity analysis We simulated the population trajectory with different values for probability of age-1 recruitment and spawning probability of 05, and accepted the parameter values that most closely resembled the recruitment variability (RCD) observed in our catch-curve model We then projected the abundance of Blue Suckers over time and calculated discrete population growth (λ) When probability of age-1 recruitment was 01 – 016, the simulated RCD matched the observed RCD and the Blue Sucker population slowly declined (λ = 095) Analyses of hydrology data indicated that Blue Sucker were unlikely to undergo spawning migrations when flows were below the 80th percentile of stream flow Given this information, we tested the potential effects of prolonged low-flow periods on a stationary population (λ = 1) Our model indicated that the population was declining and drought had the potential to exacerbate these conditions The migratory ability of Blue Suckers may allow for immigration and could potentially mitigate population declines, provided adequate stream connectivity

Effects of Hydrologic Variation on Dynamics of Channel Catfish Populations below R L Harris Dam on the Tallapoosa River, Alabama (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

M Clint Lloyd, Alabama Cooperative Fish and Wildlife Research Unit, Quan Lai, Alabama Cooperative Fish and Wildlife Research Unit, Steve Sammons, Auburn University, Peter Sakaris, Georgia Gwinnett College and Elise Irwin, US Geological Survey*

Anthropogenic alteration in flow regimes below hydropeaking dams are often considered one of the most serious and continuing threats to aquatic biodiversity in streams and rivers R L Harris Dam on the Piedmont region of the Tallapoosa River has been operating since 1983; flows from the dam have been managed adaptively for multiple stakeholder objectives since 2005 One of the stakeholder's primary objectives is to provide quality sport fisheries in the Tallapoosa River in the managed area below the dam Historically, Ictalurids and Cyprinids dominated the fish community in the river above Lake Martin However, investigations after Harris Dam closed have detected a shift in community structure to domination by Centrarchids Flow management (termed the Green Plan) has been occurring since March 2005; however, sport fish populations as measured by recruitment of age-0 sport fishes below the dam has not responded adequately to flow management In this study, we investigated Channel Catfish *Ictalurus punctatus* age and growth before and after implementation of the Green Plan to determine if changes in flow regime had any effects on Channel Catfish growth Additionally, vital rates and hydrological variables were used in age-based population models to determine age-specific parameters and environmental factors contributing to Channel Catfish population stability Management options for

persistence of stable or increasing Channel Catfish populations below the dam will likely be related to further modification of flow and thermal regimes

Long-Term Adaptive Management of Flows below a Hydropeaking Dam (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Elise Irwin, US Geological Survey, eirwin@usgs.gov, Mary C Freeman, USGS Patuxent Wildlife Research Center, James T Peterson, USGS Oregon Cooperative Fish and Wildlife Research Unit, Clint Lloyd, Alabama Cooperative Fish and Wildlife Research Unit, Kristie Ouellette, Alabama Cooperative Fish and Wildlife Research Unit and Katie Kennedy, The Nature Conservancy*

Freshwater resources are a basic need of society and ecosystems Because the management of water is multi-objective for diverse users, conflicts are inevitable when environmental concerns are pitted against economic interests Adaptive management and decision analysis can account for multiple competing objectives identified by stakeholders and these frameworks are applicable to water issues Recently there has been a call for large-scale flow manipulations in rivers to facilitate rapid learning so that theoretical frameworks can be transferred into knowledge of system function Adaptive management is an iterative process that facilitates learning by making predictions relative to system uncertainty (decision support or other models), applying the scientific process to monitor effects of management actions that are applied to optimize resource objectives, and updating the knowledge base (relative to predicted responses) to improve future management This paper describes the implementation and long-term application of adaptive management in a regulated river in the southeastern US The implementation process included significant stakeholder involvement, development of flow prescriptions, predictions regarding system response and design and implementation of a long-term monitoring program We present the decision framework used to assist stakeholders in prescribing initial flow manipulations and twelve years of model updates from the monitoring program which indicate that uncertainty remains regarding optimal management strategies In addition, metapopulation responses of fishes and community structure of macroinvertebrates were also monitored and related back to degree of river regulation and thermal regime alteration The long-term data analysis to determine if biological objectives were met indicate that monitoring future responses to additional management scenarios are warranted The adaptive management project will provide inference for proposed future management as the stakeholders this year enter into a Federal Energy Regulatory Commission process to relicense the dam

Macroinvertebrate Response to Flow and Temperature in Regulated and Unregulated Reaches of a Hydropeaking River (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Kristie Ouellette, Alabama Cooperative Fish and Wildlife Research Unit, kmo0025@auburn.edu, M Clint Lloyd, Alabama Cooperative Fish and Wildlife Research Unit and Elise Irwin, US Geological Survey*

Dams and other barriers to the natural flow regimes are well known to cause changes in hydrologic conditions of downstream river reaches Hydropeaking is a method commonly utilized by hydroelectric dams to generate electricity during peak demand However, these sudden releases, often from hypolimnetic zones of the reservoir, can cause dual waves of sheer stress and thermal stress that can alter faunal communities immediately downstream of the reservoir Furthermore, active control of flow conditions reduces flow extremes but increases the frequency of pulse disturbances, reducing potential community variability downstream of the reservoir RL Harris Dam is a hydropeaking facility located in the upper-central Tallapoosa River Basin that has been subject to an adaptive flow management project

(RL Harris Adaptive Management Program, or AMP) since 2005 Our objective is to provide reliable estimations of the impacts of changes in flow and temperature on downstream macroinvertebrate communities The goal is to identify macroinvertebrate taxa or functional trait groups which can be utilized to predict community response to flow management from Harris Dam Macroinvertebrates were collected in spring and fall seasons since the inception of the AMP Fall samples from the 2005 (normal), 2008 (drought), 2009 (wet), 2012 (drought), and 2014 (normal) years were analyzed to determine the macroinvertebrate community response to extremes in natural hydrologic variation in regulated and unregulated reaches in the river basin Macroinvertebrate community composition in the river displays clear differences between regulation type throughout all years, with less variation in community composition in the regulated versus the unregulated reaches Furthermore, regulated and unregulated communities appear to be most similar during years with more extreme hydrologic conditions, especially flood conditions These data will be used to inform best practices for management of the flows from Harris Dam

US Stream Classification System to Support Fisheries Habitat Protection and Restoration (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Ryan A McManamay, Oak Ridge National Laboratory, mcmanamayra@ornl.gov and Christopher DeRolph, Oak Ridge National Laboratory*

The US Stream Classification is an effort to organize the nation's 26 million stream reaches into groups of similar physical properties Stream environments, their physical properties, and the biological communities they support are dynamic systems whose structure and function are determined by a number of processes operating at local to basin-level scales Adequately protecting streams and understanding their responses to disturbance is challenging because these systems are complex and diverse Part of the challenge arises because a framework for generalizing stream behavior does not currently exist Without such a framework, every stream is viewed as unique and appropriate management and mitigation actions are handled on an individual basis By organizing stream environments into different physical typologies, we are providing a template to understand and generalize stream responses to disturbance and assist in determining best mitigation, restoration, and conservation practices The Stream Classification is made up of five essential layers: 1) Hydrology, 2) Size, 3) Gradient, 4) Temperature, and 5) Valley Confinement We provide a case study on how the Stream Classification could be used to inform management

Local Colonization and Extinction of Red River Stream Fishes in Relation to Groundwater Contribution (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Robert Mollenhauer, Oklahoma State University, Shannon Brewer, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Derek Ryter, USGS and Desiree Moore, Oklahoma State University*

Groundwater contributions to streamflow are essential to aquatic biota for a variety of reasons including nutrient cycling, productivity, and thermal refuge Groundwater also sustains base flow conditions during drought, which is critical for the local persistence of stream fishes Flow regimes have been severely altered due to changes in precipitation patterns and groundwater pumping, and both intermittent and prolonged drying of stream channels is increasingly common Thus, identifying relationships between species occurrence and groundwater and streamflow metrics is essential for establishing minimum flow requirements to support stream fish persistence We compiled stream fish sampling data for 148 stream

segments in the North Fork Red River of southwest Oklahoma from 1984-2016 We delineated five seasons based on wet (1984-2001, 2007-2009, and 2015-2016) and dry periods (2002-2006 and 2010-2014) We modeled local colonization and extinction probability in relation to flow variables, while accounting for imperfect detection, for six diminutive cyprinid fishes native to the study area: Chub Shiner *Notropis potteri*, Emerald Shiner *Notropis atherinoides*, Plains Minnow *Hybognathus placitus*, Red River Shiner *Notropis bairdi*, Sand Shiner *Notropis stramineus*, and Suckermouth Minnow *Phenacobius mirabilis* Flow variables, including groundwater and surface flow metrics, water depth, and hydraulic gradient, were derived using a simulation model developed for the North Fork Red River aquifer The proportion of stream segments occupied declined over time for all stream fishes; however, species-specific trends were variable and both extinction and colonization of stream segments were often associated with wet or dry periods Not surprisingly, local species extinction probability was related to decreased groundwater flow and water depth Local species colonization was associated with stream segments that had relatively higher surface and groundwater flow during dry periods, which suggests that these areas may not provide optimal fish habitat, but are essential for species persistence during dry periods Our resulting colonization-extinction model can predict changes in stream fish assemblages and identify potential species of conservation concern under different groundwater pumping and climate-change scenarios

Using Dynamic Multistate Models to Examine Effects of Streamflow Variability on Changes in Fish Abundance (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Kit Wheeler, University of Georgia, kitwheeler@gmail.com, Mary C Freeman, USGS Patuxent Wildlife Research Center, Seth Wenger, University of Georgia and Stephen J Walsh, US Geological Survey*

Streams in the southeastern United States, and elsewhere, will undoubtedly continue to experience altered temporal and spatial patterns of streamflow in response to changing climatic conditions and water resource allocation As a result, managers are likely to find dynamic flow-ecology relationships that evaluate changes in ecological states over time and in response to hydrologic variability especially valuable Here, we describe a dynamic multistate modeling approach that examines transition probabilities among different population abundance states (undetected, present, abundant) through time as a function of intervening flow conditions, while also accounting for incomplete detection We illustrate our approach by applying it to a seven-year dataset of streamfish counts from multiple taxa at 40 tributary sites dispersed among six sub-watersheds throughout the Apalachicola-Chattahoochee-Flint River Basin Preliminary results suggest that transition probabilities are indeed related to median flow magnitude between sampling occasions Fishes are more likely to colonize (ie, transition from undetected to either present or abundant) or, if already present, to transition from present to abundant, during periods with higher median flows Conversely, fishes are less likely to decline in abundance or become locally extinct (ie, transition from either present or abundant states to undetected, or from abundant to present) when median flows are higher Given the general flexibility of these models, along with their capacity to predict biotic responses to specific streamflow sequences produced by alternative scenarios, we argue that the application of dynamic multistate models to environmental flow issues could benefit both conservation and management of freshwater taxa

Multi-Disciplinary Instream Flow Regime Recommendations for the Lower San Antonio River, Texas (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

Kevin Mayes, Texas Parks and Wildlife Department, kevinmayes@tpwdtexas.gov, Gordon Linam, Texas Parks and Wildlife Department, Clint Robertson, Texas Parks and Wildlife Department, Sarah Robertson, Texas Parks and Wildlife Department, Mark Wentzel, Texas Water Development Board and Nolan Raphelt, Texas Water Development Board*

Instream flow assessments have evolved over the last five decades from a single minimum flow to defining ecological flow regimes representing a significant shift in the technical and philosophical basis of protecting aquatic ecosystems In a study of the lower San Antonio River, the Texas Instream Flow Program used multi-disciplinary assessments to identify instream flow regime recommendations for subsistence flows, base flows, high flow pulses and overbanking flows to support aquatic biota, such as fish and freshwater mussels, and riparian systems These recommendations specifically incorporate inter- and intra-annual flow variability We also explore flow regime scenarios and their implications on sediment transport dynamics to maintain channel structure and instream habitat

Uncertainty and Certainty in Mississippi's Instream Flow Program (Advancing environmental flows: novel findings, challenges to conventional thinking, and embracing uncertainty)

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This presentation deals with the uncertainty and certainty faced by state agency fisheries biologists in response to the question "How much water do you need for fish and wildlife?" The state water permitting agency desired to change the state law which specified only one instream flow method, $7Q_{10}$ Since these fisheries biologists began not knowing anything about instream flow methods, they faced massive uncertainty The state agency was also unsure what role it had for setting instream flows A pressing opportunity to provide recommendations for new instream flow standards existed but there was uncertainty on what methods to specify to provide protective flow levels for fisheries habitat This talk will cover how the biologists reacted to the uncertainties that situation presented The valid and invalid uses of the flow statistic, $7Q_{10,}$ will be discussed as well as its misuse as an instream flow standard Flows at $7Q_{10}$ will be compared to those in a natural hydrograph The effects of $7Q_{10}$ on fish populations and their habitats will be explored Options for responding to uncertainty and situations when you do not have the resources for data collection will be discussed In this case, uncertainty lead to consultation, reliance on the literature, involvement in an interagency organization - the Instream Flow Council - and flexibility in the revised law The advantages of the revised law and how it was applied years later will be provided

Industrialization and Issues of Global Contamination (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

Teresa Mathews, Oak Ridge National Laboratory, mathewstj@ornl.gov*

Continued population growth and economic development are expected to put increasing demands on energy and infrastructures, with significant changes projected in our nation’s energy portfolio and urban expansion in the coming decades Because the energy and industrial sector is responsible for over half of all water use in the country, these changes have the potential to directly and significantly affect fish health and fish populations by affecting factors such as flow, temperature, dissolved oxygen, and connectivity Likewise, other energy strategies (eg coal combustion, mining, bioenergy, and hydraulic fracturing etc) and industrialization can affect fish health by affecting water quality or through the mobilization of contaminants in freshwater and marine systems Furthermore, innovative strategies are needed to manage, conserve, and restore aquatic ecosystems and their fisheries in light of growing human demands In this kickoff presentation to the symposium, I will give an overview of key issues regarding the impacts of

industrialization and issues of global contamination to fisheries and will introduce the speakers on these topics

The Current and Future US Energy Profile and Implications for Fisheries (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

Ryan A McManamay, Oak Ridge National Laboratory, mcmanamayra@ornl.gov and Teresa Mathews, Oak Ridge National Laboratory*

Continued population growth and economic development are expected to put increasing demands on energy and infrastructures, with significant changes projected in our nation's energy portfolio and urban expansion in the coming decades These choices could also have significant impacts on our nation's water resources and fisheries Most all conventional and renewable energy technologies rely on water resources, either directly or indirectly, at some stage of development, operation, or production National and international policies aimed to reduce carbon emissions by fostering renewable development may not fully recognize or ignore localized impacts of water-resource technologies on aquatic ecosystems This presentation will provide a brief overview of energy-related impacts on fisheries We will examine the current and future energy portfolios and discuss potential implications on water availability and aquatic resources Much balance and multi-scale understanding is needed, however, in international-to-local policy choices, as over-reliance on some energy strategies is either infeasible or will create instabilities in meeting growing energy demands Ensuring scientists are well-informed of the future constraints in meeting energy demands and participate in discussions to foster the most sustainable future for our nation's fisheries

Landscape Factors Affecting the Distribution of a Federally-Threatened Great Plains Minnow (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

Shannon Brewer, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Thomas A Worthington, Oklahoma Cooperative Fish and Wildlife Research Unit, Oklahoma State University, Daniel Logue, OSU and Aaron Mittelstet, University of Nebraska*

Truncated distributions of pelagophilic fishes 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 Our study objective was to compare the predicted distributions of the federally-threatened Arkansas River Shiner *Notropis girardi*, constructed using different flow regime metrics We compared four hypotheses: mean annual flow (a baseline), the 75th percentile of daily flow, the number of zero-flow days, and the number of days above 55th percentile flows, to examine the relative importance of flows during the spawning period of a historic (1923-1989) and current (1990-2010) distribution Our spatial network consisted of 53,617 individual river segments in the Arkansas River Basin We ran MaxEnt using a samples-with-data approach Building on earlier SDMs, we added covariates that quantified wells in each catchment, point source discharges, and non-native species presence to a structured variable framework The 75th 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 This study presents water-management options that may be considered to improve the conservation status of pelagophils

Somatic Growth Dilution and Population Dynamics Effects on Methylmercury Bioaccumulation and Flux in an Industrialized Stream (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

Ryan A McManamay, Oak Ridge National Laboratory, mcmanamayra@ornl.gov, Teresa Mathews, Oak Ridge National Laboratory and Franklin Linam, Texas A&M University*

Mercury (Hg) is a widespread environmental pollutant released anthropogenically through industrial operations, energy production, mining, and nuclear weapons production Methylmercury (MeHg), the organic form of mercury, is a result of microbial reduction of inorganic Hg^{2+} and is a potent neurotoxin MeHg binds to organic carbon chains and efficiently bioaccumulates through the food web to toxic levels in consumers, including humans For these reasons, understanding the transport and fate of pollutant mercury is important The premise of the Somatic Growth Dilution (SGD) concept is that bioaccumulation of contaminants will become more dilute within an organism's body as it displays higher growth efficiency While multiple studies have substantiated the effects of SGD on reduced MeHg concentrations at the individual level, it is unknown how it interacts on the population level We tested the role of SGD in overall population dynamics and how it affects total MeHg standing stock and flux We used a biodynamic model to relate MeHg concentration in stonerollers (*Campostoma oligolepis*) to growth rate, assimilation efficiency, and elimination and uptake of MeHg at five sites in East Fork Poplar Creek (EFPC), a stream contaminated by Hg on the Oak Ridge Reservation We then developed models to analyze the effects of fish population density on per-capita growth rate, individual MeHg bioaccumulation, and MeHg standing stock for the entire population In congruence with the SGD concept, higher individual growth led to lower MeHg concentrations within specific reaches However, among reaches, higher MeHg concentrations were associated with higher per capita relative growth Our results also show that higher relative growth is related to a higher total MeHg flux through the system This is presumably due to lower densities associated with higher growth rates Our results will be used to develop management strategies to minimize MeHg accumulation and flux through the system by manipulating the size, density, and age of fish populations

Faunal Habitat Linkages for Alabama Barrier Island Restoration Assessment at Dauphin Island (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

M Clint Lloyd, Alabama Cooperative Fish and Wildlife Research Unit, Kristie Ouellette, Alabama Cooperative Fish and Wildlife Research Unit, Quan Lai, Alabama Cooperative Fish and Wildlife Research Unit and Elise Irwin, US Geological Survey*

Dauphin Island is a strategically significant barrier island along the northern Gulf of Mexico, serving as the only barrier island providing protection to much of the state of Alabama's coastal natural resources The island has sustained impacts from both storms and the recent Deepwater Horizon oil spill, warranting evaluation of restoration options This work will identify the most beneficial and effective restoration activities for Dauphin Island that, if implemented, would ensure long-term sustainability and resiliency of the state of Alabama's only barrier island, its habitats, the living coastal and marine resources it supports, as well as estuarine conditions in Mississippi Sound and the extensive coastal wetlands to the north We have identified multiple objectives associated with long-term sustainability and resiliency of Dauphin Island To evaluate the influence of restoration alternatives on conservation values we are developing a decision tool for the decision maker (Alabama Department of Conservation and Natural Resources) that will constitute a transparent assessment of the tradeoffs among the restoration strategies A fundamental

objective of this project is to maximize costal marine resources, particularly for the fauna that inhabit the island and the specific habitat types that these species utilize Team members worked together to elicit faunal expertise and developed a list of species that utilize Dauphin Island This list was used to estimate and rank general linkages of species to habitats The rankings were then used in nonmetric multi-dimensional scaling (NMDS) ordination to identify similarities among faunal species based on estimated habitat usage These habitat groupings will be used alongside geospatial models currently being developed to help quantify changes in habitat as a result of a suite of restoration alternatives Through conceptual and predictive ecological modeling, reducing uncertainty can ultimately illuminate how these restoration alternatives contribute to the long-term sustainability of Dauphin Island as a barrier island

Predictors of Fish Injury and Survival during Hydropower Turbine Entrainment at Dams (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

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Even dams lacking dedicated passage structures can be passable by fish in a downstream direction These downstream passed fish can be important to population dynamics in fragmented rivers In the case of hydropower dams, downstream turbine passage can also introduce a new and significant source of mortality to fish populations There is not currently a broad understanding of species-, life stage- and turbine-specific injury and survival rates of fishes passing through turbines In this study, we synthesized data from field studies of fish turbine passage to provide linkages between dam and turbine characteristics, turbine injuries, and survival Our analysis contained data on juvenile and adult life stages of 20 unique species, although juvenile salmonids comprised 81% of the total number of fish tested in turbines Like previous studies, we found that Francis turbines, the most commonly deployed hydropower turbine in the US, have the lowest associated fish survival We also found that injuries and relationships between injury and survival and factors related to survival varied by turbine type Turbine passage studies reported herein are largely from hydropower facilities sympatric with distributions of anadromous fishes Expanded efforts towards understanding the effects of turbine passage on juvenile and adult life stages of potamodromous and other freshwater fish are needed to better understand the effects of hydropower on aquatic resources

Whack a Fish! Laboratory Studies on Turbine Blade Strike to Inform Friendlier Turbine Design (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

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Injury and mortality of fish during downstream passage through hydropower turbines is a common impact of hydropower development on streams with migratory fish Strike injuries, which range from minor (eg, descaling or bruising) to severe (eg, organ damage or broken bones) can result in immediate or latent mortality and vary greatly among species due to differences in fish morphology To better understand the relationships among blade strike variables and fish injury/survival, we subjected four species (Rainbow Trout Oncorhynchus mykiss, Gizzard Shad *Dorosoma cepedianum*, Hybrid Striped Bass *Morone saxatilus X M chrysops*, and American Eel *Anguilla rostrate*) to simulated blade strike in laboratory studies in which we

could control the physical parameters of the blade and the precise strike location on the fish Experimental variables included different blade thicknesses, blade velocity, strike location, and fish orientation After simulated strike each fish was evaluated for 1-hr survival and then examined for external and internal injuries General findings included higher mortality with decreasing blade thickness and increasing blade speed Midsection hits were usually more damaging than head hits, and tail hits rarely caused injury Depending on the species, ventral and dorsal hits could cause more damage than lateral hits, and angled hits were either less damaging or more damaging depending on the proximity of the path of the blade to a fish's center of gravity and vital organs Results from this study will be used to define biologically-based design criteria that can be used by turbine manufacturers to improve turbine runner designs and project operations

Implications of Benthic Macroinvertebrate Community Structure on Mercury Bioaccumulation in Fish (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

Teresa Mathews, Oak Ridge National Laboratory, mathewstj@ornl.gov, Ryan McManamay, Oak Ridge National Laboratory, John Smith, Oak Ridge National Laboratory, Monica Poteat, Education and Training Systems International and Mark Peterson, Oak Ridge National Laboratory*

Mercury is a globally important contaminant which is of particular concern in stream systems Because the consumption of contaminated fish is the most significant source of mercury (Hg) exposure to humans, regulatory guidelines that focus on the protection of human health require monitoring of both aqueous and fish tissue Hg concentrations at contaminated sites However, because Hg is predominantly accumulated in fish via dietary rather than aqueous exposure, the link between aqueous Hg concentrations and concentrations in fish is not always straightforward, confounding remediation efforts at contaminated sites Benthic macroinvertebrates can often comprise a major portion of fish diets and can therefore be important in the trophic transfer of bioaccumulative contaminants like Hg to fish Benthic macroinvertebrate communities are commonly monitored in streams as an indicator of water quality, and while these community surveys do not provide direct information on Hg bioaccumulation, they can provide information relevant to understanding food web dynamics, and therefore Hg bioaccumulation, within a given system Here, we examined changes in the invertebrate community over 30 years at two sites in East Fork Poplar Creek, a Hg-contaminated stream in East Tennessee, to explain why Hg concentrations in resident fish have not decreased in response to remediation activities that have been successful in decreasing aqueous Hg concentrations We used the density and biomass of the major functional feeding groups in the invertebrate community, in conjunction with current efforts to quantify mercury inventories within the biota of this stream, to create a food web model to predict the most important factors leading to elevated Hg concentrations in fish Bioconcentration factors (BCFs) were calculated for macroinvertebrate functional feeding groups using Hg concentrations in macroinvertebrates relative to aqueous Hg concentrations from 2013-2016 The BCFs were then applied to historical aqueous Hg concentrations to back-calculate Hg concentrations in the macroinvertebrate community over time The diet of rock bass, the target fish species, was estimated at a given time period based on relative biomass and densities of macroinvertebrates at that time to calculate a weighted concentration for Hg trophic transfer to this species Our results suggest that observed increases in the benthic macroinvertebrate community species diversity over time (ie longer food chain lengths) could explain why Hg bioaccumulation in fish has not changed despite substantial reductions in Hg loading into this stream

Opportunities for Fish Conservation through Ferc Relicensing at the Toledo Bend Hydroelectric Project, Sabine River, Texas/Louisiana (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

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The Sabine River Authority of Texas and the Sabine River Authority, State of Louisiana, are joint licensees of the 81-megawatt Toledo Bend hydroelectric project on the Sabine River, Texas/Louisiana Toledo Bend Reservoir and Hydropower Project became operational in 1969 The project was originally licensed in 1963 and relicensed in August 29, 2014 Pre-licensing studies were designed to assess potential project impacts and protection, mitigation and enhancement measures for fish and wildlife A "large river" index of biotic integrity was developed for the lower Sabine River to assess fish communities while surveys of freshwater mussels revealed longitudinal patterns in assemblages Several license orders include provisions for fish and wildlife conservation as identified in settlement agreements involving state and federal agencies and the Authorities including a monthly flow release pattern rather than a constant minimum, warm water releases from the spillway, as well as weekend operations to moderate drops in river stage A Section 18 fishway prescription includes five years of testing ramp traps on both the tailrace and spillway to evaluate upstream movement of American Eel Results of fish and mussel assessments and ongoing eel ramp operations and monitoring will be highlighted

Delaware River of Texas: Research and Partnerships for Management of Arid Aquatic Communities in the Middle of an Oil and Gas Fracking Boom (Energy and Industrialization Impacts, Contamination, Management, and Restoration of Freshwater and Marine Ecosystems and Fisheries)

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Permian Basin of Texas and New Mexico is the second largest oil field in the world and contributes about 20% of the USA's total crude oil production Delaware Basin is one of two sub-basins within the Permian Basin and includes tributaries and a main stem reach of the Pecos River (Rio Grande drainage) Recent concerns about imperiled aquatic species within the Delaware Basin prompted a rapid assessment of aquatic species on private properties and development of a conservation plan to fund monitoring and safeguarding of aquatic habitats and species In return, oil companies received regulatory assurances from US Fish and Wildlife Service Purpose of this study is to describe the process, challenges, and successes of multiple stakeholders (landowners, oil companies, university and NGO researchers, state and federal agencies) working together under a truncated time frame to achieve and fund a conservation plan that was mutually-acceptable by industry and regulatory agencies

Sex-Specific Age and Growth Characteristics of Red Drum *(Sciaenops ocellatus)* in the North-Central Gulf of Mexico (Student Best Paper Symposium 1)

Corbin Bennetts, The University of Southern Mississippi, School of Ocean Science and Technology and Robert T Leaf, The University of Southern Mississippi, School of Ocean Science and Technology*

Quantitative descriptions of length-at-age of Red Drum *(Sciaenops ocellatus)* in the Gulf of Mexico generally use sex-combined data modeled with the von Bertalanffy growth function (VBGF), despite evidence of sexual dimorphism However, the VBGF performs relatively poorly when modeling growth when there is the presence of abrupt changes in growth dynamics Red Drum exhibit discontinuous patterns in growth likely as a result of the onset of maturity and ontogenetic movement to the pelagic environment The

objective of this work was to use sex-specific data to model length-at-age of Red Drum in the northern Gulf of Mexico Red Drum were collected in the northern Gulf of Mexico from September 2016 through October 2017 (n = 791) The sex-specific and sex-combined length-at-age relationships were modeled using otolith-derived age estimates, histological sex determinations, and seven candidate growth models Integer age estimates were adjusted by accounting for the time between catch date and the assumed birth date of October 1st The candidate growth models were evaluated using AIC, and were further assessed by sensitivity to starting parameter estimates, and overall biological interpretation Sex-specific differences were tested using an F-test and sex-specific parameter estimates were compared using confidence intervals for each model The best candidate model, as indicated by the lowest AIC, was an eight parameter model developed by Porch (2002) This model indicated the presence of significant differences in the male and female growth (F = 206, p < 005), with the females reaching a larger asymptotic length The other six growth functions had similar sex-specific patterns The logistic growth model had the second best fit to the data and had a more intuitive biological interpretation than did the Porch (2002) model This work will inform management and benefit future assessments by providing information on sex-specific growth dynamics of Red Drum in the north Gulf of Mexico

Using Side-Scan Sonar and N-Mixture Modeling to Estimate Atlantic Sturgeon Spawning Migration Abundance (Student Best Paper Symposium 1)

Josh Vine, Clemson University, Yoichiro Kanno, Colorado State University, Chad Holbrook, South Carolina Department of Natural Resources and Brandon Peoples, Clemson University*

Adult Atlantic sturgeon (*Acipenser oxyrinchus*) typically enter the upriver portion of the Savannah River system during summer months and exhibit various upstream migration patterns throughout the late Summer - Fall spawning season We sampled nine sites throughout the supposed spawning grounds in the uppermost undammed portion of the Savannah river near Augusta, GA through 84 occasions using the Hummingbird Helix 12 CHIRP-Mega-SI-GPS-G2N side scan sonar unit August 16–November 9, 2017 We analyzed sonar files to obtain sturgeon count data using Sonar-TRX software, and estimated spawning population abundance using N-mixture modeling We included fish greater than 12 meters in the population analysis, which can only represent Atlantic sturgeon No evidence of spawning occurred during our sampling period (eg visual observation of spawning or capturing of eggs) However, up to 36 sturgeon were detected on suspected spawning grounds during a single sampling occasion Single-season spawning population estimates provide insight as to how many individuals may contribute to the Fall Atlantic sturgeon spawning population each year, and can be a useful index of spawning stock size if monitored annually

Evaluation of Four Low-Frequency Electrofishing Pulse Rates for Collecting Blue Catfish Ictalurus Furcatus in the Arkansas River (Student Best Paper Symposium 1)

Charles Jordan, Fish and Wildlife Program, Arkansas Tech University, Anthony Fernando, Arkansas Game and Fish Commission and Joe Stoeckel, Fisheries and Wildlife Program, Arkansas Tech University*

Low-frequency electrofishing is an effective gear for collecting Blue Catfish *Ictalurus furcatus*, but the relative effectiveness of specific low-frequency pulse rates has not been fully evaluated Differences in total catch, catch rate, and length frequency distributions were tested among four pulse rates: 7, 10, 12, and 15 pulses per second (pps) We used a random block design in July 2017 on 19 wing dikes in Pool 9 of the Arkansas River All wing dikes were sampled once at each pulse rate with a rest period of four days between sample runs Duration of sample runs was 5 minutes and temperature ranged between 287 and 317C A total of 691 fish were collected, 12 pps had significantly higher total catch of N_{12}=247, and 7 pps

had significantly lower total catch of N_7=94 Seven pps had significantly lower catch rate than 10 and 12 pps No difference in catch rate was observed among other pulse rates Significantly fewer fish >300 mm were collected at 7 pps compared to all other pulse rates, but there was no difference among 10, 12, and 15 pps Our results indicate that sampling at 12 pps was the most efficient of the pulse rates tested Twelve pps should be used for sampling Blue Catfish when possible

Age and Growth of Hogfish (Lachnolaimus maximus) Off Southeast Florida (Student Best Paper Symposium 1)

Ian Towne, Nova Southeastern University, it86@nova.edu*

Hogfish (*Lachnolaimus maximus*) is an economically important, reef-associated species, which supports a moderate commercial and recreational fishery in the western Atlantic In recent years, *L maximus* has become of high interest to fisheries managers due to the overwhelming evidence of overfishing In areas of high fishing pressure for *L maximus*, such as the Florida Keys and inshore areas of the eastern Gulf of Mexico, overall growth rates decreased and mortality increased As a result, significant revisions to the management of *L maximus* were recently implemented (08/31/2017) and a ten-year stock recovery plan was initiated The primary objective of this study was to determine age and growth (via sagittal otoliths) of *L maximus* in southeast Florida, where a paucity of data exist, and make comparisons to previous findings from other geographic areas The secondary objective was to compare *L maximus* by reef tract in southeast Florida In this study, over 325 hogfish were collected from 2016-2017 and aged using otolith analysis The findings indicate that, despite the higher human population in Broward County, the observed growth rate was higher than the Florida Keys Significant separation at the 95% confidence level was found between all regions aside from the eastern Gulf and the Bahamas The average maximum fork length increased from the Florida Keys (336mm) to southeast Florida (414mm) Additionally, growth rates of *L maximus* collected from different depth reef tracts in southeast Florida showed significant differences In contrast with prior studies, the most accessible reef tract (ca 4-6m deep) had a significantly higher growth rate than the outermost reef (ca 15-25m deep) The maximum fork length decreased with reef depth (857mm, 420mm, 352mm) while the mean age (age 3, 4, 5), maximum age (age 9,10,12), and annual survival rate (42%, 65%, 73%) increased with reef depth This study demonstrates the importance of factoring sample location into determining growth rates of a species, as this may influence future fishery stock assessments and the development of new fishery regulations for *L maximus*

Status, Habitat, and Genetics of the Endemic Carolina Madtom (Student Best Paper Symposium 1)

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Nongame fishes contribute to diversity and important ecological functions in freshwater ecosystems However, many nongame species are imperiled, and their status and ecology are poorly understood One such species is the Carolina Madtom, *Noturus furiosus*, a small nongame catfish endemic to the Tar and Neuse river basins of North Carolina Systematic surveying of Carolina Madtom populations first began in 1962, and subsequent surveys in 1989 and 2007 have shown declining occurrence and abundance in the Neuse River basin, with stable populations in the Tar basin The 2007 survey showed a 92% occurrence decrease throughout historically inhabited sites in the Neuse River basin Habitat suitability analyses and comparative habitat surveys between river basins suggest that suitable instream physical habitat for

Carolina Madtom occupancy and reproduction is widely available in the Neuse basin As such, habitat limitation does not readily explain the decline in population numbers in these areas Alternative causes such as poor water quality or predation by nonnative species may be adversely affecting Neuse basin Carolina Madtom populations In 2016, we sampled 20, 150-m reaches in snorkel surveys of sites previously sampled in 2007 In 2017, we surveyed three to four, 30-m sites within 16, 4-km reaches for a total of 55 surveys In total, we collected 59 Carolina Madtoms during snorkel surveys in the Tar River basin, whereas no fish were collected from the Neuse River basin Analysis with the occupancy software PRESENCE estimated Carolina Madtom occupancy probability at 034, and detection probability was 081 Generalized Linear Modeling analyses of microhabitat covariates showed that mean column velocity (p = 003) was positively related to detection of Carolina Madtoms Artificial habitat units were constructed and deployed for 14-day periods at 8 sites in both the Tar and Neuse basins, and 26 Carolina Madtoms were collected in them in the Tar River basin, but none in the Neuse River basin, indicating the potential of artificial habitat units as an efficient sampling device Additionally, fin clips were taken from collected specimens, and combined with archived tissue samples from 2007 surveys, analysis of genetic differentiation among Tar and Neuse river basin populations is ongoing Findings from surveys and genetic analyses will be applied to inform future species protective listing decisions and potential population augmentation in the Neuse River basin

Testing for Hardy-Weinberg Equilibrium: Does It Do What It's Supposed to Do? (Best Student Paper Symposium 2)

Tyler Plum, West Virginia University, Tsplum@mixwvu.edu, Lauren Schumacher, West Virginia University, Darren Wood, West Virginia University, Tom Rounsville, West Virginia University and Amy Welsh, West Virginia University*

Under the assumptions of Hardy-Weinberg Equilibrium (HWE), it is expected that allele and genotype frequencies of a single breeding population are constant However, tests for HWE may not be sensitive to small temporal changes in allele or genotype frequencies in a population To determine if genetic differences exist between sampling years in a long-lived species, we collected lake sturgeon (*Acipenser fulvescens*) tissue samples from a single population over the course of several years (2001 (n=41), 2003 (n=14), 2008 (n=50), 2011 (n=50), and 2012 (n=50)) Following extraction of genomic DNA, 12 microsatellite loci were amplified and visualized using capillary electrophoresis Results of HWE exact tests show significant departures from HWE in 2001 (X^2=388, p=0028) and 2012 (X^2=386, p=0007) Significant changes in both allelic and genotypic frequencies were observed between 2001 and 2011 (allelic p=0000, genotypic p=0000), 2001 and 2012 (allelic p=0001, genotypic p=0003), and 2003 and 2011 (allelic p=0002, genotypic p=0003), after Bonferroni correction This study demonstrates that HWE tests can successfully detect significant yearly changes in allelic and genotypic frequencies This may signal the need for additional years of sampling data in order to understand departures from HWE in this population

Historical Occupancy Modeling of Non-Game Fishes in the Clinch River Watershed (Best Student Paper Symposium 2)

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The Clinch River watershed supports a highly diverse fish fauna with over 110 species occurring in the drainage (area = 115-thousand km^2) Many of these species are in decline and are federally listed as threatened or endangered Historical abundance estimates for these species are highly uncertain Our study

estimates the historical status of these species using occupancy modeling We used standardized backpack electrofishing data collected by the Tennessee Wildlife Resource Agency, US Geological Survey, Tennessee Valley Authority, and Virginia Department of Game and Inland Fisheries covering a 40-year period (1976-2016) Presence-absence data for 32 species of conservation concern were analyzed using the software Presence, which estimates occupancy rate (Ψ) and probability of detection (*p*) for each species Occupancy and detection probability estimates were highly variable for each species due to possible gear bias and the rarity of some species used in these analyses For example, the mean ± SE historical occupancy and detection of the Warpaint Shiner *Luxilus coccogenis* were 095 ± 003 and 094 ± 007, for the Gilt Darter *Percina evides*, occupancy was 067 ± 009 and detection was 081 ± 009, and for the Stonecat *Noturus flavus*, occupancy was 047 ± 030 and detection was 062 ± 033 These historical estimates suggest the need for continued monitoring efforts of these species, so that agencies can detect true changes in species status Continued monitoring efforts would provide evidence to determine if management decisions need to be made to preserve the highly diverse fish fauna in the Clinch River watershed

Impacts of Urbanization on Freshwater Fishes in the Upper Neuse Watershed (Best Student Paper Symposium 2)

Emilee Wooster, North Carolina State Unviersity, Craig Layman, North Carolina State University and Jesse Fischer, North Carolina State University*

Urbanization degrades ecosystems through a cascade of physical, biogeochemical, and biological modifications While previous research has identified the drivers and associated responses of terrestrial systems impacted by urban land development, there is still a gap in our understanding of the mechanisms driving the highly variable responses observed in aquatic systems Current projections predict a 139% increase in urban land cover by 2060, suggesting an urgency to understand how anthropogenic disturbances affect aquatic ecosystems and the mechanisms that drive those disturbances To address this issue, we documented the responses of fish communities and populations in 10 streams across an urban-forested environmental gradient within the Upper Neuse Watershed in North Carolina, which is expected to experience the greatest rate of urban land development in the US in the coming decades We sampled a 50-meter reach at each stream site, and designated streams as “urban” or “forested” by using 2011 National Land Cover Data to calculate the percent land cover within each delineated stream catchment Urban sites had a lower mean species richness, 7 fishes per stream (SD = 4), compared to 12 in forested sites (SD = 2) We documented a community shift from ecologically sensitive fish species in forested streams to ecologically tolerant species in urban streams Specifically, forested streams had high abundance of Cyprinids, such as bluehead chubs (*Nocomis leptocephalus*), whereas urban streams were characterized by high abundances of Centrarchids, such as green sunfish (*Lepomis cyanellus*) There was an overall trend of decreasing population densities of fish with increasing urban land cover Populations also showed differences in age structures, with ages ranging from 0 to 3 in forested and 0 to 6 in urban streams This trend is most likely due to decreased competition between individuals in urban streams and increased available resources from nutrient loading Overall, our results demonstrate the impacts of urbanization on freshwater fishes and are foundational to our future research Our future research will link these measured responses to specific watershed characteristics, which will be the first study to identify watershed-level traits driving ecosystem responses to disturbance Our work will provide valuable information to stream ecology and watershed management, including how urban watershed degradation affects fish assemblages and the watershed-level mechanisms by which these changes occur

Effects of Ultraviolet (UV) Radiation on Crude Oil Toxicity in the Estuarine Species, Cyprinodon Variegatus (Best Student Paper Symposium 2)

Kaitlin Aaby, National Oceanic and Atmospheric Administration (NOAA)*

In 2010, the Deepwater Horizon Spill released massive amounts of crude oil into the Gulf of Mexico Oil that is spilled into the ocean can travel to sensitive estuarine habitats Estuaries provide shelter and nutrition for reproductive and juvenile life stages of many recreationally and commercially important fish and shellfish species It is important to elucidate the effects of crude oil on the organisms within estuarine systems However, many studies do not include the variable of UV radiation in their testing, which is known to enhance the toxicity of oil Thus, we studied the UV-enhanced toxicity of crude oil on larval and juvenile life stages of the sheepshead minnow (*Cyprinodon variegatus*) using several exposure scenarios; 1) larval fish in high-energy water accommodated fractions (HEWAF), 2) larval and juvenile fish in larger tanks with a thin sheen of oil, and 3) larval fish with oil-contaminated sediment and clean overlying water Mortality thresholds (LC50 values) showed that UV increased oil toxicity to larval fish in the HEWAF treatments four fold No latent effects on mortality or growth were found in fish moved to clean water and no UV Increasing temperature increased HEWAF toxicity In fish exposed to thin oil sheens, there was no difference in mortality between the tanks exposed to UV versus regular lighting Oiled sediment exposure did not affect fish survival under either light condition Results of this study will provide new insight into the various ways in which UV radiation interactions with oil pollution can affect these estuarine fishes

Nesting Microhabitat Use of Bartram's Bass in the Upper Savannah River Basin (Best Student Paper Symposium 2)

Emily Judson, Clemson University, ejudson@clemson.edu, Yoichiro Kanno, Colorado State University and Brandon Peoples, Clemson University*

Bartram’s Bass (*Micropterus sp cf cataractae*) is an undescribed species of Shoal Bass endemic to the Savannah River basin of South Carolina and Georgia Bartram’s Bass populations are threatened by habitat alteration and hybridization with the invasive Alabama bass (*M henshalli*), which were introduced into several Savannah River impoundments in the 1980s Identifying the reproductive isolating mechanisms that have broken down to facilitate hybridization will be critical for conserving Bartram’s Bass In spring/summer 2017, snorkel surveys were performed in eight tributaries to the upper Savannah to quantify nesting microhabitat use of Bartram’s Bass Egg samples were collected for genetic analysis, and microhabitat parameters (depth, velocity, and substrate) were recorded at each of the 34 nests detected Habitat transects were used to quantify available habitat Average velocity of the 34 nests observed was 012m/s, and average available velocity in the transects was 023m/s (P=00184) Average depth of the nests was 075m, and average available depth was 080m (P=07736) Depth selection ranged from 05m to nearly 15m, where velocity was observed below 05m/s The preferred substrate was primarily silt (35%) and cobble (44%), with some nests composed of gravel (6%) and bedrock (15%), whereas the most available substrate observed was sand (18%), cobble (21%) and bedrock (21%) (P<00001) The preliminary results indicate that the nesting Bartram’s bass are selecting more for velocity than depth and substrate, and although there is a relationship between substrate use and availability, we believe the main factor driving substrate use is velocity Genetic analyses of eggs and individuals are underway to confirm species identity, hybrid presence, and the extent of hybridization throughout the range in the upper Savannah River basin

Poster Presentation Abstracts

BSP 1 **Assessing Culvert Use By Non-Game Fishes in Small Forested Piedmont Streams** (Best Student Poster Session)

Jacob Corbett, Clemson University, William Hobbie, Clemson University, Ricki Hughes, Clemson University, Joshua Smith, Clemson University, Seoghyun Kim, Clemson University, Patrick Hiesl, Paul Smith's College and Yoichiro Kanno, Colorado State University*

Culverts are commonly installed in managed forests to allow for passage of aquatic organisms at road crossings, but their effectiveness has not been thoroughly studied for non-game fishes In this study, passage by five non-game stream fish species was investigated at three culverts in two streams in the upper Piedmont region of South Carolina Culvert passage was monitored by PIT tag antenna systems for Bluehead chub (BHC, *Nocomis leptocephalus*), Creek chub (*Semotilus atromaculatus*), Mottled Sculpin (*Cottus bairdii*), Northern hogsucker (*Hypentelium nigricans*), and Striped jumprock (*Moxostoma rupiscartes*) Passage of fishes depended on culvert length, downstream drop height, water depth, and wetted width In general, culvert passage was highest by catostomids, followed by cyprinids and then by sculpin The result of generalized additive mixed models showed that water temperature was an important driver of movement for Bluehead Chub, Creek Chub, and Northern Hogsucker, whereas water level was related to the movement of Striped Jumprock Fish were more likely to pass at warmer temperature or higher flow conditions, indicating temporal variation in frequency of fish movement The results suggested that inappropriate culvert designs could have negative impact on movement of some fishes Culvert installment should consider ecological requirements of stream fishes to move and access spatially heterogeneous habitats in order to sustain aquatic biodiversity

BSP 2 **Evaluating Length Bias in Three-Pass Depletion Backpack Electrofishing** (Best Student Poster Session)

Elijah Lamb, Clemson University and David Bell, Clemson University*

Evaluating Length Bias in Three-Pass Depletion Backpack Electrofishing

By Elijah Lamb and David Bell

Three-pass depletion electrofishing is a common method used to collect fishes from wadeable streams While the number of individuals collected tends to decrease per pass, pass-specific length bias is less understood The focus of this investigation was to understand size biases for species collected in sequential backpack electrofishing passes with the prediction that total length would decrease with each successive pass We sampled four wadeable streams seasonally from September 2016 to November 2017 We used a Poisson generalized linear-mixed model (GLMM) with species and site as random intercepts to examine length bias among all species Next, we estimated effect sizes using GLMMs for each species and modeled them as a function of maximum total length and total abundance in the dataset Overall, total length decreased significantly with additional passes, and was significant for some, but not all species; these trends were not related to either maximum total length or abundance These results suggest that pass-related bias is species-specific Further analyses are underway on larger datasets

BSP 3 **Annual and Seasonal Patterns of Fish Body Growth in South Carolina Piedmont Streams** (Best Student Poster Session)

Daniel Jones, Clemson University, djj@clemson.edu, Alexander Michaeli, Clemson University, Ashley Padgett, Clemson University, Seoghyun Kim, Clemson University, Kasey Pregler, Clemson University and Yoichiro Kanno, Colorado State University*

Repeated observations of marked individuals allows for robust estimates of body growth rate in fishes Body size is a major factor affecting fish performance, and growth patterns of freshwater fish species can vary spatially, temporally, as well as within and among species Growth rates of Bluehead Chub (*Nocomis leptocephalus*), Striped Jumprock (*Moxostoma rupiscartes*), and Mottled Sculpin (*Cottus bairdii*) were assessed using a bi-monthly mark-recapture survey in two wadeable Piedmont streams of South Carolina from September 2015 to September 2017 A total of 6,852 unique individuals (> 60 mm total length) were collected using backpack electrofishing and were marked with 8-mm Passive Integrated Transponder tags Growth rates of Bluehead Chub differed between the two streams, which could be explained by temperature, stream size or fish density Growth rates of Bluehead Chub and Striped Jumprock were highest during summer months, but Mottled Sculpin grew most during fall-winter months Growth rates declined with increasing body size This study allowed for comparisons between spatial and temporal growth patterns in small-bodied stream fishes Life history information is generally lacking for non-game species, but may be needed for mechanistic understanding of global change effects on population dynamics and persistence

BSP 4 **Dietary Study on Bartram's Bass in Upper Savannah River Basin** (Best Student Poster Session)

Wesley Moore, Clemson University, wmoore6@gclemson.edu, Austin Rodgers, Clemson University, David Luke Bell, Clemson University, Alex Michaeli, Clemson University, Emily Judson, Clemson University and Brandon Peoples, Clemson University*

Bartram’s Bass (*Micropterus sp cf cataractae*) is an undescribed species of black bass that is endemic to the Savannah River Basin of South Carolina and Georgia Little is known about Bartram’s Bass feeding habits In spring/summer 2017, 589 individuals were collected from 53 sites We recorded length, weight, gut weight and diet content of each individual Individuals ranged from 31 mm to 433 mm in length 213 individuals were captured with empty stomachs Overall prey prevalence in the diet showed that 618% of the individuals consumed soft-bodied macroinvertebrates, 136% consumed crayfish, 18% consumed fish, and 55% consumed organic matter Analyzed by weight, diets consisted of 53% crayfish, 358% fish, 88% soft-bodied macroinvertebrates, and 14% organic matter As Bartram’s Bass grow, we found that their diet steadily shifts from benthivorous to piscivorous The transition to piscivory occurs in Bartram’s Bass individuals at 124 mm of growth Our results suggest that there is an ontogenetic shift that occurs as individuals grow, but that individuals will consume soft-bodied macroinvertebrates throughout life

BSP 5 **Age-Specific Diet and Habitat Trends of Red Drum *(Sciaenops ocellatus)* in the North-Central Gulf of Mexico As Reflected in the Stable Isotope Composition** (Best Student Poster Session)

Corbin Bennetts, The University of Southern Mississippi, School of Ocean Science and Technology, Kevin S Dillon, The University of Southern Mississippi, School of Ocean Science and Technology and Robert T Leaf, The University of Southern Mississippi, School of Ocean Science and Technology*

Red Drum *(Sciaenops ocellatus)* exhibit inshore to offshore movement during ontogeny, the timing of which is thought to coincide with reproductive status An improved understanding of the timing of emigration from estuaries to the coastal zone will provide managers with insight into the drivers and dynamics of ontogenetic movement, refine the currently highly variable age at maturity estimate for the species, and

allow assessment scientists to better understand the metapopulation dynamics of the stock In this study, we assess age-specific patterns in carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope composition of Red Drum collected in the north-central Gulf of Mexico from September 2016 through August 2017 (n = 169) Using a PERMANOVA analysis, we evaluated the bivariate response of carbon and nitrogen, using Bray-Curtis dissimilarities, evaluated for factors month of collection, maturity status (mature or immature), and age We found a significant effect for all three factors: month ($F_{4, 80}$ = 1063, p < 0001), maturity status ($F_{1, 80}$ = 2104, p < 0001), and age $F_{18, 80}$ = 271, p < 0001 Additionally, we detected a significant interaction effect between month and age $F_{14, 80}$ = 212, p < 0002 In simulation, we iteratively aggregated fish of known age into two groups In each iteration, group one consisted of fish age 1 to t, and group 2 consisted of fish age t+1 to t_{max} For each iteration, we performed a series of Levene's tests, to assess the equality of variance in carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope composition in each group We found that older fish exhibited reduced variance in their isotopic composition than did the youngest fish There was a significant difference in variance (p < 005) between groups when group one consisted of fish age 0 to 2 y (for $\delta^{13}C$) and age 0 to 3 y (for $\delta^{15}N$) This study provides insight on the timing of ontogenetic movement of Red Drum in the northern Gulf of Mexico which will inform metapopulation dynamics and assessment

BSP 6 **Effects of Temperature on the Catchability of Golden Tilefish (*Lopholatilus chamaeleonticeps*) in the South Atlantic** (Best Student Poster Session)

Connor Neill, University of Minnesota-Twin Cities, neill020@umn.edu and Genevieve Nesslage, University of Maryland Center for Environmental Science*

Golden tilefish are a demersal, stenothermic species that support a sizable fishery off the Southeast coast of the United States The current stock assessment model heavily relies upon fishery-dependent data over fishery-independent data, and does not incorporate environmental effects on catchability We analyzed longline survey data from the fishery-independent MARMAP (Marine Resources Monitoring Assessment and Prediction) program, catch data from the South Atlantic fishery, and publicly available climate data to determine the effects of a variety of environmental variables on catchability and abundance indices Our results suggest the presence of sex-varying catchability and time-varying catchability, neither of which is accounted for in the current assessment We also detected delayed declines in abundance indices following anomalously cold years, and identified a potential predictor of abundance in climate data describing the North Atlantic Oscillation These tentative findings require more data to verify, but suggest that survival of juvenile tilefish is affected by low temperatures and that existing climate data could be used to predict future stock abundance We recommend that future stock assessments for this species increase the weight of fishery-independent data relative to fishery-dependent data, and begin collecting sex-specific data to support stock assessments

BSP 7 **Reproductive Biology of Queen Triggerfish (Balistes vetula) in Puerto Rico** (Best Student Poster Session)

Jesús M Rivera-Hernández, University of Puerto Rico, Mayaguez Campus, Virginia Shervette, University of South Carolina Aiken, Noemi Peña, Puerto Rico Department of Natural and Environmental Resources and Richard S Appeldoorn, University of Puerto Rico, Mayaguez Campus*

Queen triggerfish *Balistes vetula* is an important food fish in the Caribbean Based on landings data (total pounds landed), queen triggerfish ranks in the top five most important reef fish fisheries species for the US Virgin Islands and in the top 10 for Puerto Rico A recent stock assessment for queen triggerfish in US Caribbean waters determined that due to data limitations (including the lack of current species-specific life history information) projections for future stock status could not be constructed The purpose of our

study is to provide this critical life history information for this fisheries species From 2013-2017, we collected and processed 564 queen triggerfish samples from fisheries-dependent and -independent sources ranging in size from 67-434 mm fork length (FL) from waters of Puerto Rico In St Croix, from 2016-2018, we collected 561 queen triggerfish ranging in size from 190-414 mm FL Size frequency analyses for both islands indicate that a greater proportion of males were in the larger size classes compared to females Using reproductive histology and based on the presence of spawning capable females in monthly collections, we determined that the spawning season begins as early as December and continues through August Sexual maturity was evident in females and males from Puerto Rico as small as 219 and 184 mm FL, respectively In St Croix, the smallest mature female and male samples were 230 and 196 mm FL Puerto Rico females became sexually mature at a larger size than males Female size at 50% sexual maturity (L_{50}) was 245 mm FL (95% Confidence interval of 237-251 mm FL) Male L_{50} was 206 mm FL (95% Confidence interval of 186-217 mm FL) St Croix females appeared to mature at a larger size with an L_{50} was 265 mm FL (95% Confidence interval of 256-272 mm FL) Differences in size-at-maturity may reflect differing levels of fishing pressure between islands

P 10 **Comparison of the Macroinvertebrates Communities in Areas Covered and Devoid of the Floating Fern Salvinia Spp in Boqueron Wildlife Refuge (BWR) at Cabo Rojo, Puerto Rico** (Poster Session)

Nahíra Arocho-Hernández, University of Puerto Rico, Mayagüez Campus, nahiraeah@gmail.com and Carlos Santos-Flores, University of Puerto Rico, Mayagüez Campus*

Mangrove forests are recognized as highly productive ecosystems; nevertheless, their ecological values, biota, and food webs are complex and yet to be understood Information on aquatic invertebrates in the mangroves of Puerto Rico is scarce and mostly outdated The Boquerón Wildlife Refuge (BWR), located in Boquerón, Cabo Rojo, is the largest mangrove forest stand in Puerto Rico's west coast Many of the mangrove channels in the BWR are invaded by thick mats of floating ferns (*Salvinia* spp) A monthly assessment of the aquatic macroinvertebrate diversity in three mangrove areas in the BWR invaded by *Salvinia* spp and three areas lacking these floating ferns was conducted from June to November of 2013 Salinity and pH were measured for each sampling Three sampling methods were used: aquatic light traps, Malaise traps, and D-net sweeps Whole samples were screened and the organisms sorted and identified A total of 21,305 invertebrates, in 20 orders and 81 families, were collected and identified The most abundant organisms were dipterans The groups with the greatest family richness were Diptera (21 families) and Coleoptera (12 families) The BWR showed a highly diverse ecosystem and the abundance of macroinvertebrates showed spatial and temporal variations There was no clear relationship between the pH, salinity and precipitation and the abundance of organisms probably because the water level of the refuge is controlled manually through dikes Mangrove areas with and without *Salvinia* behave as two distinctive habitats and shared only around half of their taxa (families) Each sampling method rendered a distinctive fauna This study will serve as a baseline characterization for future studies, for the biomonitoring and specific management programs for the preservation of its biodiversity

P 11 **Improving Field Training of Caribbean Fish Identification with Tablet Technology** (Poster Session)

Chelsea Harms-Tuohy, Isla Mar Research Expeditions, Evan Tuohy, University of Puerto Rico, Mayaguez and Juan J Cruz Motta, University of Puerto Rico at Mayaguez*

Marine ecology, as a field of experimental research, uses field methods that often require extensive training and proficiency to master Such skills include underwater visual census (UVC) to characterize fish

communities in marine systems, with a simultaneous application of reef fish identification (fish ID) In general, these two skills are taught independently, usually with fish ID driving the mastery of both techniques Novice surveyors will often spend the majority of their survey feverishly scribbling details of an unknown fish, rather than focusing on terms to associate with the common name Ultimately, this compromises the quantity and quality of data obtained during a survey, as more time is spent writing and quickly recording species rather than observing fish encountered during the transect In 2015, a tablet application was developed (with crowdfunding) that allows users to experience independent instruction in fish identification while underwater This app - Artedi - was developed with the ultimate goal to train scientists, marine resource managers and citizen scientists to collect data faster, more accurately and more efficiently Artedi bridges the gap between learning in the classroom and application in the field, providing users with a functional fish ID and reference tool for use underwater that simultaneously teaches UVC in a field setting Additionally, Artedi improves the data collection process with an electronic format (comma-separated values, csv) for recording and storing survey data The feedback received from initial testing indicated both the need and desire for this technology to be incorporated into training programs Furthermore, feedback from trained and untrained fish surveyors supports that Artedi has the potential to reduce the learning curve and training time required to learn fish ID However, this statement has yet to be quantitatively evaluated Thus, an experiment to test the effectiveness of the app vs traditional training is underway The experiment will consider training time and expertise of the user as predictor variables; and efficacy and efficiency as response variables In addition, the relative effectiveness and efficiency of the app will be compared to traditional training This experiment will be conducted in the La Parguera Natural Reserve starting Spring 2018 using student scientific divers from the Department of Marine Sciences of URPM

P 12 **Initial Impacts of a Hurricane on a Shallow-Water Coral Reef Fish Community in Puerto Rico** (Poster Session)

José Bonilla Traverso, University of South Carolina Aiken, Virginia Shervette, University of South Carolina Aiken and Jesús M Rivera-Hernández, University of Puerto Rico, Mayaguez Campus*

Coral reef ecosystems can be negatively impacted by a combination of human and natural disturbances The effects of overfishing, climate change, upland deforestation-caused sedimentation, disease, and hurricanes can combine in various ways to exacerbate the decline in coral reef ecosystem health On 20 September 2017, Hurricane Maria made landfall in Puerto Rico Prior to the hurricane, from July-August 2017, we conducted a series of visual fish abundance surveys at multiple, nearshore reef sites in northwestern Puerto Rico We returned to these sites and replicated the surveys from December 2017 – January 2018 Prior to the hurricane, we documented over 50 fish species with the following families represented by five or species: Blennidae, Haemulidae, Labridae (including parrotfish species), and Pomacentridae The nearshore reef sites sustained varying degrees of damage from Hurricane Maria Some areas lost major structures, which diminished the overall amount of three-dimensional complexity of an area Although fewer fish species were documented 2-3 months after Hurricane Maria, a few new species were sighted Of the more species-rich fish families, Haemulidae and Labridae had fewer species present in our post-hurricane surveys To truly understand the impact of Hurricane Maria on our sample areas, survey work should continue every 2-3 months for at least another year to gauge the resiliency of the reef fish community utilizing the nearshore reef systems

P 13 **Redband and Yellowtail Parrotfish Reproduction: Preliminary Findings** (Poster Session)

Virginia Shervette, University of South Carolina Aiken, Richard Appeldoorn, University of Puerto Rico at Mayaguez, John Hoenig, Virginia Institute of Marine Science, College of William & Mary, Richard Nemeth, University of the Virgin Islands, Noemi Peña, Puerto Rico Department of Natural and Environmental Resources and Jesús M Rivera-Hernández, University of Puerto Rico, Mayaguez Campus*

Parrotfishes have been utilized as food fish in US Caribbean waters for centuries Information from the 1970s in Puerto Rico and US Virgin Islands seem to indicate that parrotfish were not heavily targeted by commercial interests and were mainly considered lower quality food fish However, into the late 20th century, parrotfishes steadily gained in value and ultimately became a much more highly-valued species Similar to other commercial markets across the globe, as commercially targeted populations of grouper and snapper species declined, the demand for alternative species, including parrotfish increased Parrotfishes are ubiquitous members of the coral reef community in the Caribbean and play several significant roles in coral ecosystems In spite of a wealth of ecological studies and reviews concerning Caribbean and Atlantic parrotfish species, extremely little published information exists concerning basic life history parameters of each species, yet this information is essential for sustainable fisheries management Seven species of parrotfish contribute to the reef fish fisheries in the US Caribbean, and as part of a large reef fish maturity study, we are working to fill in data gaps on all seven of these parrotfish species Here we summarize our preliminary findings on two of these species: Yellowtail Parrotfish *Sparisoma rubripinne* and Redband Parrotfish *Sparisoma aurofrenatum* Yellowtail and Redband Parrotfish occur in the commercial catch for Puerto Rico and St Croix Yellowtail Parrotfish initial phase samples (n = 193) ranged in size from 109-371 mm total length (TL) and terminal phase samples (n = 21) ranged ifrom 263-370 mm TL Approximately 30% of initial phase yellowtail parrtofish were males, according to gonad histology Redband Parrotfish initial phase samples (n = 83) ranged in size from 155-255 mm TL and terminal phase samples (n = 278) ranged from 173-268 mm TL The majority (98%) of initial phase Redbands were female Preliminary analyses of monthly gonad histology data indicate that both species may spawn year-round in the US Caribbean

P 14 **22 Years of North Carolinian Fishing What's Been Trending? a Review of Temporal and Spatial Commercial Gear Usage** (Poster Session)

Amanda Tong, North Carolina Division of Marine Fisheries, amandatong@ncdenr.gov and Stephanie McInerny, North Carolina Division of Marine Fisheries*

North Carolina Trip Ticketing program has existed since 1994 and has collected a large historical set of data on commercial fishing activities In a twenty-two year period various trends can be analyzed When divulging into where recorded fishing activities primarily occurred during a trip, shifts in spatial usage over the time series can be seen Many factors can influence this usage but one of the more influential is the associated fishing gear used Fifty-five specific gears have been actively used in the North Carolina fishing community While only five of those gear types including crab pot, anchored gillnet, rake, by hand, or shrimp trawl were used on eighty-one percent of all recorded trips and were associated with over half of all landed whole pounds in the data set Focusing on these pivotal gear types display some interesting shifts in spatial usage over the entire statewide resource Such shifts like sound to river usage, Northern to Southern distribution, and complete degradation to localize absence can have large ramifications to management and regulations that maintain healthy North Carolina fisheries

P 15 **Does 25 Years Change a Tidal Freshwater Fishery? a Creel Comparison from the Nation's Largest Estuary** (Poster Session)

Joseph Love, Maryland Department of Natural Resources and Branson Williams, Maryland Department of Natural Resources*

The Department of Natural Resources examined recreational fishing (May through October) for the two largest tidal freshwater fisheries in the Chesapeake Bay watershed and compared those results to fishing characteristics in the early 1990's Such surveys are important because agencies strive to meet the demands of anglers who invest heavily into their fishing trips In the past 25 years fishing opportunities may have changed because of establishment of two invasive food fish species (Blue Catfish, *Ictalurus furcatus*; Northern Snakehead, *Channa argus*) and widespread promotion of catch-and-release fishing for sport fishes such as Largemouth Bass (*Micropterus salmoides*) We conducted 335 interviews spread across 17 access points in tidal freshwater of Potomac River (n = 8) and the upper Chesapeake Bay (n = 9) Fishing effort on Potomac River in 2017 (13,541 angler-hours) was at least 20-times less than that reported in 1990 and 1994; in contrast, fishing effort in upper Chesapeake Bay in 2017 (23,301 angler-hours) was similar to that measured in 1987 (20,878 angler-hours) Of those targeting a species, recreational fishers spent their time targeting Largemouth Bass (386%) and catfish (234%) These top ranks are similar to those 25 years ago, but catch rates are now at least twice as high The proportion of harvested fish has not noticeably changed since the early 1990's Relatively few anglers sought or harvested Northern Snakehead, which constituted a small fishery; however, our survey did not account for night archery that is very popular for snakehead harvesting Total number of harvested catfish has not changed noticeably, but harvest rates of catfish have soared on Potomac River from 003 fish/ang-hr to 037 fish/ang-hr Harvest rates have changed little in the upper Chesapeake Bay (010 fish/ang-hr to 018 fish/ang-hr) where Blue Catfish have only recently invaded Taken together with the decline in fishing effort on Potomac River, our results suggest that the invasion of Blue Catfish has contributed to increases in harvest rates of catfish, but not total harvest because of lower fishing effort (ie, shorter fishing trips and/or fewer fishers) Fishing opportunities in the two largest tidal freshwater areas of the Chesapeake Bay watershed appear to have changed moderately in 25 years, providing a new but small harvest fishery for Northern Snakehead, greater ability to catch the top two targeted species by recreational fishers, and much lower fishing effort on Potomac River

P 16 **Assessing the Age, Growth, and Survival of the Invasive Mayan Cichlid in the Everglades Ecosystem, Florida: A Course-Embedded Research Approach** (Poster Session)

Peter Sakaris, Georgia Gwinnett College, psakaris@ggc.edu and John Galvez, US Fish and Wildlife Service*

A course-embedded undergraduate research experience (CURE) was incorporated in the curriculum of Ichthyology at Georgia Gwinnett College (GGC) in Fall 2017 Students were directed to investigate the age, growth, and survival of the invasive Mayan Cichlid, *Cichlasoma urophthalmus*, in the Everglades Ecosystem, Florida The Mayan Cichlid was first documented in Everglades National Park in January 1983, and has become well-established and continues to expand its nonnative range throughout South Florida In Summer 2017, the US Fish and Wildlife Service collected 43 Mayan Cichlids from three canals in South Florida (C-111, L-28 Interceptor, and Hillsborough canals), and fish samples were subsequently delivered to the laboratory at the School of Science and Technology at GGC Ichthyology students weighed (g) and measured (mm TL) all Mayan Cichlids, and extracted sagittal otoliths from each fish Students were trained in fish gender identification, otolith processing, and age estimation procedures Mayan Cichlids ranged from 160 to 299 mm TL, and the sex ratio was strongly skewed towards females in the population (255:1 ratio, chi-square = 741, P = 0006) A strong relationship was detected between weight and length of fish, with females weighing heavier than males, although a larger sample size is needed to verify this assessment Ages of Mayan cichlids ranged from one to 7 years, with an age structure consisting of strong year classes from 2011 to 2015 Age-1 fish were difficult to collect during high water; therefore, reliable assessment of the 2016 year class was not possible Mean lengths of fish at age were 215, 243, 216, 260, and 269 mm at ages 2, 3, 4, 5, and 6 In addition, a sexual dimorphism in growth was discovered, with males attaining greater lengths at age than females Mayan cichlids exhibited a high survival rate (72%) from ages 2 to 7 Future research should analyze a larger sample of Mayan cichlids to corroborate these findings We hope that this information assists biologists in the management of this invasive species, and in their efforts to minimize the negative effects of the Mayan cichlid on native fauna

Finally, this study demonstrated the effectiveness of integrating CURE's in the lab experience of an upper-level Biology course

P 17 **American Eel: Utilizing Modern Techniques to Assess Conservation Status in Texas** (Poster Session)

Melissa Casarez, The University of Texas at Austin, Stephen Curtis, Texas Parks and Wildlife Department, Dean Hendrickson, The University of Texas at Austin, Adam Cohen, The University of Texas at Austin, Kevin Mayes, Texas Parks and Wildlife Department, kevinmayes@tpwd.texas.gov, Gary Garrett, The University of Texas at Austin and Douglas Martin, The University of Texas at Austin*

The American Eel, *Anguilla rostrata*, is a remarkable fish that makes epic migrations throughout its complex life history, which begins in the Sargasso Sea, goes far inland in rivers of North and Central America and the Caribbean, then back to the Sargasso Populations in US and Canadian drainages have been well-studied for years, with events such as the arrival of early life stage "glass" and "elver" eels coming into coastal basins well known and predictable However, relatively little is known about those that make their way into Gulf of Mexico and Caribbean drainages Additionally, there is debate as to the species' conservation status, with listings among agencies ranging from 'Threatened' or 'Endangered' to no listing at all Especially in Texas, there is a critical need for data to many unanswered questions about the species' historical and current distribution, genetics, parasites, age structure, habitat utilization, etc to help guide establishment of effective management and conservation strategies To help answer some of these questions, we are conducting basic sampling and genetic and life history studies, organizing a state-wide citizen-science effort to help collect specimens of all ages and sizes, and reaching out to fish enthusiasts (fisherman and scientists alike) to help better understand these astounding fishes

P 18 **Occurrence of Atlantic Sturgeon in the New York Wind Energy Area** (Poster Session)

Evan Ingram, Stony Brook University, Michael G Frisk, Stony Brook University and Keith Dunton, Monmouth University*

Offshore wind energy endeavors are increasingly being considered as sources of clean and renewable power generation The New York Wind Energy Area (NYWEA) off the coast of New York and New Jersey was recently leased for commercial wind-energy development in 2017 and comprises important marine habitat that may be used by federally protected Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) and other commercially and ecologically significant finfish species The timing and extent to which these species use the NYWEA is unknown; however, scientific and commercial fisheries data suggest these species spend significant time in the area In particular, Atlantic sturgeon are known to make seasonal migrations along the eastern seaboard of the United States and will often form marine aggregations comprised of individuals of mixed genetic origin--two known aggregation areas that occur in the New York Bight off of Sandy Hook, New Jersey, and Rockaway, New York, are located in close proximity to the NYWEA Individual Atlantic sturgeon have also been observed as commercial fisheries by-catch in the NYWEA; however, the timing and extent that juvenile and adult Atlantic sturgeon use offshore waters of the New York Bight is relatively unknown and there is a dearth of data regarding marine habitat use of this species in general An array of acoustic receivers (Vemco VR2AR) was deployed in the NYWEA in November 2016 to monitor seasonal occupancy and movements of Atlantic sturgeon and other commercially and ecologically important finfish species Acoustic transmitters were surgically implanted in Atlantic sturgeon (n = 133) during samples cruises that occurred during 2016 and 2017; additional transmitters were implanted in black sea bass (*Centropristis striata*; n = 36), summer flounder (*Paralichthys dentatus*; n = 40), winter flounder (*Pseudopleuronectes americanus*; n = 17), and various elasmobranchs (n = 34)

An initial data download resulted in 73,201 detections of 294 individual tags on NYWEA array receivers At least 155 unique Atlantic sturgeon tags representing 3,365 total detections were identified on downloaded receivers Initial results suggest that presence of Atlantic sturgeon in the NYWEA is seasonal; however, additional confirmation and analysis are ongoing This study provides information regarding the presence of Atlantic sturgeon in offshore marine waters that is essential to assess any potential impacts (positive or negative) of offshore wind-energy development and will provide data that are critical for ongoing management efforts by state and federal agencies

P 19 **Long-Term Fish Assemblages of the Ohio River: Modified Trophic and Life History Strategies with Hydrologic Alterations and Landuse Modifications** (Poster Session)

Mark Pyron, Ball State University, mpyron@bsu.edu, Mario Minder, Ball State University, Robert Shields, Ball State University, Nicole Chodkowski, Ball State University, Caleb Artz, Ball State University, Meryl Mims, Virginia Tech and Julian Olden, University of Washington*

Long-term monitoring of large river fish assemblages are available to test for temporal variation and correlation with environmental data The Ohio River Valley Water Sanitation Commission (ORSANCO) was founded to monitor water quality and curb overwhelming pollution throughout the Ohio River Basin Biological assessments included lockchamber fish rotenone surveys from 1954-2014 We used multivariate procedures to detect temporal patterns in the fish assemblage, and we tested for correlation with landuse variation Ohio River fish assemblages are modified from 50 years ago, with decreased omnivores and increased piscivores Agriculture landuse decreased and forest landuse increased during this period, and these patterns were significantly correlated with fish assemblage variation We will discuss sport fisheries modifications, food web effects and compare to other rivers with longterm fish assemblage results

P 20 **Field Guide to the Freshwater Fishes of Virginia** (Poster Session)

Paul E Bugas Jr, Virginia Department of Game and Inland Fisheries, Michael J Pinder, Virginia Department of Game and Inland Fisheries, Valerie A Kells, Val Kells Illustration, Corbin D Hilling, Virginia Polytechnic Institute and State University, Derek Wheaton, Conservation Fisheries Inc and Donald J Orth, Virginia Polytechnic Institute and State University*

A *Field Guide to the Freshwater Fishes of Virginia* is needed to fulfill a longstanding need in nature education Central and Southern Appalachians are unrivaled in the US for aquatic species diversity, which makes this regional field guide extremely important Most authoritative information is contained in extensive (66 pound) references or online databases that are not useful for the beginning naturalist nor a field biologist Furthermore, biologists worldwide are clamoring for more natural history skills to prepare young biologists for future challenges We are creating a 5x75-inch, field guide on water-resistant paper The book will teach the beginner how to identify the families and reliably identify Virginia fish species with field characteristics The taxonomy of family and common names will follow recent authoritative references The field guide will include introductory chapters on fishes, river drainages, and freshwater habitats of Virginia, how to use the field guide, how to observe fish in the wild and captivity, and essential messages of fish conservation Distribution maps will be based on recent distributional databases Selected drawings will be incorporated to illustrate most reliable diagnostic characteristics (eg, snout shape, pigment patterns, mouth morphology) for field identifications Poster presentation will include a sample page layout and excerpts from the field guide Johns Hopkins University Press has agreed to publish the field guide when completed

P 21 **Age and Growth of Quillback in a Reservoir of the New River, Virginia** (Poster Session)

Haley Jenkins, Virginia Tech, Rachel Wadsworth, Virginia Tech, Corbin D Hilling, Virginia Polytechnic Institute and State University, John R Copeland, VA Department of Game and Inland Fisheries and Leandro Castello, Virginia Tech*

Quillback (*Carpiodes cyprinus*) were discovered in 2006 in Claytor Lake, a mainstream reservoir of the New River in Pulaski County, Virginia While Quillback are native in Virginia, they are not native to this region of the New River; however, the age and growth of Quillback in Claytor Lake has not been studied The goal of this study was to investigate the growth and age structure of Claytor Lake Quillback We collected 48 Quillback using gill nets set overnight at long-term sportfish monitoring sites Collected specimens were weighed (g) and measured (mm), otoliths were extracted for age assessment, and growth was described using the von Bertalanffy growth model The von Bertalanffy parameters were estimated as average maximum length (L_∞) = 512 mm, Brody growth coefficient (K) = 012 yr^{-1}, and age at which length would be 0 (t_0) = -11 yr The von Bertalanffy growth model fit the data well, but parameter estimates may be subject to selectivity against small fish, generating an unusually low estimate for t_0 Continuing this work using less size-selective sampling gears may help us understand if small Quillbacks are selected against by gill nets or if the population structure of this recent invader is skewed toward individuals longer than 300 mm The continuation of this study can help to lead management strategies for this potentially invasive species

P 22 **Assessment of the Stream Fish Community in the Upper Red River of Texas and Oklahoma** (Poster Session)

David S Ruppel, Texas State University and Timothy H Bonner, Texas State University*

The Red River drainage contains one of the most diverse fish communities in Texas, and is divided by a reservoir into an upper prairie stream and lower lowland stream section The upper section of the Red River has a unique habitat composition and multiple endemic species However, current and future anthropogenic alterations to river connectivity, water quality, and water quantity could pose as threats to endemic fishes within this section Purpose of this study was to conduct a range wide survey to assess fish community structures within drainages of the upper Red River Objectives of this study were to quantify occurrence, abundance, and habitat associations of the fish community among longitudinal and abiotic gradients Range wide surveys were conducted in Fall and Winter of 2015 and Summer of 2016 Preliminary results of the upper Red River indicate that there is an east to west gradient in abiotic conditions, stream morphology and community structure Insights from this study can be used to assess risks associated with current and future anthropogenic alterations within the basin

P 23 **There′s an App for That! Development of a Web-Based Application for Predicting the Sex of Alligator Gar Afield** (Poster Session)

Daniel Daugherty, Heart of the Hills Fisheries Science Center, DanDaugherty@tpwd.texas.gov, Dusty McDonald, Inland Fisheries, Corpus Christi Management District, J Warren Schlechte, Texas Parks and Wildlife Department and Chris Cummings, Inland Fisheries, Waco Regional Office*

Sexual dimorphism in the Alligator Gar, *Atractosteus spatula*, is limited to relatively small differences in snout and anal fin base lengths, making non-lethal sex identification difficult afield We describe a handy smartphone application that uses snout, anal fin, and standard length measurements to both predict the sex of fish and estimate the certainty of predictions Our method uses a discriminant function built and tested using a sample size of 262 Alligator Gar ranging from 707 to 1920 mm TL from seven Texas populations

The discriminant function was then built into a web-based application platform, which can be accessed afield on any smart device using cellular data Use of our prediction tool will improve our ability to understand sex-specific population dynamics, as well as provide a means to identify sex afield, which will be useful for general monitoring, broodfish selection, and trap-and-transfer reintroduction efforts

P 24 **"Increasing Recreational Fisheries in a Major Metropolitan Area"** (Poster Session)

Alice Best, Texas Parks and Wildlife, Ashley N Ragan-Harbison, Texas Parks and Wildlife and Mark Webb, Texas Parks and Wildlife*

Urban fisheries management faces several challenges that traditional fisheries do not including perceived and genuine absence of fishing opportunities, greater travel time to fishing locations, and competition for time with other activities The Greater Houston Metropolitan Statistical Area (MSA) is the fifth largest metropolitan area in the United States and represents an important place to examine given its size (9,444 square miles) and young, diverse population (65 million) Texas Parks and Wildlife Department's Inland Fisheries College Station – Houston Management Team developed a conceptual model to increase the type and total number of recreational fisheries across the MSA Existing and potential recreational fisheries were identified and categorized into five types of angling resources: Neighborhood Fishin' Program lakes, large reservoir fisheries, lotic fisheries, urban back country ponds in natural preserve areas, and sunfish ponds geared to young anglers The MSA was divided into five sectors surrounding main travel arteries, and each type of diverse recreational fishery is being developed and managed in each sector Using the conceptual model, we hope to reduce barriers to angling as an activity by providing convenient and diverse angling opportunities to communities throughout the Houston MSA and increase angling in the Houston MSA

P 25 **Kayak/Snorkel/Scuba-Based Underwater Videomapping System for Aquatic Habitat Management** (Poster Session)

Paul Ayers, University of Tennessee, ayers@utk.edu*

The need to develop GIS-compatible large-scale maps of aquatic habitat in river systems led to the design of a kayak-mounted GPS-based river videomapping system The river mapping system is kayak-mounted with georeferenced above and under water cameras, depth sounder, width sensors and underwater lasers GIS maps of river and streambank characteristics - (pool, riffle, run), substrate (modified Wentworth scale), embeddedness (EPA classification), woody debris, bank cover, depth, width and river characteristic (pool, riffle, run) were developed River thalweg rugosity and sinuosity were also determined Every linear foot of river can be mapped at a rate of 10 miles per day The system provides a GIS-based georeferenced database for river and stream inventory and can be used for watershed-scale aquatic habitat management A technique to define optimum habitat locations and habitat suitability indices for aquatic species was developed and implemented

Complemented with a GPS-based snorkel and scuba videomapping system close-up under-structure video exploration technique, site-specific fish population monitoring provide video documented georeferenced information regarding population, size, species distribution, location, and habitat Day vs night snorkelmapping for species distribution resulted in different fish population densities GIS-based video databases of the above and below water river features are generated Virtual tours within ArcGIS are available

P 26 **Development and Evaluation of Regional Standard Weight (Ws) Equations and Standard Length Categories for Brook Trout, Brown Trout, and Rainbow Trout** (Poster Session)

Daniel Hanks, Clemson University, rhanks@clemson.edu, Jacob M Rash, North Carolina Wildlife Resources Commission, Yoichiro Kanno, Colorado State University and David Goodfred, North Carolina Wildlife Resources Commission*

Relative weight (W_r) as a means of evaluating the body condition of an individual fish is commonly used by fishery managers, where the ratio of an individual fish's weight is compared to a standard weight (W_s) of a fish with the same length Standard weight equations have been developed for Brook Trout *Salvelinus fontinalis*, Brown Trout *Salmo trutta*, and Rainbow Trout *Oncorhynchus mykiss* across their North American range and fish are often evaluated against this national standard However, managers (eg, within state agencies) may wish to evaluate local populations relative to a regionalized W_s equation to better inform local fisheries decisions We developed and compared W_s equations for the three trout species in four regions in the USA (northern and southern Rockies, and central and southern Appalachians) For a given body length, Brook Trout and Rainbow Trout in the Rockies tended to weigh more than fish in Appalachians (but not Brown Trout) and fish in southern Appalachians were typically least plump among the four regions examined Accordingly, percent difference between existing national and our new regional W_s equations ranged -96–60% for Brook Trout, -43–03% for Brown Trout, and -42–43% for Rainbow Trout, highlighting the need for these regional equations Regional variation in length–weight relationships may reflect environmental influences, genetic differences, or both Regional W_s equations should aid in monitoring spatial and temporal changes in fish conditions resulting from a range of drivers including climatic changes and land use conversion

P 27 **Replacement of Fish Meal By Yeast in Rainbow Trout (Oncorhynchus mykiss) Diets: Growth Performance and General Health Indices** (Poster Session)

Clay Ferguson, Virginia Tech and Dave Kuhn, Virginia Tech*

Protein replacement has been a critical area of research in the aquaculture industry for the past decade The potential for discovering an alternative feed that is efficient, abundant, and cheap enough to compete with fishmeal has led scientists to search within commercial waste production systems for a solution This study utilized yeast as a by-product of glycerol waste from an Australian ethanol company to formulate three trout diets (20%, 40%, and 60%) compared alongside a 0% yeast replacement control as well as a baseline commercial trout feed A total of thirty tanks were stocked with ten trout each (six tanks per diet type) and weighed weekly for progressive data and adjusted feed calculations The control and yeast diets were formulated to be equivalent for levels of crude protein, total fat, crude fiber, calcium, magnesium, phosphorus, and potassium At the end of the 21-week trial, fish were sampled for response variables and analyzed via one-way analysis of variance and Tukey's honest significant difference post-hoc The 0% yeast replacement diet yielded significantly (alpha=005) higher weight and length gains compared to 40% [L= 00041 | W=00376] and 60% [L= 00097 | W=00237] diets, but not the 20% diet Food conversion ratios, K-condition factors, hepatic and viscerosomatic indices, and muscle ratios were not significant amongst all four diets Although the 40% and 60% diets were surmounted in general growth parameters, they showed potential for improved condition factors and muscle ratios compared with the other diets, as well as potential for higher survivorship when compared to 0% alone These results suggest that yeastprotein replacement sourced from industrial organic waste could prove viable in the aquaculture feed industry as a cost reduction ingredient as well as a fish health benefactor

Contributed Oral Presentation Abstracts

Environmental and Behavioral Factors Affecting Variation in Bluehead Chub (Nocomis leptocephalus) Nest Size and Utilization By a Nest Associate, Yellowfin Shiner (Notropis lutipinnis) (Conservation and Biodiversity 1)

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Yellowfin Shiner (*Notropis lutipinnis*) has evolved to spawn on Bluhead Chub (*Nocomis leptocephalus*) nests built by males and such reproductive interactions can play a key role in maintaining community structure and biodiversity In this study, nest size variation of Bluhead Chub and nest utilization by Yellowfin Shiner were studied at three streams in the upper Piedmont region of South Carolina We conducted 89 consecutive days of field observations in April-July 2016 and recorded spawning activities, size of nest, the number and size of male Bluehead Chub, the number of Yellowfin Shiner and environmental variables Structural equation modeling (SEM) was applied to identify networks of direct and indirect theoretical relationships among the variations of both nest size and utilization by Yellowfin Shiner and environmental and behavioral factors A total of 90 nests were located in three streams and spawning was observed on 71 nests We defined six types of nest based on nest resources, such as pebbles and location, were re-used by Bluehead Chub The results of SEM showed that photoperiod and water temperature were important environmental variables to account for the size of male Bluehead chub, larger males spawned earlier than smaller ones Nest size was influenced by the number, size, duration of nest construction, and their re-use of nest resources The number of spawning days, nest size, the number and size of male Bluehead Chub were important factors for attracting more Yellowfin Shiner The number of male was the most important direct factor affecting both nest size and the number of Yellowfin Shiner The important indirect factor affecting behavioral variations of Bluehead Chub was the male size This study suggested that nest size and interaction with associate was influenced by environmental variables and behavioral variations, which can be a key factor for reproductive success and evolution

Streamflow Effects on Recruitment and Migration of Blue Sucker in the Lower Colorado River, Texas (Conservation and Biodiversity 1)

Matthew R Acre, Texas Cooperative Fish and Wildlife Research Unit, Texas Tech University, matthewacre@ttu.edu, Timothy Grabowski, US Geological Survey, Dakus Geeslin, Texas Parks and Wildlife Department, Allison Pease, Texas Tech University and Nate Smith, Heart of the Hills Fisheries Science Center*

Alteration of flow regime, eg, timing, duration, flashiness, and magnitude of discharge, has serious implications to fluvial specialists inhabiting large rivers that have evolved flow-dependent life histories Blue Sucker *Cycleptus elongatus*, is a fluvial-specialist considered vulnerable throughout its range due to habitat requirements and life-history traits However, relationships between river discharge, migratory behavior, and Blue Sucker recruitment have not been thoroughly examined, particularly in southern portions of its range The primary objectives of this research were to assess effects of varied streamflow, regulated by water releases from upstream reservoirs, on Blue Sucker movement, habitat use, and recruitment in the lower Colorado River downstream of Austin, Texas Radio telemetry was used to characterize movement in response to river discharge changes Quantile regression suggests that large-scale movements are related to seasonal changes in temperature and river discharge prior to relocation

Directional movement models incorporating temperature and streamflow predicted migrations with high accuracy and precision Furthermore, home range and minimum displacement were correlated with riffle density and habitat complexity Fin-ray sections (n = 200) taken from specimens during mark-recapture efforts were used to estimate age and associate relative year-class strength with historical discharge Preliminary results suggest the population in the lower Colorado River has had limited recruitment, and stronger cohorts appear to be associated with years with higher discharge This work will provide critical information for replicating natural flow regimes vital to fluvial specialist's life history cycles, including Blue Sucker, and inform water management policy decisions in the lower Colorado River, Texas

Spatial Ecology of Shoal Bass in Two Chattahoochee River Tributaries (Conservation and Biodiversity 1)

Amy Cottell, Auburn University; School of Fisheries, Aquaculture and Aquatic Sciences*

Native populations of Shoal bass are threatened due to land-use changes, impoundments, and introduced species As habitat specialists, rocky shoal habitats used for spawning as well as maintaining the larval nursery is crucial, yet it's a relatively understudied component We used radio telemetry to determine movement patterns and habitat use of Shoal bass in two geomorphically distinct tributaries in Georgia 20 individuals from each creek were tagged and tributaries were tracked every week for 18 consecutive months, overlapping two spawning seasons We also used low-cost side scan sonar to create substrate maps to look at the relationship between habitat quality and frequency of use by Shoal Bass across seasons and among individuals We hope to use these results to support effective conservation and management practices as part of the Native Black Bass Initiative (NBBI)

Use of Strong Habitat-Abundance Relationships to Assess Population Status of Cryptic Fish Species: An Example Using Harlequin Darter (Conservation and Biodiversity 1)

Kate Harriger, University of Florida, kateharriger@myfwc.com, Paul Schueller, Florida Fish and Wildlife Conservation Commission, Howard Jelks, US Geological Survey and Mike Allen, University of Florida*

Understanding trends in abundance is important to fisheries conservation, but techniques for estimating stream-wide abundance of cryptic fish that use complex habitat are not well established We developed techniques to address this need using Harlequin Darter *Etheostoma histrio*, which is a small, cryptic freshwater fish that is associated with woody structure in streams where it occurs Specifically, our objectives were to (1) determine how darter abundance and in-stream wood were related at sampled sites, and (2) to use this relationship to estimate darter abundance at unsampled sites and extrapolate for stream-wide darter abundance estimates and associated uncertainty We conducted mark-recapture studies using visual surveys to sample Harlequin Darter from Big Escambia and Pine Barren creeks in northwest Florida In-stream woody debris abundance was quantified and mapped in both creeks using side scan sonar and GIS tools These darter and wood data were used in a hierarchical Bayesian model to determine site abundance of Harlequin Darter, the effect of in-stream wood on darter abundance, and to extrapolate darter abundance stream-wide We found a positive relationship between wood and darter abundance at both creeks, though a significant interaction between wood and creek suggests there is a difference in this relationship between the creeks The extrapolated stream-wide abundance estimates were 7,238 darters (95% credible interval = 5,746-9,220) in Big Escambia Creek and 8,804 darters (95% credible interval = 7,684-10,116) in Pine Barren Creek Our methods were effective for estimating stream-wide abundance of a cryptic fish with a strong habitat-abundance relationship, and our findings will benefit the conservation of Harlequin Darters range-wide

Evaluating the Success of Translocation Efforts for a Rare Darter Species in Oklahoma (Conservation and Biodiversity 1)

Colt Holley, Oklahoma State University, coltholley@okstate.edu and Jim Long, US Geological Survey*

Currently, little is known regarding the status of state-endangered Longnose Darter (*Percina nasuta*) within Oklahoma Longnose Darters were known from two river systems in Oklahoma, but are believed to have been extirpated from the Poteau River system Translocation efforts from Lee Creek into Blackfork Creek were made in 1991-92 with hopes of reestablishing a Poteau River system population, but whether this population currently persists is unknown Our objectives were to sample these two systems thought to contain Longnose Darters in an occupancy modeling framework to evaluate the success of past translocation efforts and to examine differences in detection between systems Between the two systems, a total of 31 stream reaches were sampled via backpack electrofishing in the summer of 2017 We failed to detect Longnose Darters within the stream where the translocations took place, but eight individuals from four reaches were detected in Lee Creek Among co-occurring darter species, Longnose Darters had the lowest detection probabilities (54%, range 54—41%) The translocation of Longnose Darters in Oklahoma appears to have been unsuccessful and the species is now thought to be restricted within Oklahoma to a single stream Results from this study will used to further manage for this state-endangered stream fish

Tournament Economics in Florida (Policy, Programs, and Human Dimensions)

Lee Grove, Florida Fish and Wildlife Conservation Commission*

Black bass are the most targeted fish by freshwater anglers nationwide accounting for 39% of all freshwater fishing effort Major economic impacts generated from angling revenue have been observed in regions with productive black bass fisheries According to the US Fish & Wildlife Service National Survey of Fishing, Hunting, and Wildlife Associated Recreation in 2016, angling generated $461 billion dollars This high price tag has led managers in Florida to evaluate how much money is spent in their state overall and to determine what portion of the revenue comes from bass fishing tournaments In 1999, FWC biologists used data collected by US Fish & Wildlife survey to generate a $/hr value for bass fishing in Florida That value has since been used to assign recreational dollar values to fisheries across the state and now to assess the economic impacts of bass tournaments in Florida Hours of tournament effort were calculated by water body, county, region, and statewide using FWC tournament Permit Me data and then multiplied by the FWC $/hr value and correction variables to account for inflation and days of practice From the Permit Me data, we were also able to calculate average winning weight and big bass by lake, region, and statewide Average winning weight for bass tournaments is 1410 lbs and average big bass is 581 lbs Overall, freshwater fishing in Florida generates approximately $12 billion per year and 14% of the total is from bass fishing tournaments (eg, $158 million in 2016) Although these are impressive figures, tournament angling is likely underestimated by our methods that assume the same rate of spending per hour by all anglers Our study underscores the importance of recreational and tournament black bass fishing to the Florida economy and highlights the need to better define revenues by angler group to provide the best estimates freshwater angling to local, regional, and state interest groups

Negotiation of Perceived Constraints to Trout Fishing in Georgia Based on Angler Specialization Level (Policy, Programs, and Human Dimensions)

Hailey Yondo, University of Georgia, Bynum Boley, University of Georgia, Brian Irwin, US Geological Survey and Cecil Jennings, US Geological Survey*

Participants in leisure activities, such as trout angling, often face constraints that play a pivotal role in determining participation levels and dropout rates Constraints can influence an individual's participation by interfering with the desired benefits of the activity or by altering the desire to participate Experiencing constraints does not necessarily lead to cessation of participation for all individuals For instance, some recreational anglers are able to negotiate constraints by becoming more aware of fishing opportunities, acquiring new skills, altering timing or frequency of participation, or modifying aspects of non-recreational life like family and work responsibilities If constraints are ongoing and thought of as non-negotiable, participants may drop out of trout angling, which could lead to a decrease in license sales To better understand constraints and negotiation strategies, we gathered data via a 2017 mail survey completed by 528 Georgia trout license holders Recipients were asked to evaluate the extent to which potential constraints were a hindrance to trout fishing in Georgia Recipients were also asked to indicate how often they use various strategies to overcome the potential constraints to trout fishing For example, potential constraints could be the cost of trout fishing, work obligations, or lack of transportation Strategies used to negotiate these constraints could be budget money, organize work schedule, or carpool To capture variation in trout angler preferences, survey responses were grouped by level of angler specialization, which is commonly used to observe diversity among participants Angler specialization grouping was conducted using K-means cluster analysis with a three-cluster solution Segmenting the respondents allows investigation of the heterogeneity of perceived constraints and subsequent negotiation strategies of trout anglers ANOVAs were used to detect potential differences among the three specialization groups, and these tests revealed differences among groups for both perceived constraints and negotiation strategies For instance, the least specialized group was more constrained by limited skills, lack of interest, and lack of a fishing partner than the most and moderately specialized groups The most and moderately specialized groups indicated they are more likely to search for uncrowded areas and high-quality trout fishing spots than the least specialized group This research could benefit fishery managers by contributing to a better understanding of the differences among trout anglers regarding participation constraints and strategies used to navigate these constraints The results may be of use to managers when considering different fishing opportunities, which could be catered to anglers that experience different constraints

Angler Survey Analysis from a Popular Oklahoma Seasonal Trout Fishery (Policy, Programs, and Human Dimensions)

Matt Mauck, Oklahoma Department of Wildlife Conservation*

Seasonal trout fisheries allow resource managers to provide unique and expanded opportunities to angling constituents Descriptive statistics provided by creel surveys allow evaluation of stocking rates, catch and harvest, demographics, improved understanding of angler opinions, and programmatic evaluation The Blue River Public Fishing and Hunting Area is located in Southcentral Oklahoma and provides 10 km of picturesque trout fishing opportunities between November 1 and March 31 of each year Creel data, collected from two successive trout seasons, provided valuable information to managers involved with this fishery and will be discussed

Understanding Fishing Participation Constraints of Underrepresented Demographic Groups in the Southeastern US and Puerto Rico (Policy, Programs, and Human Dimensions)

Ramon Martin, US Fish and Wildlife Service, ramon_martin@fws.gov and Marielle Peschiera, US Fish and Wildlife Service*

Fishing is one of the most popular outdoor sports in the United States of America (USA), contributing billions to the economy Many states rely on the sales of fishing licenses and excise taxes on fishing equipment to support aquatic conservation programs, research, habitat restoration, fisheries management, and development of public fishing access (PFA) through the Sport Fish Restoration Act From 2001 to 2016, the adult population of the US increased 20% while the number of freshwater anglers increased 6% Fishing participation by certain demographic groups was lower than others, and demographic composition of anglers did not match that of the general population This research aimed to understand how distance and location of fishing access facilities act as a constraint for fishing participation by urban populations and certain demographic groups We used ArcGIS to determine the distance between major urban areas and PFA facilities in four Southeastern states and Puerto Rico We found that on most states more than 50% of boat ramps are located further than 20 miles from major urban areas Meanwhile, in all states more than 50% of the public fishing areas are further than 20 miles from major urban areas Population size around a public fishing area ($F = 5015$, $p < 00001$) and the distance to the nearest Metropolitan Statistical Area ($F = 5124$, $p < 00001$) are strong predictors of angling effort Our results also show a significant negative relationship between angler visitation and distance of public fishing areas from urban areas, confirming that location does influence fishing participation In Puerto Rico, fishing participation in freshwater public fishing facilities was significantly lower than other states in the Southeast With rural populations decreasing and the demographics of the USA diversifying we suggest that natural resource managers use urbanization prediction models and social data to determine optimum locations for new PFA projects to increase fishing participation by underrepresented groups

"The Mona Island MPA 13 Years after No-Take Designation: Testing the NEOLI Paradigm"
(Policy, Programs, and Human Dimensions)

Jack Olson, University of Puerto Rico at Mayaguez, Richard Appeldoorn, University of Puerto Rico at Mayaguez, Michelle Schärer, HJR Reefscaping and Juan J Cruz Motta, University of Puerto Rico at Mayaguez*

Marine protected areas (MPAs) are capable of rebuilding biodiversity and increase fishery output However, MPA success is not always achieved, and assessment of MPA performance is necessary for management accountability to stakeholders MPA success requires adequate design, compliance and time Success probability is enhanced if an MPA meets 4 of the 5 NEOLI criteria: No-take, Enforced, Old, Large, and Isolated, but often some of these factors are not accounted for when assessing MPA performance Here we present preliminary results of a study evaluating patterns of temporal variation of fish assemblages of two MPAs with distinct management and enforcement plans: the no-take area of the Mona Island Natural Reserve, an offshore island between Puerto Rico and Hispaniola, and the La Parguera Natural Reserve, off the southwest coast of Puerto Rico Both are considered large and old by NEOLI criteria, but differ in no-take status and degree of isolation, with enforcement unquantified in both areas A prior study at Mona Island, 5-years after no-take designation, found only marginal changes in abundance for larger, commercially important species, with the largest increases in abundance detected for smaller species of groupers and early life stages Non-compliance at Mona Island has been cited as a potential hindrance to the recovery, but this has not been formally assessed In the present study, structure and composition of fish assemblages associated with coral reefs (collected via belt transects) are being analyzed using permutational multivariate analyses of variance (PERMANOVA) based on a multifactorial mixed model that considered several spatial and temporal scales, while compliance is being indirectly evaluated with a series of scaled stakeholder surveys If compliance within the no-take zone at Mona Island is sufficient, significant increases in the average biomass and abundance of larger species are

expected relative to La Parguera Preliminary findings suggest that the average fork length of red hind (*Epinephelus guttatus)* at Mona Island has increased by 22% since establishment of no-take regulations in 2004, while mean density is unchanged In the La Parguera Natural Reserve, red hind average fork length decreased by 25% relative to 2007 and density decreased by 16% Mean herbivore density at Mona Island was unchanged but had increased by 18% in La Parguera

Estuario Revive: The Revitalization and Restoration of an Urban Estuary in Puerto Rico (Policy, Programs, and Human Dimensions)

Brenda Torres, San Juan Bay Estuary Program*

On September 20, 2017, Hurricane Maria swept a path of destruction across the precious habitat known as the San Juan Bay Estuary, as well as its wildlife and human communities The natural infrastructure was not spared, with forest cover decimated, rivers flooding entire communities, and sanitary discharges flowing into the network of water bodies The San Juan Bay Estuary Program (SJBEP) has been working for over 20 years to protect and restore the water quality of the Estuary and the health of this ecosystem After the hurricane, the SJBEP quickly launched the relief campaign "Estuario Revive" and has been working and raising funds in four key areas: Environmental Assessment, Infrastructure Support, Community Support and Friends of the Condado Lagoon Learn about the relief and recovery work of the SJBEP and its strategy for the restoration of this large urban estuarine ecosystem The San Juan Bay Estuary is the natural ecosystem of forests, creeks, rivers, lagoons, beaches, and the bay, which connect eight municipalities and the metropolitan area of Puerto Rico It is home to more than 500 species of fish, birds, mammals, amphibians, plants, and hundreds of thousands of people who live and work within it

South Carolina Oyster Restoration and Enhancement Program: Encouraging a Conservation Ethic through Stewardship Activities (Policy, Programs, and Human Dimensions)

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The South Carolina Oyster Restoration and Enhancement (SCORE) Program, a community-based habitat restoration program, has been engaging community volunteers in hands-on restoration activities since 2001 We strive to engage volunteers of all ages, backgrounds, and abilities with the objective of increasing awareness of environmental issues and inspiring further stewardship By allowing volunteers to get their hands dirty (literally and figuratively) building oyster reefs, we connect them to their environment and empower them to take action on its behalf In addition to the core goal of constructing oyster reefs, the program also includes salt marsh restoration, oyster shell recycling and water quality monitoring Since its inception, SCORE has engaged more than 33,500 volunteers in stewardship activities Volunteers have bagged more than 1,770 tons of oyster shell and constructed oyster habitat at 100 different locations along the South Carolina coast In the last 5 years, 57 K-12 schools have participated in growing *Spartina alterniflora* seedlings for transplanting behind the oyster reefs The program also hosts field trips by local school groups to investigate biodiversity on the oyster reefs through fish sampling and other hands-on activities The SCORE program works with as many as 40 local schools each year, spreading the "oyster message" to more than 2,500 students annually

Simulating Oyster Reef Building for Application to Coastal Restoration (Policy, Programs, and Human Dimensions)

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New simulation models of oyster reef building and coastal salinity regimes were developed to predict performance of oyster reef restorations, along with their associated ecosystem services for fisheries harvest and ecosystem regulation, under deep uncertainty in future climate and harvest policy The goal of this modeling is to understand the coupled dynamics of coastal salinity and oyster reefs, so that one can be predicted from the other and vice versa Important features of the reef system are that live oysters, shell, and recruits all occupy space on the reef, and that the overall area and height of the reef reach a limit determined by the balance between its accretion rate and by intertidal hydrodynamics Thus, some reduction in one group is necessary in order to make room for the others, and so that the reef can grow Previous models of oyster bioenergetics, shell longevity and budget, and population dynamics were compiled here to build a new model of the reef system, and an energy budget was included so that individual organisms could be modeled Oyster reefs were simulated as three-dimensional structures composed of individual oysters, oyster shell substrate, and recruits Live oysters and reef shell were tracked explicitly as individuals, and reproduction was modeled as a combined process of gamete production, larval survival, and spat settlement Key feedbacks occur in the model both during the reef accretion process and when reefs approach capacity, as the oysters, shell, and recruits interact with environmental conditions One critical variable impacting the ability of the reef to accrete to its potential size is the turnover rate of shell “boxes”, which are intact shell valves left behind post-mortality Long term persistence of actual oyster reef restorations will likely depend on future climate conditions that are difficult to predict We present a methodology for simulating alternative scenarios of future coastal salinity and water temperature based on different potential climate extremes We consider uncertainty by applying alternative scenarios to the oyster model, and restoration performance is predicted by estimating the expected return and associated risk to ecosystem services provided by the reefs across these scenarios

Scope and Scale of Mentored Undergraduate Research Practices in University Fisheries, Aquatic Sciences, and Related Programs (Policy, Programs, and Human Dimensions)

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The fisheries profession has a long history of providing career preparation to the next generation of fisheries professionals and undergraduate research experiences has been one of the primary mechanisms for providing this important training In the last decade, undergraduate research programs at both research universities and teaching institutions alike have expanded exponentially In fact, mentored undergraduate research programs have even become somewhat in vogue or trendy among universities and have greatly expanded beyond the sciences The recent rapid expansion and diversity of approaches to these programs has highlighted the need for a better understanding and evaluation of how best to accomplish effective undergraduate research mentoring To that end, a recent comprehensive literature review of the topic identified 10 of the most important practices leading to successful mentoring programs In light of this newly published information, we sought, through this project, to make a comparison of the 10 recommended practices with current practices of fisheries faculty Using the American Fisheries Society’s 2015 Master List of Fisheries Schools Database, we sent an email survey to 756 university faculty members to collect information about their mentoring practices Responses to the survey were compiled and a comparative analysis of the survey responses was made with the practices recommended in the literature Results of our study provide a contemporary perspective on the effectiveness of current

undergraduate research mentoring in the broader fisheries profession and identifies several important insights for improving undergraduate mentoring in our discipline

Survival Rates of the Endangered York River Atlantic Sturgeon Adult Population (Population Dynamics - Freshwater and Anadromous)

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Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, experienced a significant decline in abundance caused by a century of overfishing and habitat alteration leading to the listing of five distinct population segments (DPSs) under the Endangered Species Act in 2012 Recent analyses produced range-wide annual apparent adult survival estimates of approximately 94%, with Chesapeake Bay DPS specific annual survival estimate of approximately 82% River specific annual adult survival estimates have also been calculated throughout the southeast US, ranging from 778% to 871% Those calculations were all made using the Cormack-Jolly-Seber Model This project calculated apparent annual survival of adult Atlantic sturgeon natal to the York River in Virginia using internally applied acoustic telemetry tags and applied three different models to estimate apparent annual survival rates: the Pradel model for survival and recovery, a Cormack-Jolly-Seber model, and Program RELEASE in Program MARK We tagged approximately one fifth of the York River adult population and recaptured 21 individuals within and between years, providing insight into the fate of telemetry tags after their release Two tagged fish were recaptured following tagging revealing that the tags were either lost or ceased transmitting after implantation but the fish were still alive in the population Three tags are thought to have been expelled during spawning on spawning grounds and another fish is suspected of being poached from the river After removing those tags from the data, the calculated monthly apparent survival rates for adult Atlantic sturgeon in the York River were 0993882 (95% CI, 09726-09985), 0993887 (09726-09985), and 09893 (09765-10127), using the Pradel, CJS, and Program RELEASE models This gave an average apparent annual survival rate of 0929 (95% CI, 07164-09827), 0929 (07164-09827), and 08787 (07520-11641) for the three models, respectively In populations without high recapture rates, there is a high probability of under-estimating monthly and annual survival using telemetry tags due to premature tag loss, tag failure, or expulsion

Sex-Specific Dynamic Rates in Alligator Gar: Implications for Managing Exploited Populations (Population Dynamics - Freshwater and Anadromous)

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Many studies have suggested that female Alligator Gar attain larger maximum sizes than males However, few studies have quantified such differences, or considered their implications in sustainably managing fisheries To this end, we used bias-adjusted catch, size and age structure data from multiple Texas Alligator Gar populations to quantify differences in growth, maximum size, mortality and longevity between sexes Differences in these factors were biologically significant, with important implications for population sampling and the determination of appropriate fishery regulations

Evaluating the Resiliency of Brook Trout in West Virginia Headwater Streams Using Yield per Recruit Modeling (Population Dynamics - Freshwater and Anadromous)

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Environmental perturbations can have great impacts on fish populations As global temperatures continue to warm, cold and cool water fisheries will feel further environmental stress This stress can lead to additional mortality and potentially crash populations This is especially true for populations at the southern edge of the species range One example of such an at-risk population is the Brook Trout population in West Virginia Existing near the southern margin of Brook Trout native range and inhabiting historically disturbed stream systems, West Virginia Brook Trout could provide a sentinel for future environmental perturbations to core populations Yield per recruit modeling was used in order to evaluate the resiliency of Brook Trout populations Yield per recruit modeling can provide an estimate of the extent of the mortality above natural mortality that would need to occur before a population crashes This additional mortality can come from any source such as fishing and environmental perturbations like drought, flood, excessive temperature, etc Given the short lived and fast growing life history of Brook Trout, their populations are generally resilient to high levels of mortality Long term population data (2003-present) was used to construct yield per recruit models and resiliency of headwater stream Brook Trout populations was evaluated

Brook Trout Population Growth and Synchrony in the Central Appalachians (Population Dynamics - Freshwater and Anadromous)

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Identifying populations which act in synchrony across time and space may be valuable for understanding vulnerability and/or resilience to disturbance We sought to identify variables which correlated highly with population growth rates and levels of synchrony for brook trout populations We used a long-term brook trout dataset within 25 streams of West Virginia to analyze population growth rates across time and the correlation among demography of separate streams We used regression to identify both local and regional variables related to population growth, and classification trees and random forest generation to identify variables which separated populations based upon their synchrony Variables such as relative abundance of age-0 fish, mean fish length, and fall drought index were all important for defining population growth rate in a given stream or year Variables such as age-2 fish abundance, spawning area, and distance to tributaries contributed greatly to partitioning of synchronous and asynchronous populations These results help identify populations which are experiencing unique demographics and variables which may help explain reasons for these scenarios Furthermore, this research provides some insight into resilience of brook trout populations within West Virginia as they respond differently to both local and regional factors

Quantifying Long-Term Population Dynamics in Relation to Habitat Reconnection (Population Dynamics - Freshwater and Anadromous)

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Pacific salmon (*Oncorhynchus spp*), commercially, recreationally, and culturally important taxa, have been threatened by habitat fragmentation due to dam construction The Landsburg Dam, built in the Cedar River, WA fragmented the habitat which salmon use to spawn and rear In 2003, a fish ladder was added to the dam effectively reconnecting salmon with the upper reaches of the Cedar River for the first time in over 100 years While salmon are adept at recolonizing suitable habitats, few studies have shown the effects reintroduced salmon populations have on resident fish This study investigates the effects recolonizing coho salmon (*Oncorhynchus kisutch*) have on resident trout species (*Oncorhynchus mykiss, Oncorhynchus clarki*) in the Cedar River through a 17 year time series analysis Species populations densities

were determined by fish counts collected through snorkel surveys per area snorkeled; densities were calculated for each reach and for each year sampled to observe spatial and temporal trends Preliminary evidence suggests coho had a slightly negative impact on resident trout densities These results could have implications for other fish passage or barrier removal projects

Population Dynamics of Blue Catfish and Flathead Catfish in Three Oklahoma Rivers (Population Dynamics - Freshwater and Anadromous)

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The Oklahoma Department of Wildlife is responsible for managing sport fish populations in rivers across Oklahoma Flathead *Pylodictis olivaris* and Blue catfish *Ictalurus furcatus* are among the most popular sportfish in streams and rivers in Oklahoma A regulation to protect large Blue Catfish has been implemented No length protections exist for Flathead Catfish Evaluation of the current regulations is being conducted using population dynamics modelling examining the potential for both growth and recruitment overfishing in 11 rivers across Oklahoma over the course of 6 years This talk will focus on the results from Poteau, Verdigris, and Washita rivers Catfish in the aforementioned rivers were all sampled using boat mounted low-frequency spring electrofishing Basic population parameters such as growth, weight-length relationships, proportional size distributions, and mortalities were all examined using standard methods Fecundities and age at maturity were examined using egg counts, and susceptibility to harvest was examined using angler creel data We used a Beverton-Holt yield-per-recruit model to examine various length limits and the potential effects of these regulations on growth overfishing for both species for each river, while recruitment overfishing was examined using spawning potential ratios General trends in populations were examined using stage-structured matrices and reproductive contribution by age class was examined using relative current fitness The results of this study will be included within a larger examination of all 11 rivers to assess the overall effectiveness of the current catfish regulations in Oklahoma rivers, both at a regional and statewide

Striped Bass Population Characteristics Among North Carolina Reservoirs (Population Dynamics - Freshwater and Anadromous)

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Striped Bass (*Morone saxatilis*) populations in three reservoirs in North Carolina were sampled to describe abundance, size and age structure, condition, and estimate growth using sinking experimental gill nets Totals of 7,719 fish and 28 species were sampled across all three reservoirs in 2017 with Striped Bass composition varying from 1 to 6% of the total catch within each reservoir Relative abundance (number of fish per net-night; NN) of Striped Bass differed among reservoirs (Badin, 28 per NN; Gaston, 15 per NN; Jordan, 07 per NN) and was inversely related to mean-back-calculated-length at age 1 (Badin, 292 mm total length [TL], SE=29; Gaston, 246 mm TL, SE=63; Jordan, 209 mm TL, SE=63) and mean relative weight (Wr) of Striped Bass sampled from all three reservoirs (Badin, Wr = 25, SE= 19; Gaston, Wr=37, SE=37; Jordan, Wr= 57, SE=87) Proportional size distribution (PSD) was highest in Badin Lake (PSD=63), but was similar between Jordan (PSD=49) and Gaston (PSD=41) populations Age structure was similar among populations with age-3 individuals comprising over 50% of each population Overall, our results suggest density-dependent regulation of Striped Bass populations and provide guidance on the optimization of stocking strategies in North Carolina reservoirs

Florida's American Eels: On the Atlantic-Gulf Line (Migratory Fishes)

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Based on its most recent assessment, the American Eel stock has been determined by the Atlantic States Marine Fisheries Commission (ASMFC) to be in a state of decline Unfortunately, this assessment only includes data from US Atlantic coast populations, whose management is under the jurisdiction of the ASMFC There is now genetic evidence that fish in at least some Gulf of Mexico (GoM) drainages are part of this same stock; yet, the lack of a significant eel fishery has resulted in little research or management efforts for eels in these areas A study conducted by the Florida Fish and Wildlife Conservation Commission (FWC) from 2014-2016 resulted in the collection of biological, age, condition, and *Anguillicoides crassus* parasite infection data for over 600 American eels throughout Florida, including GoM drainages These data provided the first confirmed cases of *A crassus* infection in a wild GoM population and indicated there is annual recruitment of eels into these GoM drainages Additional information is needed, however, to learn about eels in this region, including basic life history, growth, and abundance To address some of these data gaps, the FWC began a pilot young-of-year (glass) eel monitoring program using an eel ramp in Martin Lake, located near Panama City, Florida The eel ramp was first installed in November 2017 and will be checked weekly through spring 2018 If successful, efforts will be made to install additional ramps along the west Florida coast and other GoM states to obtain information about the timing of upstream migration of glass eels, pathway of movement of eels from the Sargasso Sea, and size and abundance of eels migrating into different GoM drainages

Inventory of American Eels in Selected El Yunque National Forest Streams (Migratory Fishes)

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There is relatively little information available on the distribution, abundance, or ecology of American Eels in Puerto Rico streams Prior to 2007, American Eels were considered to be present but generally quite scarce in Puerto Rico Extensive island-wide fish community surveys in 2007 and 2013 revealed that American Eels were much more widespread and abundant on the island than previously believed, and that some of the highest densities of American Eels were in watersheds in the northeast corner of the island, on or adjacent to El Yunque National Forest However, sampling was generally limited to 3 or fewer low elevation sample sites per watershed In 2014, El Yunque National Forest partnered with the USDA Forest Service, Southern Research Station, Center for Aquatic Technology Transfer (CATT) to complete more extensive eel surveys in the Rio Fajardo, Rio San Juan, Rio Pitahaya, Rio Sabana, and Rio Mamayes watersheds We selected sites in the lower and upper reaches of each watershed and used 3-pass depletion sampling methods to: 1) further describe eel distribution both within and among the 5 watersheds, and 2) quantify relative abundance in watersheds known to contain American Eels We collected eels from 9 of 14 sample sites Eel density ranged from 0 to 1,984 eels per ha and size from 100 mm to 920 mm Natural and manmade barriers to upstream fish passage clearly impacted distribution and abundance Despite their disjunct distribution within the national forest, El Yunque has a clear role to play in securing favorable flows, high quality water, and in public education for the American Eel

Ecology and Conservation of the American Eel in the Caribbean Region (Migratory Fishes)

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The American Eel *Anguilla rostrata* is a widely distributed, economically valuable, culturally significant, and ecologically important, but imperiled fish It is a facultatively catadromous and panmictic species that occurs in freshwater and estuarine habitats from eastern Canada to Venezuela, including the Gulf of Mexico and Caribbean regions This species is declining in abundance throughout its distribution and is considered depleted in the most recent stock assessment and globally endangered by the IUCN, but is not currently protected under the Endangered Species Act in the United States Its distribution, biology, and ecology are reasonably well documented on the continental United States and Canada, but less so in the Caribbean, where it occurs on islands with permanent rivers, and Central and South American coastal rivers and freshwaters

We synthesized findings of original research on American eel distribution, abundance, population biology, habitat ecology, and threats from the Caribbean island of Puerto Rico Puerto Rico may serve as a model to illustrate the interactions between humans and natural resources in such complex insular ecosystems American eel were captured from 48 of 116 sites (414%) in 26 of 49 river basins (531%) during 2005–2016, and it was extirpated upstream of dams and migration barriers >30 m high (389% of habitat) Mean density and biomass were 4389 fish/ha and 2344 kg/ha, respectively Upstream habitats favored larger individuals, and females were larger than males The swim-bladder parasite *Anguillicoloides crassus* was not found in 120 eels examined Realized threats include dams and other migratory barriers, habitat loss and alteration, and pollution; exotic species and commercial fishing are impending threats; and the least understood is climate change Our research findings and others in the Caribbean region form the basis for informed conservation and management of this widespread, but imperiled fish species

Comparing Models and Abundance Estimates of Adult Atlantic Sturgeon in the York River, Virginia from 2013 to 2017 (Migratory Fishes)

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Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, were listed as five distinct population segments (DPSs) under the Endangered Species Act in 2012, with the Gulf of Maine DPS listed as threatened and the four DPSs to the south listed as endangered At that time, Atlantic sturgeon researchers were aware of 20 extant populations but had only produced two abundance estimates from the Hudson and Altamaha Rivers In 2013, our team discovered a spawning population in the York River system, within the endangered Chesapeake Bay DPS, and research commenced to estimate its abundance and status Spawning in the York River takes place in the late summer and fall with no evidence of spring spawning A closed population Schumacher-Eschmeyer model (modified Schnabel) and robust models with open and closed periods (Huggins p and c robust model) produced estimates of annual spawning abundances from 2013 to 2017 Within year spawning run sizes using Schumacher-Eschmeyer models and Huggins p and c robust models were not significantly different Mean spawning population estimates with 95% confidence intervals were 68 (17-133), 154 (97-211), 174 (128-220), 233 (68-398), and 197 (133-261) using the Schumacher-Eschmeyer model during 2013, 2014, 2015, 2016, and 2017, respectively The Chao M(t), Chao M(h), Chao M(th), Darroch, Jacknife, and Null equations in the Huggins p and c robust model in Program MARK produced six different mean abundance estimates ranging from 44 to 73 (range of 95%

confidence intervals from 24 to 273), 137 to 162 (96-272), 152 to 190 (117-277), 224 to 294 (134-647), and 181 to 215 (134-343) in 2013, 2014, 2015, 2016, and 2017 respectively The other five Huggins p and c robust equations failed to produce reliable estimates The Schumacher-Eschmeyer model provided a reliable estimate of annual spawning run abundance Likewise, if a robust model is preferred, the six equations applied all worked well, but the Darroch and jackknife equations in Program MARK provided the most precise estimates with means that match closely with the modified Schnabel model estimates These abundance estimates should help management agencies better understand the abundance of adult sturgeon spawning in the York River system and the seasons in which adult sturgeon are present and subjected to anthropogenic threats

Annual Movement Patterns of Roanoke River Atlantic Sturgeon, Including Inter-Dps Marine Movements and Spawning Periodicity (Migratory Fishes)

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For endangered Roanoke River, North Carolina Atlantic Sturgeon *Acipenser oxyrinchus oxyrinchus*, there are questions regarding annual migration patterns, spawning timing, and marine movements Six adult Atlantic Sturgeon from the Roanoke River were implanted with acoustic telemetry tags from 2010-2012 These sturgeon were monitored through a network of passive receivers in North Carolina and eight additional states We used a multi-state model to estimate movement probabilities among riverine, estuarine, and marine areas From September 2010 to December 2014, five of six of our Atlantic Sturgeon were detected in three different NOAA Distinct Population Segments Seasonally, sturgeon were observed to either spend the entire year in marine waters or winter-spring in marine waters, summer in Albemarle Sound and fall in the Roanoke River spawning The multi-state model suggests that movement probabilities were seasonably variable Annual estimated Atlantic Sturgeon mortality during the study was low (003) and detection probability high (>050) in most study areas Sturgeon were observed to spawn in consecutive years or with a year in between spawning events The complexity of Atlantic Sturgeon movements and the mixing of populations in marine waters add to the potential difficulty in managing the recovery of this species

What Did the Shad Say to the Fishway Entrance? More Water Please (Migratory Fishes)

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A common problem among fishways is attraction and entry Competing flows and complex hydraulics in and around the fishway can at times hinder passage and result in significant migration delays The purpose of this study was to evaluate how flow conditions at a fishway entrance and the structural design of the entrance can affect entry In most instances, a fishway entrance consists of a fully submerged hydraulic control (eg gate, weir) located at the downstream end of an open channel that guides fish to the main body of the fishway (eg lift, pool-and-weir) Changes to this hydraulic control design can influence the hydraulics (eg entrance jet velocity, flow pattern) and thus attraction and entry performance To address these issues, a pilot study was performed in 2016 with upstream-migrating, adult American Shad (*Alosa sapidissima*) which documented the performance of a variety of hydraulic controls under a limited number of conditions Water depth over the crest of the gate was shown to be the main driver in performance rather than gate design Additional trials were completed in the spring of 2017 and demonstrated similar results Water temperature also significantly affected fish performance in both years The results of these

studies provide guidance to state and federal resource agencies and the hydropower industry on methods to improve fishway attraction and entry rates

Temporal Variability in the Egress and Ingress of Southern Flounder in the NW Gulf of Mexico (Migratory Fishes)

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Southern flounder *(Paralichthys lethostigma)* populations in the northwestern Gulf of Mexico have been in decline in recent years, and improved knowledge of their migration patterns is needed to manage this important fishery The purpose of this study was to characterize the timing of egress and ingress events of southern flounder as well as to identify their migratory pathways in a Texas estuary Egress and ingress patterns were assessed using acoustic telemetry with receivers strategically placed throughout the Galveston Bay Complex (GBC), including the coverage of points of connection between bays and the tidal passes leading into the Gulf of Mexico (GoM) Vemco V-9 acoustic transmitters were placed inside the peritoneal cavity of adult southern flounder (range: 43-60 cm TL), tagged at several locations within the GBC to ensure that movement behaviors were representative of the subpopulation within this estuarine complex Southern flounder showed high site fidelity to tagging sites during summer, but made larger-scale movements (> 1 km) in the fall during the months of November and December Observed patterns of egress during the fall reflected contrasting migratory patterns, with some individuals migrating from the GBC to the GoM, while others were retained in the bay complex throughout the presumed spawning season Conclusions from this research will provide a better understanding of estuarine-coastal connectivity in southern flounder populations and identify specific factors affecting the timing and spatial configuration of crucial migratory pathways

Use of Video Monitoring to Quantify Spatial and Temporal Patterns in Fishing Activity across Sectors at Moored Fads Off Puerto Rico (Marine Fisheries)

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A key challenge in small-scale fisheries that use anchored fish aggregating devices (FADs) is the ability to accurately quantify multi-sector fishing activity through fishery independent methods Here, we present a novel fishery independent assessment of multi-sector fishing activity associated with a newly developed open access FAD program off San Juan, Puerto Rico We identified 3 fishing sectors (recreational, charter, and commercial) and 158 individual fishing vessels that routinely operated in the vicinity of FADs Results indicate that daytime fishing activity varied by time of day, day of week, by location, and sector During fishing tournaments, data revealed fishing activity increased threefold, across monitoring periods for-hire charter vessels were the most consistent day to day user segment, and recreational activity predominately occurred over weekends Our study represents a new technique to rapidly identify and detect multi-sector fishing activity near FADs and highlights the potential to gather comparable data wherever FADs are deployed Results are used to discuss how this technique can be used to assess the performance of FADs to identify sector overlap and guide management in determining deployment patterns and facilitate the design of cost-effective surveys to estimate MFAD vessel activity, and potentially catch, of MFAD associated species

Red Drum *(Sciaenops ocellatus)* Reproductive Biology in the North-Central Gulf of Mexico (Marine Fisheries)

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Understanding the reproductive dynamics of a fish stock is essential for conservation and management The Gulf of Mexico Red Drum (*Sciaenops ocellatus*) stock is a data limited species and is assessed using proxy methods that necessitate accurate information of life history dynamics including their age-specific reproductive patterns In this study, we describe the spawning season and length- and age-specific maturity dynamics of Red Drum Red Drum were collected in the north-central Gulf of Mexico from September 2016 through October 2017 (n = 743) using fishery-independent and -dependent methods Morphometric data and gonads were collected from each fish and age was determined from a subsample (n = 572) by extracting the otolith and quantifying the number of annuli present using established methods Integer age estimates were adjusted by accounting for the time between catch date and the assumed hatch date of October 1st Maturity status was determined using histological examination of reproductive tissue and used in combination with length and age data to determine the sex-specific mean length and age at 50% maturity with a logistic model Spawning season was determined using reproductive phase distributions by month, as determined with histology, and verified with gonosomatic indices Results indicate a spawning season of late July through mid-September The mean length and age at 50% maturity was 512 mm TL and 12 y for males and 563 mm TL and 21 y for females Red Drum stock assessments are sensitive to variation in reproductive inputs, thus the findings will be useful to increase precision of future assessment efforts

Say No to Floaters: The Effects of Venting and Descender Tools on Post-Release Survival of Black Sea Bass (Marine Fisheries)

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The usefulness of venting tools and descender devices to increase post-release survival of physoclistous reef fishes is unknown; their usefulness is likely water depth-specific We tested the ability of two commercially available venting tools as well as a descender device to increase post-release survival of black sea bass *Centropristis striata* caught and released in waters ~40 m deep, a depth where this species both targeted off of North Carolina and often unable to submerse without angler intervention We used capture-mark-recapture data to inform a relative risk model that evaluated the performance of each experimental treatment relative to controls (no venting or descending) Our updated results show that using an 11 gauge or 16 gauge venting needle increases the percentage of black sea bass that submerge after release relative to control fish (no intervention) However, the 11 gauge venting tool did not improve post-release survival compared to the control In contrast, the 16 gauge venting needle and descender device had relative post-release survival rates higher than control fish Using published information on absolute survival by condition, we estimate that the 16 gauge venting needle and descender at this depth may achieve post-release survival rates approaching 100% relative to ~70% for untreated (control) black sea bass These data give guidance to managers charged with seeking easy methods to reduce rates of discard mortality among reef fishes Further work on the usefulness of these efficient devices in other depths and other species is warranted

Dolphinfish Research Program: 16 Years of Collaborative Fisheries Science (Marine Fisheries)

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The Dolphinfish Research Program (DRP) has become the largest private research program aimed specifically at better understanding the movements, population dynamics, and life history of dolphinfish around the world From 2002 to 2017, at least 1,313 captains, aboard 1,332 vessels, and more than 3,285 fishing mates, participated in the release of over 21,511 dolphinfish around the world Of those fish, 580 have been recaptured, which amounts to the world's largest database on individual dolphinfish movements In addition, the program has deployed 17 satellite tags since 2006 to describe dolphinfish habitat utilization and migration routes Participants in the DRP are present in 25 countries and 43 states in America In the US Caribbean Sea (Puerto Rico and the US Virgin Islands), the program has been active since 2008, where 150 participants have tagged and released 742 dolphinfish, deployed 7 satellite and 9 acoustic tags, and since 2016, 20 vessels have contributed detailed catch information from more than 697 offshore fishing trips The northeast Caribbean Sea is a key location to continue to expand the DRP to further describe local movements and regional connectivity with not only northern Caribbean Islands and the United States, but within the Caribbean Sea as a whole, which is largely unknown Lastly, new data collection processes are beginning to establish a time series on seasonal variations in abundance and offshore catch per unit effort which can be useful to better understand high versus low annual runs of dolphinfish This type of information can be useful for fishermen to adapt fishing practices based on levels of abundance and fisheries managers to implement size or catch limits to prevent episodes of low productivity of seasonal runs

Data-Poor Subsistence Fisheries in Two Distinct Regions on the Tanzanian Coast: Specializations Drive Variability (Marine Fisheries)

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Near-shore marine fisheries provide the main source of protein for the nearly 9 million people in coastal villages of Tanzania, yet for decades the fisheries have shown signs of overexploitation These fisheries are small-scale and managed by local coastal communities in groups known as Beach Management Units (BMUs) BMUs record individual fishing trip data (eg gear, taxa, biomass, price), yet, there have been no formal analyses of catch data outside of the nationally aggregated catch statistics The purpose of this project was to identify any spatio-temporal trends in the landings data to develop actionable management plans We collected all available landings data from 2014 to 2017 from BMUs in fourteen villages in two spatially, socially, and ecologically distinct regions of the country Our results show that each village differed in the diversity of vessels, gears, and taxa captured, but every village was specialized in some measure (ie more than 50% of fishing trips involved a certain vessel, gear, or taxa captured) The diversity of gears used in particular villages varied substantially (eg ten gears in Kiechuru and one in Stahabu), which resulted in differences between captured taxa Collectively, BMUs reported fishers using 16 different types of gears, which were used to catch 61 different locally-identified taxa Two villages specifically landed octopus or parrotfish almost exclusively, suggesting potential community shifts after years of overexploitation The shift in effort toward certain taxa appeared to be strongly influenced by economic value and/or perceived taxa abundance, depending on whether the village fishery focused on catch for subsistence or sale to markets Although imperfect, the catch data collected by the community organizations has generated the first descriptions of how village-based fisheries in Tanzania function

Using these findings, we suggest implementation of fisheries management plans specific to each community Continuing to collect and analyze community collected data is necessary to gain insights on the range of specialization and diversity of small-scale fisheries that is required to improve current management programs

Seasonal and Daily Limnological Changes at a Pumped-Storage Reservoir (Fish Habitat 1)

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With increasing, intermittent renewables (eg solar and wind) on the US electrical grid, growing interest in energy storage has led to the potential for new pumped-storage hydroelectric development Pumped-storage uses two adjacent reservoirs to generate electricity (from upper to lower reservoir) during times of peak electric demand while replenishing water supplies (from lower to upper reservoir) during periods of excess generation Pumped storage systems can exhibit limnological impacts that are very different from traditional hydroelectric reservoirs that do not pump back from a lower reservoir

The impoundment of the Oconee River at Georgia Power's Wallace Dam in central Georgia forms Lake Oconee Another Georgia Power reservoir, Lake Sinclair, impounds the Oconee River immediately downstream These form the upper and lower reservoirs in a pumped-storage system, respectively We collected monthly temperature and oxygen profiles at nine stations on Lake Oconee from May 2015-August 2016 to characterize seasonal changes in water quality We also collected hourly profiles at seven stations over two 24-hour periods in July and August 2016 Our results indicated that pumpback operations often completely destratify much of the reservoir, with peak summer temperatures over 30°C from top to bottom Temperature appears to be a limiting factor for *Morone* species in Lake Oconee, however dissolved oxygen below the thermocline likely would be limiting given operations without pumpback Despite the summer mixing from pumpback operations, the reservoir supports a balanced and healthy warmwater fishery typical of southeastern reservoirs Mixing occurred throughout most of the reservoir, though some tributaries exhibited a tendency to stratify and appear somewhat isolated from the effects on the main stem of the Oconee River

Influence of Surface and Near-Surface Geology on Fish Assemblages in the Colorado River Basin of Texas (Fish Habitat 1)

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The Colorado River drainage is the third largest drainage in Texas and is of great importance both economically and ecologically Like most rivers, and especially gulf coast drainages, the Colorado River has great variation in water quantity, water quality, and corresponding species assemblages among its georegions, ranging from arid prairie streams in the west to gulf coastal river in the east In this study, our aim was to categorize the river into distinct georegions based on surface and near-surface geology and assess how each region's corresponding abiotic factors and anthropogenic alterations influence community structure as well as community resiliency, representation, and redundancy We found high correspondences among georegions, water quality, water quantity, and fish communities Georegion perspective enables a better understanding of mechanisms underlying community structure and how anthropogenic alterations differentially affect community structure

Establishing Environmental Flows in Puerto Rico: Past Efforts, Lessons Learned, and the Challenges Ahead (Fish Habitat 1)

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Water management policy in Puerto Rico prioritizes meeting human water supply needs before any other water use For instance, at low flows, such policy establishes that other water uses can be met once human water supply needs are satisfied Here we present a summary of recent efforts to establish environmental flows in Puerto Rican rivers, with emphasis on the 2015 drought While we present an islandwide assessment, we focus on the Rio Fajardo, where recent changes in river management incorporated a novel water extraction design with environmental flows considerations Our investigation revealed that despite some important advances, much efforts are still required to improve river habitats and lotic ecosystems below water intake structures Particularly during droughts, integrated and coordinated river management efforts will be critically needed to minimize impacts to river biodiversity while meeting human population water supply needs

Habitat Associations and Guild Assignments of Inland Fishes within Gulf Slope Drainages of Texas and Louisiana (Fish Habitat 1)

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Aquatic communities are determined through several coarse and fine filters, causing fish-habitat associations to differ at local scales Heterogeneity in fish-habitat associations allow for management and research opportunities Managers group species into guilds based on habitat associations in order to classify fish in to manageable categories, (*eg,* IBI guilds) Functional guilds are also useful in ecological and evolutionary comparisons and analysis However, the current problem with functional habitat guilds are that they are often made from qualitative or binomial data, and rarely are at fine scale quantification When quantitative approaches are used, they often rely on small sample sizes of one population to make inferences for habitat associations of a species Fish biologists, managers, and ecologists are in need of high resolution species habitat association guilds, which are supported by a large sample size across many basins Habitat association guilds derived from large sample sizes covering multiple drainage basins will help managers and researchers in accurate and precise production of functional guilds from habitat In this study we used data from >1 million observations (*ie,* individual fishes) collected over 16 years from university, government, and private consulting studies in an effort to quantify habitat associations and prescribe high resolution habitat association guilds to over 144 species from Texas and Louisiana Habitat association variables explored were mesohabitats (*ie,* riffle, run, pool, backwater), % substrate (*ie,* clay, silt, sand, gravel, cobble, boulder, bedrock, detritus), % cover, % vegetation, % large woody debris, current velocity, depth, temperature, conductivity, pH, and dissolved oxygen We found variability in habitat associations between species Guild classifications were formed using ACFOR (Abundant 75-100%, Common 50-74%, Frequent 25-49%, Occasional 5-24%, Rare 0-4%) scale for proportional data, and using quartiles from all sampled habitats for continuous data categories Production of habitat association guilds will be beneficial for future management and research questions

Understanding Trends in Catch, Size, Abundance, and Potential Ecological Impacts in Ornamental Fishes of the Florida Keys Reef Tract (Fish Habitat 1)

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Coral reefs provide habitat to a wide-variety of reef fishes However, reef fish management often focuses on economically valuable sport and food fishes Comparatively, limited resources have been allocated

toward management of other ecologically valuable species such as ornamental reef fishes The goal of the current study was to evaluate fishery-independent and fishery-dependent monitoring data to assess temporal population and catch trends of ornamental reef fish species in the Florida Keys reef tract from 2001 to 2016 Fishery-independent Reef Visual Census (RVC) monitoring data collected by NOAA's National Coral Reef Monitoring Program (NCRMP) were used to evaluate population trends in ten groups of ornamental reef fishes Similarly, fishery-dependent marine life harvest monitoring data collected by Florida Fish and Wildlife Conservation Commission (FWC) were analyzed for trends in catch and then were compared to NCRMP independent data Our analyses indicated an increase in ornamental reef fish abundance and a decrease in the number of marine life harvests over time The lack of exploitation of ornamental fishes by the marine harvest fishery is promising, however, this fishery is small and likely not responsible for the observed abundance increases Instead, population increases may be attributed to a larger-scale trophic release caused by the decline of larger, economically important reef fishes that typically control ornamental fish populations While this shifting baseline is concerning to managers, increases in ornamental fishes may be beneficial to the Florida Keys as these readily recognizable, colorful fishes are considered eco-tourism (snorkeling, diving, etc) favorites

Seasonal Food Habits of Introduced Blue Catfish in Lake Oconee, Georgia (Nonindigenous Fishes 1)

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Blue catfish (Ictalurus furcatus) are native to the Coosa River drainage in northwest Georgia, but have been widely introduced outside of this range, including Lake Oconee, a 7677-ha impoundment on the Oconee River in central Georgia Blue catfish abundance and growth rates have increased dramatically since their introduction in Lake Oconee, but their food habits are unknown Therefore, food habits of blue catfish in this impoundment were determined by examining the stomachs of 808 specimens in the reservoir's upper and lower regions across all seasons from summer 2012 to summer 2013 Diet was summarized using the Relative Importance of specific prey by weight In the upper region of the reservoir, Asian clams (Corbicula fluminea) were the dominant prey item during the summer (757%), fall (664%), and winter (376%); whereas, crappie (Pomoxis spp) was the dominant prey item in the spring (387%) Asian clams also were the dominant prey items in the lower region during the fall (684%) and winter (339%), and spring (364%) Blue catfish seemed to feed opportunistically on seasonally abundant prey items in both the upper riverine and lower lacustrine portions of the reservoir Of the many sportfishes in the reservoir, only crappie was an important prey item in the upper region during the spring Our results do not support concerns that blue catfish are an apex predator that would decimate the sportfish assemblage in the recently colonized reservoir

Invasive Blue Catfish in the Chesapeake Bay Region: Status and Outlook (Nonindigenous Fishes 1)

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The introduction of non-native blue catfish *Ictalurus furcatus* in tributaries of the Chesapeake Bay resulted in the intended establishment of a recreational fishery, and in the inadvertent expansion of populations into brackish habitats Having spread from stocked tributaries to new systems, blue catfish are considered an invasive species in the region, and management is hampered by competing objectives, namely, limiting ecological impacts on native communities and supporting trophy fisheries We discuss management approaches recommended by the Invasive Catfishes Task Force for controlling the spread of invasive blue catfish in light of our estimate of population size (164 million fish; 95% confidence interval [CI]: 093 –

291 million) from a multi-year tagging study in the James River subestuary, and of salinity tolerance (72-hr lethal concentration: 157 psu; CI: 147 – 161 psu) from an acute salinity tolerance experiment Observations from a long-term trawl survey and a dart-tagging study support the habitat suitability model predictions that blue catfish are physiologically capable of exploiting estuarine environments (> 10 psu) and using these habitats to invade new river systems, particularly during the wet months The large population size, generalist feeding strategy and high salinity tolerance of blue catfish highlight the need to identify effective management measures for this species

Expansion of Northern Snakehead in the Chesapeake Bay Watershed (Nonindigenous Fishes 1)

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Northern Snakehead (*Channa argus*), non-native to North America was discovered in tidal freshwater of Potomac River in 2004 Since then Northern Snakehead has expanded its range throughout the tidal Chesapeake Bay watershed We estimate that the species has spread at a rate of about 27 sub-watersheds/year The rate of expansion in Maryland's portion of the Chesapeake Bay watershed has been consistent over time with exception to short periods of expansion that followed heightened levels of spring precipitation This rate of expansion is greater than that of other invasive fishes of the Chesapeake Bay, which include Blue Catfish (*Ictalurus furcatus*) and Flathead Catfish (*Pylodictus olivaris*) Attempts at controlling the spread of the species have included public education, incentives for harvest, agency surveys, and law enforcement The rapid and natural expansion of Northern Snakehead in the nation's largest estuary highlights the importance of federal and state laws that prevent importation and live possession of the species

Predictive Modeling of Northern Snakehead Range Expansion in Arkansas and Mississippi (Nonindigenous Fishes 1)

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Northern Snakehead *Channa argus* have been expanding their range within Arkansas and more recently into Mississippi We examined snakehead range expansion from 2008 to 2017 for potential spatial trends using a GIS Initial analysis of presence-only location data indicated very little movement of the mean (geographic) center of snakehead locations over time, however, location data exhibited a trend of north-south expansion directionality rather than east-west We also attempted to characterize areas of Arkansas and Mississippi that might be most susceptible to colonization We used machine based learning maximum entropy modeling (Maxent v341) to predict distribution likelihood in new areas based on presence data and environmental constraints Environmental parameters of the model included land cover and crop type, mean minimum and maximum temperatures, and mean annual precipitation Based on Maxent models the GIS generated maps of areas in Arkansas and Mississippi with a low to high likelihood of colonization Although preliminary and not fully comprehensive, these models have the potential to inform researchers and agencies about snakehead movement into new areas and provide insight on where the forefront of invasion is likely to occur

Estimating Effective Water Conductivity Ranges for Four Backpack Electrofisher Models (Gears and Techniques)

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There are several considerations when selecting electrofishing gear One important factor is the range of water conductivity the unit can efficiently sample Effective range is the span of water conductivity wherein the electrofishing unit can output the required amount of power for successful sampling Effective water conductivity ranges of four backpack models were estimated in the lab under a simulated ambient water conductivity interval of approximately 15 µS/cm – 11,538 µS/cm Waveforms applied were pulsed direct current (PDC), 60 pps, and either 15%, 20%, 25%, or 30% duty cycle Maximum outputs (volts, amps, power) at a given water conductivity were measured and compared to power required based on the power transfer model and unpublished data collected during electrofishing classes in small, shallow streams (250 W at 115 µS/cm water conductivity) Effective range of conductivity narrowed with increasing duty cycle For a PDC, 60 pps, 25% duty cycle waveform, the estimated effective conductivity ranges were:

Infinity Xstream (Midwest Lake Electrofishing Systems): 16 – 2,700 µS/cm

LR-24 (Smith-Root, Inc): 19 – 830 µS/cm

ABP-3 (ETS Electrofishing Systems, LLC): 38 - 625 µS/cm

Model 12-B POW (Smith-Root, Inc): 40 – 375 µS/cm

Georeferenced Video and Sensor Technologies for Aquatic Habitat and Fish Species Distribution Mapping (Gears and Techniques)

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New georeferenced technologies have revolutionized aquatic habitat and species distribution mapping A variety of video and sensor platforms have been developed to quickly and accurately acquire georeferenced underwater data and provide opportunities for large-scale mapping Improvements in GPS positioning, as well as video and data storage capacities have allowed this technology to become available for implementation The presentation includes boat-based deep-water ocean mapping, canoe-based river mapping, kayak-based stream mapping, snorkel and scuba-based mapping, and shallow water backpack-mounted pole camera mapping Capturing georeferenced video, side scan sonar and water quality data provide GIS attributes for a variety of aquatic applications Techniques to define optimum habitat locations and habitat suitability indices for endangered fish and other aquatic species was developed and implemented The systems offer low-cost mapping solutions, and easy access to diverse aquatic environments All information is stored within the ArcGIS environment, and the video footage is available for historical reference

Switching Gears in a Multispecies Fisheries Survey in Chesapeake Bay: Calibration Trials & Tribulations (Gears and Techniques)

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A bottom-trawl survey to assess recruitment of fishes and blue crabs in Chesapeake Bay was initiated in 1955 and has since undergone considerable changes in sampling gear and methodology Recently, a new vessel, the R/V *Tidewater,* replaced the R/V *Fish Hawk,* which had been in service for 25 years In addition to the change in vessel, a new net was adopted to reduce variability in net performance Therefore, a calibration study was conducted to estimate species-specific factors necessary to adjust catches from the

R/V *Tidewater* Comparison sampling with the R/V *Tidewater* and R/V *Fish Hawk* was conducted monthly between April 2014 and May 2015, with additional paired tows in August 2016 We completed 1,141 paired tows, and yet, for some species, sample size was insufficient to estimate relative catch efficiency of the new vessel and net We used beta-binomial models for overdispersed data to estimate calibration factors for species groups (species-size combinations) with 50 or more paired tows In addition, we investigated the use of surrogate species to permit estimation of calibration factors where fewer paired tows existed The surrogate-species approach was not supported, likely due to subtle differences in behavior among species during trawl-gear encounters Our whole-survey approach allowed us to estimate calibration factors for species in all habitats that are routinely monitored by the survey Further, inclusion of a multitude of factors in the calibration models ensured applicability of calibration factor estimates across the range of estuarine characteristics that are inhabited by these species Calibration factors were applied to catches of the R/V *Tidewater* since 2015, thus preserving the integrity of the long-term survey data for estimating relative abundance of juvenile fishes and blue crabs in Chesapeake Bay

Implementation of a Passive Acoustic Monitoring System on a SV3 Wave Glider and Application to Identify Grouper Spawning Aggregations (Gears and Techniques)

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Fisheries independent research strives for new technology that can help remotely and unobtrusively quantify fish biomass Some large fish species, such as groupers vocalize during mating Fish sounds provide an innovative approach to assess fish presence and numbers However, large datasets make the detection process by a human ear very tedious and lengthy We have developed an algorithm based on machine learning and voice recognition methods to identify and classify fish sounds This algorithm currently operates on a SV_3 Liquid Robotics wave glider, which has been fitted to accommodate a passive listening device Fish sounds detection and classification results, and location, along with environmental data are transmitted in real-time to the science crew who can ground truth the detection with divers This passive acoustic monitoring system was deployed in the US Virgin Islands, Puerto Rico, the Florida Keys and on the East Florida shelf The detection algorithm proved comparable to humans for well defined calls, but faint or distorted calls were more difficult to detect Limited surveys confirmed known test aggregations and located potentially new spawning sites The glider also proved capable of mapping the spatial extent of spawning aggregations

Variation in Strontium Abundance in Calcite and Vaterite Calcium Carbonate Polymorphs of Otoliths (Gears and Techniques)

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Aquatic organisms record ecosystem properties such as contamination, temperature, and land-use by incorporating elemental and isotopic environmental markers from water into calcium carbonate ($CaCO_3$) structures like earbones and shells While environmental interpretation of $CaCO_3$ structures is not new, recent work shows structures containing more than one $CaCO_3$ polymorph—a fairly common occurrence among aquatic organisms— requires accounting for density differences among polymorphs when interpreting environmental markers This study seeks to couple ecological approaches for quantifying trace elements found in calcium carbonate ($CaCO_3$) structures of aquatic organisms with materials science

techniques to overcome the inability of current environmental techniques to account for all $CaCO_3$ polymorphs Specifically, we will 1) quantify and spatially map $CaCO_3$ abundances, 2) spatially quantify elemental abundance of strontium (Sr)—the most commonly examined trace element in otoliths, and 3) merge spatial data on polymorph distribution with Sr data to understand links between different forms of $CaCO_3$ and Sr Like previous reports on the effects of $CaCO_3$ polymorphs on trace element distributions, we found that Sr concentrations differed between calcite and vaterite portions of sturgeon otoliths However, we also report that based on position, size and Sr concentrations in calcite crystals of these otoliths that sturgeon otoliths may be primarily composed of calcite during early life history and vaterite as fish age Changes in polymorph composition of a fish otolith with age has never before been reported in fish but bears heavily on the analysis and interpretation of otolith trace element chemistry data As well, this is the first study to examine differences between calcite and other forms of $CaCO_3$ Calcite is commonly found in many other forms of $CaCO_3$ structures of aquatic organisms such as coral and mussels and can aid investigators in interpretation of their trace element chemistry data

Application of Otolith Chemistry to Assess Population Structure of Snowy Grouper in the Gulf of Mexico (Gears and Techniques)

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Snowy Grouper (*Hyporthodus niveatus*) are valuable components of the recreational and commercial fisheries in both the western Atlantic Ocean and Gulf of Mexico Despite the ecological and economic importance of the species, relatively little is known about the population structure of Snowy Grouper and recent stock assessments indicate that stocks are overfished (western Atlantic) and/or data deficient (Gulf of Mexico) The population structure of Snowy Grouper was assessed with otolith chemistry using archived otolith samples from four regions (south Atlantic, northwestern, northcentral and northeastern Gulf of Mexico) collected over two years (2012 – 2013) Lifetime element:Ca ratios (Li:Ca, Mg:Ca, Mn:Ca, Sr:Ca, Ba:Ca) were quantified from the core to the edge along the sulcus with laser ablation inductively coupled plasma mass spectrometry Results indicated that otolith chemistry varied regionally for Snowy Grouper, implying that discrete stocks may exist in US waters with limited exchange of individuals inhabiting the different regions investigated This species is currently managed as a single stock, and our results suggest that the current approach may need to be altered Future otolith chemistry analyses on additional years, in conjunction with genetic approaches, are needed to determine the stock structure and population connectivity of Snowy Grouper

Disentangling *Sicydium* Diversity in the Western Atlantic (Genetics and eDNA)

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Sicydium is a genus of amphidromous gobies native to high gradient insular and small coastal streams of the tropical eastern Pacific and Atlantic basins Of the 23 nominal species, 18 are currently recognized as valid Seven of those species are found in the western Atlantic Morphological and molecular analyses both suggest a lower diversity in the western Atlantic with four or five lineages present, but they differ in lineage composition While oral morphology and dentition offer key diagnostic characters, molecular results suggest that some morphological species represent either *very* recent speciation events or strongly divergent, binary, plastic tooth morphologies

Genetic Analysis Reveals Complex Genetic Structuring and Historical Biogeographical Patterns in the Macrhybopsis Species Complex (Genetics and eDNA)

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Fishes from the *Macrhybopsis* complex (*M hyostoma*, *M australis*, *M tetranema*, *M marconis*, and *M aestivalis*) were sampled throughout their Texas ranges for population genetic analysis; a total of nine rivers were sampled We utilized SNPs to better understand the underlying genetic relationship among members of this closely related species complex and to interpret their genetic structuring in a historical biogeography pattern A total of 32,297 SNPs were used in all analysis Entropy (a Bayesian genetic clustering analysis) was run with groups ranging from k 2 – 6; this analysis was used to determine the underlying genetic structure of the complex and to interpret their historical biogeographical divergence patterns PCA plot and k = 2 show a divide between several of the species: group one consists of species from the Red, Pease, Wichita, and Canadian Rivers (*M hyostoma, tetranema,* and *australis*), with the other group consisting of species from the Colorado, Brazos, Guadalupe, and San Antonio Rivers (*M hyostoma,* and *marconis*); the Rio Grande River (*M aestivalis*) shows admixture between the two groups At k = 3, the major groupings are the *M marconis* populations, Brazos and Colorado River *M hyostoma*, and Red River drainage *M australis* At k = 4 and 5, there is not much of a change, the additional groupings are adding in as admixture in the already existing groups However, at k = 5, individuals from the Canadian and Rio Grande are clustered in the same group We believe the most biologically relevant k is 6 genetic clusters The six clusters are Brazos and Colorado River *M hyostoma*, Red River *M hyostoma*, Wichita, Pease, and Red River *M australis*, Colorado, Guadalupe, and San Antonio *M marconis*, Canadian River *M tetranema*, and Rio Grand River *M aestivalis* The highest genetic diversities were found in the Red River fishes (*M hyostoma* and *australis*), followed by the Canadian (*M tetranema*), Pease and Wichita Rivers (*M australis*) The lowest genetic diversities were found in the Colorado, San Antonio, and Guadalupe *M marconis* The genetic structuring found in the entropy analysis reveals complex historical divergence patterns with regards to biogeography In general, we see northern, southern, and mid-latitude groups distinct first with mixed ancestry before the species split out at k = 6 This indicates that historical rivers and stream captures played an important role in the formation of this species complex

Use of Environmental DNA to Assess Population Genetics of Blackbanded Sunfish *Enneacanthus chaetodon* (Genetics and eDNA)

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This project is intended to provide a comprehensive and proactive assessment of the distribution and genetic health of populations of *Enneacanthus chaetodon* in SC and GA through the development and application of a new eDNA tool combined with traditional surveys and population genetics We developed and optimized an eDNA tool capable of detecting *E chaetodon* in environmental water samples, and subsequently visited 61 sites in SC and GA to collect replicate water samples for testing with the tool Results in GA documented detection of Blackbanded Sunfish at one site with a previously known population as well as at four sites with previously unknown populations (16% of all sites were positive) All of the positive detections in GA, including the positive control site, showed signals of low *E chaetodon*

DNA concentrations The SC results indicated that 9 of the 30 sites were positive (30% of sites positive) All detections in SC showed signals of relatively high concentrations of DNA present, as we were able to amplify 80% to 100% of replicate water samples at each positive site We revisited all positive eDNA sites and sampled them with substantial effort and multiple gear types (ie seines, dip nets, traps, electrofishing) to support a population genetic health assessment Despite considerable efforts, we were unsuccessful in collecting Blackbanded Sunfish at any of the sites in GA; however, sunfish were collected at all nine sites in SC, ranging from 3-34 individuals/site (total n = 193) Fin clips of all these individuals were taken back to the lab and were supplemented with all archived samples at the SCDNR's genetics lab and samples made available by collaborators in other states for a total of 364 samples of *E chaetodon* across 34 different collection sites and eight states along the east coast Genetic population structure results indicated that Blackbanded Sunfish were highly isolated by collection site Clustering in Structure indicated that the greatest differentiation occurred when sunfish were assigned to two groups with the division occurring between northern (NJ, DE, MD) and southern (SC, GA, FL) collection sites and the one individual from VA showing signatures of admixture between the north and south Overall, heterozygosity was low, particularly in the northern populations where some genetic diversity metrics exhibited extremely elevated levels of inbreeding In the south, diversity metrics were slightly elevated relative to the north, but still considered low with isolated instances of high inbreeding

Introgression of Florida Largemouth Bass Genetics in Two Large Arkansas Reservoirs: A Success Story? (Genetics and eDNA)

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Florida Largemouth Bass (*Micropterous salmoides floridanus*) have been stocked into Arkansas waters since the late 1970's with the intent of increasing the opportunity for anglers to catch trophy bass Initially, Florida Largemouth Bass were only stocked into small south Arkansas reservoirs with suitable habitat (eg complex cover) Beginning in the early 1990's black bass anglers from the west central region of Arkansas began lobbying fisheries biologists with the Arkansas Game and Fish Commission (AGFC) to introduce Florida Largemouth Bass into Lakes Ouachita (16,188 ha) and DeGray (5,423 ha), both major highland Corps of Engineers reservoirs During the spring of 2006 and 2007 AGFC initiated a new stocking strategy of introducing Florida Largemouth Bass into select arms of Lakes Ouachita and DeGray Fingerling Florida Largemouth were stocked into both reservoirs at a rate of 100 fingerlings/acre with the goal of 40% gene introgression after eight consecutive years of stocking During the spring of 2015 and 2016 more than 400 Largemouth Bass fin clips were collected from both reservoirs for microsatellite analysis to evaluate the percent of Florida Largemouth Bass gene introgression

Genetic Composition of Largemouth Bass Populations Stocked with Florida Bass in Tennessee (Genetics and eDNA)

John Hargrove, Tennessee Tech University, Mark Rogers, US Geological Survey Tennessee Cooperative Fishery Research Unit and W Pat Black, Tennessee Wildlife Resources Agency*

Largemouth bass (*Micropterus salmoides*) are the most widely sought after freshwater sport fish in North America, and stocking of hatchery-reared bass to alter size structure and abundance is widespread In particular, Florida bass (*M floridanus*) have been stocked outside their native range to positively influencing growth patterns, and subsequent to their introduction, numerous states (eg, California, Oklahoma, Texas) have logged new record sized bass In Tennessee, the stocking of Florida bass for the establishment of

trophy fisheries began in 1997 and continues to this day In the present study, we report on the genetic composition of populations stocked with Florida bass to determine the extent of genomic introgression and relative frequency of hybrid classes (ie, pure strain vs first generation hybrids or backcrosses) Using a panel of species-diagnostic SNPs we show that levels of genetic introgression vary as a function of water body, a trend potentially explained by variation in stocking in the different reservoirs The use of genetic monitoring tools as presented here represents critical components to long-term management of black bass in Tennessee

Monitoring the Dispersal, Behavior, and Fate of Stocked Rainbow Trout, Oncorhynchus mykiss, in an Alabama Tailwater (Freshwater Fisheries 1)

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Hypolimnetic discharge from reservoirs in the southern United States provide cold enough water temperatures (< 20° C) to support successful Rainbow Trout fisheries in regions where they otherwise could not exist These tailwater trout fisheries remain widely popular for recreational anglers and are of major socioeconomic significance The objective of our research is to describe post-stocking dispersal, behavior, and fate of Rainbow Trout cohorts stocked in the Sipsey Fork tailwater below Lewis Smith Dam in Northern Alabama In a recent creel survey, only 4 to 23% of the trout stocked each month were harvested indicating that the ultimate fate of the majority of stocked Rainbow Trout is unknown In spring, summer, fall, and winter 2017, we tagged and manually tracked cohorts of Rainbow Trout to document movement patterns and determine approximate longevity in the fishery Tagged trout were tracked twice a week for the first four weeks post-stocking, once a week during the next four weeks, and then biweekly for the next two months We calculated Rainbow Trout dispersal, range, and fate using ArcView Knowledge regarding the dispersal and fate of stocked Rainbow Trout in this system will allow more efficient management of the fishery, leading to increased recruitment, retention and satisfaction of anglers that utilize this resource

Harvest in Remote Headwater Streams Alters Native Brook Trout Populations (Freshwater Fisheries 1)

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In their native range, Brook Trout (*Salvelinus fontinalis*) commonly inhabit cold, headwater streams In the central Appalachians, Brook Trout are a popular target of anglers, but given the remoteness of these systems traditional means of evaluating possible impact of angling are impractical We used a combination of angler surveys, fish population surveys, and motion activated cameras to determine the sizes and numbers of fish harvested, trout size structures, and angler effort in six streams in West Virginia Anglers retained 45 fish ≥ 170 mm TL per trip Between 13 March – 29 May, we estimate anglers harvested 02 to 41 fish per 100 m in the six streams Harvest rate of catchable-sized fish ranged from 002-110 and streams with lower productivity (lower numbers of catchable-sized fish) tended to have higher harvest rates Size structure of streams with high harvest showed truncated size structure at about 170 mm TL These results suggest low productivity streams are particularly sensitive to harvest Further, with abundant under-sized fish in these streams, post-release mortality may be an important factor limiting production of larger fish, particularly in low productivity streams

Paddlefish Management in Oklahoma: From Brushfire to Industry Leader in Ten Years (Freshwater Fisheries 1)

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Nongame fisheries management presents economic and social challenges for state managers when funding originates from angler license sales and constituent excise taxes Prior to 2008, Oklahoma Paddlefish management was hands-off and reactionary; however, a new research model facilitated the cultivation of a self-funded, sustainable harvest program allowing for in-depth species and ecological research while promoting a blue-ribbon destination fishery In this paper, we present a retrospective on the development of the Paddlefish Research Center and discuss the funding model of roe donation/caviar sales from recreational anglers A key aspect of the program's success has been the social elevation of Oklahoma Paddlefish from "trash fish" to trophy status through careful regulation and wide-reaching advocacy We highlight the numerous conservation actions and Paddlefish research findings that drive the program (eg physiology, genetics, life history and movements, spawning and recruitment, habitat use, fishery economics, and angler demographics) Lastly, we summarily discuss how the program has been a win for anglers, the state, and the resource

Utility of a Chase Boat for Sampling Blue Catfish in Six Arkansas Reservoirs (Freshwater Fisheries 1)

Zach Moran, Arkansas Tech University and Joe Stoeckel, Fisheries and Wildlife Program, Arkansas Tech University*

Contemporary studies have demonstrated chase boats to be useful when sampling Blue Catfish *Ictalurus furcatus*, and have thus resulted in their use becoming a standard for most sampling protocols However, the additional effort of a chase boat is often ignored when calculating catch per unit effort (CPUE) In addition, no studies have compared the size structures of a combined chase boat and electrofisher to those of a single electrofisher We systematically sampled six different waterbodies in central and east-central Arkansas when water temperatures were >28˚C, and collected 4,829 Blue Catfish Catch per unit effort (CPUE) and catch per unit effort per person per hour (CPUE/person-hour) were calculated for a single electrofisher and the electrofisher and chase boat combined, and compared using a Wilcoxon Signed-Rank test Proportional size distribution (PSD) categories were calculated for a single electrofisher and electrofisher and chase boat combined, and compared using a two-way analysis of variance Use of a chase boat was observed to increase efficiency when large numbers of fish surfaced, and captured more large fish However, when additional effort was incorporated, efficiency with a chase boat was nearly identical to that of a single electrofisher When low numbers of fish surfaced, the addition of a chase boat caused CPUE to decrease PSD of a single electrofisher and electrofisher and chase boat combined did not differ statistically We recommend that managers consider water body size, and fish abundance before incorporating the use of a chase boat for management purposes

Efficacy of Length and Bag Limits for Structuring Texas Blue Catfish Populations: Could a Relaxed Slot Limit Increase Trophy Potential? (Freshwater Fisheries 1)

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We assessed the effectiveness of Texas' Blue Catfish (*Ictalurus furcatus*) regulations using an age-structured dynamic pool model The model was parameterized using an extensive literature review and available data from across the United States Blue Catfish populations were simulated under various harvest conditions over a 100-year chronology, and results were reported as the mean of 1,000 simulations Rather than directly varying exploitation, we varied length and bag limits, the factors we can control Our outputs were relative population size, harvest, yield, and percentage of trophy-sized fish (>762 mm) We compared the current regulations to a relaxed slot limit option that allowed unlimited harvest below and above the slot and 2, 5, or 10 fish within the slot Our modeling results indicated that, based on current angling in Texas, the existing regulations have little impact on Blue Catfish populations or harvest On the lower end, because anglers prefer larger fish, we conclude the statewide minimum length limit of 305 mm has little effect on harvest On the trophy end of the spectrum, limiting harvest of fish over 762 mm has limited utility because relatively few fish reach this size In contrast, we saw that implementation of a 508 mm to 762 mm relaxed slot limit, with 2 fish in slot nearly doubled the trophy potential Our results suggest that most of Texas' current catfish fisheries could be managed with a relaxed slot with a variable number of fish allowed within the slot

Multi-Year Evaluation of a 14-in Minimum Length Limit for Smallmouth Bass Micropterus Dolomieu in the Eleven Point River (Freshwater Fisheries 2)

Brett Timmons, Arkansas Game and Fish Commission, Jeremy Risley, Arkansas Game and Fish Commission, Sam Henry, Arkansas Game and Fish Commission, Casey Cox, Arkansas Game and Fish Commission and Allison Asher, Arkansas Game & Fish Commission*

The Eleven Point River is 138-miles long, running through southern Missouri and northern Arkansas The Arkansas portion of the Lower Eleven Point River consists of a 40-mile stretch in northern Arkansas In 2005, the Smallmouth Bass *Micropterus dolomieu* minimum length limit (*MLL*) and creel were changed from 305 mm *MLL* and 4-fish creel to a 355 *MLL* and a 2-fish creel Smallmouth Bass were sampled in the fall of 2002 -2004, 2011-2012, and 2017 Mean lengths (± SD) for 2002-2004, 2011-2012, and 2017 were 2442 ± 697 mm, 2515 ± 721 mm, and 2535 ± 765 mm, respectively Mean ages for 2002-2004 and 2011-2012 were 2 yr and 3 yr Growth rates (k) for 2002-2004, 2011-2012 were 029 and 015 Years to reach 355mm (14 in) in 2002-2004 and 2001-2012 were 44 yrs and 54 yrs Total annual mortality of 2002-2004 and 2011-2012 were 61% and 50% Differences in mortality were analyzed using the homogeneity of slopes assumption of analysis of covariance (ANCOVA) No significant difference was found in mortality between the 2002-2004 and 2011-2012 groups (ANCOVA $F_{3,9} = 073$, $P = 048$) Further analysis and comparison of the 2017 data to previous year's data will be presented

Regulation Evaluation on a Coastal Largemouth Bass Population (Freshwater Fisheries 2)

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Length-based regulations remain the primary approach to black bass management, however effectiveness can vary depending on angler attitude towards harvesting fish Voluntary catch and release of legal-sized fish can render length limits useless, while abuse of liberal length limits can lead to overexploitation of sport fish populations Therefore, it is important to have knowledge of angler attitudes paired with current information on population dynamics to effectively measure success of regulations following implementation A new statewide regulation of a 16" maximum length limit necessitates the need to compare angler attitudes and population dynamics of the Largemouth Bass population in the Escambia River Marsh before and after implementation of this regulation Relative abundance from day-time electrofishing samples was used to quantify change in population size between years A random

subsample (20%) were sacrificed for age and growth determination to evaluate year-class strength and total annual mortality Access-point creel surveys were conducted to determine angler attitudes towards Largemouth Bass harvest This comprehensive approach will provide important data on population dynamics and determine temporal changes in angler attitudes, both before and after implementation of the regulation

Evaluation of a Largemouth Bass Selective Breeding Program: Emphasis on Performance and Maximizing Trophy Production (Freshwater Fisheries 2)

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The Texas Parks and Wildlife Department (TPWD) initiated the ShareLunker program in 1986 to encourage public participation and involvement in the management of trophy Largemouth Bass (*Micropterus salmoides;* LMB) fisheries in Texas, and enhance growth and survival of LMB through selective breeding While the program has been successful in promoting trophy LMB fishing in Texas waters, evaluation of the program's influence on growth and survival has been limited To this end, we compared growth and relative survival between ShareLunker offspring (LOS) and hatchery-produced Florida Largemouth Bass offspring (HOS), at ages-1 and 4 While data collection for all study lakes remains in progress; preliminary analyses indicated significant differences in both length (age-1 = 308 vs 283 mm; age-4 = 517 vs 475 mm) and weight (age-1 = 042 vs 029 kg; age-4 = 249 vs 175 kg) ShareLunker fish also demonstrated a substantial relative survival advantage at both age-1 (059 versus 041) and age-4 (062 versus 038) Our results to date suggest stocking selectively bred trophy LMB can enhance performance traits (ie, increased growth and survival) and thus, may be an effective management tool to maximize trophy LMB production potential These results may have further implications for hatchery production of other species across a wide geographic range

An Evaluation of Redbreast Sunfish Stocking in a Southeastern Blackwater River (Freshwater Fisheries 2)

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A stocking evaluation of redbreast sunfish is in progress on the Edisto River, South Carolina At about 250 miles, the Edisto is the longest free flowing black water river in the United States It supports a vital redbreast sunfish fishery and has been stocked routinely with the species since 1995 Stocking was begun in response to the appearance of the non-native flathead catfish, and concerns about how the species would affect the redbreast fishery Contribution of stocked redbreast sunfish has not previously been evaluated We released oxytetracycline marked redbreast fingerlings into an area defined by four contiguous stocking zones of the Edisto River's main stem, while stocking above and below these zones was halted Contribution was evaluated from collections made one year post stocking For year classes evaluated to date, stocked fish contribution varied by both zone and year Contribution within stocking zones ranged from 0 to 30 percent Average contribution across zones by year ranged from 9 to 21 percent River hydrology varied widely across years as well These results will be presented, and how they may inform future management efforts discussed

Effects of Common Angler Handling Techniques on Florida Largemouth Bass Behavior, Feeding, and Survival (Freshwater Fisheries 2)

Mike Allen, University of Florida, Yasmin Quintana, University of Florida, Jordan Skaggs, University of Florida, Nick Trippel, Florida Fish and Wildlife Conservation Commission, Michael Matthews, Florida Fish and Wildlife Conservation Commission and Stephanie Shaw, University of Florida*

Black bass *Micropterus* spp support popular freshwater sport fisheries in North America Bass anglers commonly adopt catch and release as a conservation practice, and frequently over 75% of angled black bass are released back into the water If fish survive the angling event, the practice of catch and release as an alternative to harvest reduces direct mortality, but it has the potential to affect the postrelease feeding behavior and survival of the fish The act of lifting black bass for handling, hook removal, and photograph opportunities may cause stress and injury, and the degree of injury sustained could be influenced by fish size Holding fish in a tilted grip by the jaw has raised concern among anglers about potential damage to jaw musculature and tendons, as they may not support the fish's body weight out of water, particularly for trophy bass We conducted an experiment with Florida Largemouth Bass *M salmoides floridanus* to evaluate the relative differences in survival, jaw mechanics, and feeding success after the use of three common handling treatments: (1) a vertical hold using a lip-grip device (vertical treatment); (2) a tilted, one-handed grip using only the lower jaw (horizontal treatment); and (3) two-handed support to the lower jaw and body (support treatment) The time taken by fish to regain equilibrium and resume normal swimming behavior after handling differed among the three treatments; the recovery period was shortest for fish in the support treatment (mean ± SD = 7 ± 10 s; vertical treatment: 33 ± 74 s; horizontal treatment: 12 ± 16 s) Minor injuries (eg, abrasions and sores) and diseases (eg, tumors and fungus) tended to increase after handling across the entire sample Results suggested no evidence of handling-specific differences in fish feeding behavior, jaw adjustments, and mortality after release However, based on our results, we recommend that anglers use two-handed support to handle Florida Largemouth Bass, thus minimizing the mean amount of time for an individual fish to regain equilibrium after an angling event

Physicochemical, Biological and Morphometric Factors of Lakes Influencing Crappie Growth
(Freshwater Fisheries 2)

Bryant Haley, Mississippi State University and J Wesley Neal, Mississippi State University*

Crappie fishing has long been a boon to the state of Mississippi – bringing in nearly $100 million annually in recent years Although the large flood control reservoirs (Arkabutla, Sardis, Enid and Grenada) are the top destinations, many anglers prefer smaller water bodies that are closer to home Mississippi is home to many small impoundments which currently provide or have the potential to provide quality crappie fishing opportunities The aim of this study was to determine the key characteristics that promote quality crappie populations in smaller water bodies From 2015 to 2017 we sampled 17 small impoundments throughout the state of Mississippi Impoundments ranged in size from 28 to 357 hectares Criteria for selection included the presence of a crappie population and feasibility of our chosen sampling methods (eg, lakes with excessive surface vegetation or excessively steep shorelines were excluded) Sampling consisted of spring electrofishing to assess general community structure, fall trap netting to determine crappie population characteristics, and summer physicochemical sampling to classify habitat characteristics These data were incorporated into multiple regression models using key crappie population metrics (eg, size at age, relative weight, and catch per effort) as dependent variables to determine which reservoir characteristics exert the greatest influence on crappie populations Results and management recommendations will be discussed

Hydrologic Influences on Crappie Growth in Oxbow Lakes of the Lower White River, Arkansas
(Freshwater Fisheries 2)

Shannon Smith, University of Arkansas at Pine Bluff, Justin Homan, Arkansas Game and Fish Commission, Micah Tindall, Arkansas Game and Fish Commission and Michael Eggleton, University of Arkansas at Pine Bluff*

When examining relationships between fish growth and hydrological characteristics of large-river oxbow lakes, an interesting issue arises due to lakes' intermittent inundation and connection to riverine environments Our goal was to characterize ecologically significant hydrological variables that could influence growth of Black Crappie *Pomoxis nigromaculatus* and White Crappie *P annularis* in oxbow lakes of the lower White River, Arkansas These lakes are only periodically connected to the White River main stem Additionally, more upstream (northern) lakes are influenced by hydrology in the White River, whereas downstream (southern) lakes are influenced more by Mississippi River backflow We characterized both rivers' hydrology over a 27-year period using Indicators of Hydrologic Alteration software and principal components analysis We then used stepwise regression and random forest modeling to determine which hydrological variables were most influential on crappie growth; these included discharge, flow-pulse length, and river rise/fall rates In comparing growth among years, the optimal year for age-1 crappie growth depended on lake location Age-1 crappies in northern lakes exhibited better growth in 2011 while 2013 was a better growth year in southern lakes Both years corresponded to increased discharges and high river rise and fall rates Conversely, lower discharges observed in 2009 and 2014 were associated with lower growth of age-1 crappies in all lakes during those years Relating fish growth to hydrology provides insight into biological processes that occur with large-river fisheries

Analysis of Arkansas Game and Fish Commission Historical Crappie Trap-Netting Data (Freshwater Fisheries 2)

Aaron Kern, Arkansas Game and Fish Commission and Andy Yung, Arkansas Game and Fish Commission*

Crappie spp are the second-most sought-after sportfish by Arkansas anglers, and receive considerable management effort AGFC has historically used a Crappie Assessment Score to assess crappie populations This score is computed using 5 parameters (Recruitment, Density, Age Structure, Size Structure, and Growth Rate) These parameters were analyzed, by ecoregion and species, as a complement to AGFC Crappie Management Team's revisions to the Crappie Management Plan It appears that density-dependent parameters (Recruitment, Density) may have a strong influence on the overall Crappie Assessment Score, and may skew this score positively for lakes dominated by White Crappie and negatively for lakes dominated by Black Crappie Managers should be cautious when using score-based methodologies for fish population assessment to ensure that any possible sampling bias is not exacerbated during score computation

Effects of Deepwater, Winter Time Smallmouth Bass Angling on South Holston Reservoir, Bristol, TN (Freshwater Fisheries 2)

John Hammonds, Tennessee Wildlife Resources Agency*

Smallmouth Bass (Micropterus dolomieu) mortality during summertime bass tournaments is well documented However, few studies address catch and release survival during winter months when Smallmouth Bass are more likely to be caught in deeper water In northeastern Tennessee, bass anglers became concerned about Smallmouth Bass mortality occurring from fishing in deep water during winter months Therefore, the Tennessee Wildlife Resources Agency recruited anglers to catch Smallmouth Bass

from > 10 m deep and in surface water temperatures < 10 °C to study the effects of deep water angling on Smallmouth Bass in cold water, including their movement and survival after being released Twenty-eight Smallmouth Bass > 380mm were caught, scored for signs of barotrauma and effects of deep water angling, fitted with a sonic transmitter, and released Total length, handling time, depth of catch, and water temperature were also recorded for each fish, and they were tracked weekly, up to 4-weeks, to determine movement and signs of mortality Approximately 10% (n=3) did not survive the catch and release fishing However, no significant relationships were noted between survivability and the variables measured Tracking found most (68%) of the fish stayed within 05 miles of the release site, while 32% of the fish migrated further than 05 miles Our study found mortality of Smallmouth Bass caught and released in winter months from depths > 10 m and surface water temperatures < 10°C to be relatively low (10%) compared to summer conditions

Comparing Multispecies Edna to Traditional Approaches to Evaluate Species-Level Aquatic Biodiversity in a Stream Network (Conservation and Biodiversity 2)

Brooke Penaluna, USDA USFS Pacific Northwest Research Station*

Aquatic biodiversity has long-been a proxy for assessing environmental change Traditional approaches for measuring aquatic biodiversity, however, have not been very comprehensive or standardized, and they can be time-consuming, expensive, and limited to certain taxa and habitats Alternatively, environmental DNA is revolutionizing how we can survey biodiversity in streams by offering a rapid, accurate, and standard assessment of multiple aquatic species from various taxa Here, we compare detection of multiple aquatic species using eDNA metabarcoding of taxon-general and taxon-specific primers using microfluidic multiplexed PCR and high-throughput sequencing to traditional approaches of electrofishing to understand the utility of multiplexed eDNA counts as a qualitative and semi-quantitative proxy for species-level identification of aquatic biodiversity We evaluate the detection of multiple aquatic species of fish, amphibians, invertebrates, and pathogens in four neighboring stream networks below and above where fish reside in the network in the Trask Watershed in northern Coastal Oregon In this study, we are able to assess whether streams that are hotspots in productivity of fish are also hotspots in their upstream tributaries for amphibians Our study also allows us to examine questions about assay performance, such as reproducibility, minimum detection limits, and the ability to estimate global aquatic biodiversity at individual sites and the global network Our work broadens the scope of eDNA research by allowing for data-driven prioritization of conservation actions for multiple aquatic species

Post-Hurricane Assessment of Aquatic Resources in El Yunque National Forest (Conservation and Biodiversity 2)

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Hurricane Maria made landfall on Puerto Rico as a powerful category 4 hurricane in September 2017, bringing catastrophic damage to much of the island The mountainous terrain of El Yunque National Forest was not spared from Maria’s destructive winds and rains Roads and facilities were damaged, power was lost, and many water supply intakes located on the forest were damaged by flood waters and landslides While restoring water intakes and safe access to the national forest and its facilities remain the top priorities, El Yunque National Forest is also preparing to assess ecological impacts of the hurricane Many streams experienced record flooding and multiple landslides with unknown impacts on the shrimp, crabs, fish and other aquatic species that occupy its streams and rivers The national forest has pre-hurricane biotic and stream habitat inventories from several watersheds that will allow for assessment of

post-hurricane changes in aquatic resources The Forest Service will employ existing and emerging methods and tools to provide El Yunque with a post-hurricane assessment of aquatic resources and to establish a new baseline for long-term monitoring efforts

The Role of Refugia in Conservation: Goals, Expectations, and Realities (Conservation and Biodiversity 2)

Lindsay Campbell, USFWS, lindsay_campbell@fws.gov*

The US Fish and Wildlife Service San Marcos Aquatic Resources Center has been contracted to provide refugia, salvage, and reintroduction of ten petitioned, threatened, or endangered species endemic to the Edwards Aquifer This refugia was an integral part of the Habitat Conservation Plan for the Edwards Aquifer Implementation of the refugia requires much coordination and cooperation between federal agencies, state agencies, city governments, water management units, universities, private consulting firms, and zoos One of the unique aspects of this program is that the species cover broad taxa that include fish, plants, salamanders, and aquatic invertebrates The refugia should preserve the capacity for the covered species to be re-established should a catastrophic event, such as loss of spring flow, cause a loss of the wild population As part of the refugia contract we also will conduct research activities to expand knowledge of these species biology, life history, effective reintroduction techniques, and more effective animal husbandry techniques There is much discrepancy in the knowledge base of the species from fairly well known to almost nothing known of some of the invertebrate species While these species are endemic to this small area, the planning and lessons we are learning and continue to experience can be used to help other refugia planning across the US New animal husbandry techniques are being developed on these species that can be applied to similar species Finally we have populations of rare species and their offspring that can be studied by scientists that might not have a chance to interact with these species or similar in the wild We wish to expand the awareness of this project as it could be used as a model for other programs that are looking to supplement habitat preservation alone or where habitat preservation may be limited

USFWS National Listing Workplan and the Species Status Assessment Framework (Conservation and Biodiversity 2)

Nicole Rankin, US Fish and Wildlife Service and Tim Merritt, US Fish and Wildlife Service*

The US Fish and Wildlife Service (Service) has developed a National Listing Workplan to address Endangered Species Act listing determinations throughout the next five years To inform these listing decisions, the Service is implementing the Species Status Assessment (SSA) framework to provide a rigorous scientific assessment of a species status This framework uses the best available scientific and commercial information including input from species experts to describe the species and its ecological needs and, uses the conservation biology principles of resiliency, redundancy and representation to evaluate the current and future condition of the species The intent is for the SSA to be updated as new information becomes available and allow for engagement with states and other partners in the science that may be used to inform Endangered Species Act decisions, such as listing, recovery, consultations, grant allocations, permitting, and Habitat Conservation Plans There are over 100 aquatic species (fish, mussels, crayfish, and snails), with over 80 aquatic species that occur in Southern states, on the National Listing Workplan through 2023 The Service Southeast Region will be collaborating with states and partners on the development of SSAs and has the lead for the following fish species: Caddo madtom, Carolina pygmy sunfish, colorless shiner, longnose darter, Ozark chub, Ozark shiner, paleback darter, piebald madtom, popeye shiner, saltmarsh topminnow, sickle darter, and smallscale darter

High Macroparasite Diversity in Freshwater Fish of Puerto Rico (Conservation and Biodiversity 2)

Sean Locke, University of Puerto Rico at Mayagüez*

Freshwater fish are among organisms most frequently introduced into novel ecosystems by human activity Such alien species tend to have few parasites Alien fishes usually have fewer parasites in introduced ranges than in their native range, and lower infection levels than sympatric, ecologically similar natives One explanation for this is that alien fishes bring few parasites with them to new environments, where they are incompatible with local parasites This 'release from enemies' may contribute to the success of alien species in new environments The fresh waters of Puerto Rico are inhabited by ten native and over 15 alien species In a landmark 1994 contribution, Bunkley-Williams and Williams reported 79 species of macroparasites from the island's freshwater fishes Only five were shared by both native and alien hosts, which supports the importance of compatibility between native parasites and alien hosts in structuring host-parasite relationships However, contrary to the widely observed pattern of enemy release, alien fishes harbored more than twice as many parasite species than natives Here I update these records based on molecular and morphological surveys of parasites in local fish At least one putative parasite species allegedly shared between native and alien fishes on the island actually comprises several, genetically distinct, host-specific species Molecular data show that several larval worms common in local fish are conspecific with species found in North America At least 15 additional parasite species not previously recorded on the island are reported, mostly from native fishes Taken together, the data suggest freshwater fish parasite diversity on the island may be consistent with the enemy release hypothesis after all

A Multi-Model Evaluation of Sciaenid Growth in the Gulf of Mexico (Population Dynamics - Marine)

Shane Flinn, Louisiana State University and Stephen Midway, Louisiana State University*

Growth is a basic yet critically important biological process that integrates numerous physiological and ecological processes and significantly shapes the life history of fishes Due to their economic and cultural importance in the Gulf of Mexico, growth of fishes in the *Sciaenidae* family has been studied heavily, especially black drum (*Pogonias cromis*), red drum (*Sciaenops ocellatus*), and spotted seatrout (*Cynoscion nebulosus*) Previous studies have shown the most commonly used growth model in fisheries, the von Bertalanffy growth model (VBGM), is a poor fit for red drum and spotted seatrout length-at-age data The same may be true for black drum, which is similar to red drum in its life history The objectives of this study were: (1) to determine the best-fitting growth model for black drum, red drum, and spotted seatrout length-at-age data from coastal Gulf of Mexico (Florida, Louisiana, and Texas); (2) to evaluate the variation in growth among state-wide and sex-specific parameter estimates; and (3) to evaluate the performance and agreement of model selection criterion in selecting the best-fit growth model and how parameter estimates may vary based on what model selection method is utilized Five growth models were evaluated for each species; the VBGM, Gompertz model, logistic model, and seasonal VBGM were evaluated for all three species Additionally, the double VBGM was evaluated for red drum and black drum, and the power model was evaluated for spotted seatrout Preliminary results indicate that growth of Texas spotted seatrout, and Louisiana black drum, red drum, and spotted seatrout is sex-specific The best fitting growth models for black and red drum are the double VBGM, and for spotted seatrout, the seasonal VBGM Female Louisiana red drum, Florida black drum, and female Louisiana spotted seatrout grew to the largest maximum size, and female Louisiana black drum, Florida red drum, and female Texas spotted seatrout exhibited the largest growth coefficients (k) Model selection performance and agreement were very good, with all criteria choosing the same best-fit model in nearly all cases Choosing the best fitting

model and reducing the uncertainty surrounding the use of growth models and resulting parameter estimates is of critical value to fisheries managers to make informed management decisions

Long-Term Trends of Reef Fishes in the Florida Keys (Population Dynamics - Marine)

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Worldwide, coral reefs support a great diversity of reef fishes however; research attention often focuses only on species with high economic value We used NOAA's historical and recent Coral Reef Conservation Program's National Coral Reef Monitoring Plan datasets from the Florida Keys to examine changes in population densities for the entire community of reef fishes since the establishment of marine protected areas in 1997 Trends were examined within protected and open areas, and compared to pre-implementation estimates (1994 to 1996) As expected, trends varied widely by species depending on targeted versus non-targeted status and life history demographics In protected areas, rapid density increases were greatest for exploited species (*eg*, snappers and groupers) following implementation In 2005, many exploited species' densities greatly declined and have since remained low For non-targeted species (*eg*, parrotfishes and wrasses), density patterns varied greatly over time both within protected and open areas Some species have shown no discernible pattern, while others have recently had large density increases in both protected and open areas Overall, these long-term data from the Florida Keys have shown the value of large spatial scale monitoring to detect reef fish population trends These data are presently being used in assessments and to guide management decision making for exploited reef fishes In addition, these data provide a deep understanding of ecosystem dynamics that can be used to improve the design and implementation of marine protected areas

Progress Towards a Habitat-Based Approach for Combining Indices of Abundance of Reef Fishes from Multiple Fisheries-Independent Video Surveys (Population Dynamics - Marine)

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Because of ever-changing management regulations designed to rebuild valuable reef-fish stocks, fishery-independent data are becoming increasingly critical to characterize annual changes in relative abundance for the assessment of stock status Currently, there are three stationary video surveys to assess reef fish abundance in the Gulf of Mexico (GOM): NMFS-NOAA Pascagoula, NMFS-NOAA Panama City, and the Florida Fish and Wildlife Research Institute While these surveys generally use similar video processing protocols, the duration of each survey, specific habitat variables quantified, and site selection protocols do vary among surveys Historically all three surveys have provided separate indices of abundance for assessments; however, a combined, Gulf-wide index would likely yield a more representative and statistically-powerful characterization of changes in relative abundance through time, while also simplifying assessment inputs We explored a habitat-based method for combining video count data into a combined index for the GOM for several managed fishes using categorical and regression trees (CART) and standard generalized linear models Results indicate that the incorporation of habitat variables derived from individual CART analyses into statistical models result in a dramatic improvement to model

fit, while concomitantly reducing resultant coefficients of variation These methods indicate that combining data from these different surveys is possible and of potential great value to assessments We are continuing work towards developing habitat-weighted indices that account for variations in sample site selection and locations among the surveys and initial results will also be presented

Age, Growth, and Reproduction of the Queen Triggerfish, Balistes Vetula, from the US Virgin Islands (Population Dynamics - Marine)

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The queen triggerfish *Balistes vetula* is a commercially important, data- deficient Caribbean and Atlantic reef fish We analyzed age, growth, and reproduction for this species from fisheries-dependent samples in the US Virgin Islands (USVI) From 2015 to 2017, 1,019 samples were collected, ranging from 150 to 466 mm FL in size Queen triggerfish from St Croix were significantly smaller in size and weight than those in St Thomas We found that males from both islands were significantly larger than females Based on reproductive histology, the spawning season is from December-August Female size at 50% maturity was 287 mm FL in St Thomas and 265 mm FL in St Croix Only one immature male was observed in our study Our observed sex ratios did not significantly differ from 1:1 on either island Age and growth analysis in St Thomas found this species to be relatively long lived, ranging from 1 to 14 years, and slower growing, resulting in an overall growth coefficient of k = 033 Sex-specific growth curves were fitted, resulting in the following von Bertalanffy equations: $FL_t = 426[1 - e^{-042(t + 065)}]$ for males and $FL_t = 430[1 - e^{-028(t + 034)}]$ for females Females were significantly older and exhibited a slower growth rate than males Ninety-four percent of samples were between 3 and 10 years This is the first comprehensive study of the *Balistes* species to include age and reproduction life history information together The differences in the commercial fisheries and life history parameters between the two distinct island shelves of the USVI suggest that this species may require more tailored management by island; the queen triggerfish fishery is currently managed within the triggerfish and filefish unit across the territory Local and regional management have a need for long-term fisheries-dependent studies such as this to collect relevant data for optimally designed fishery management plans

Age and Size Dependency of Spawning, and Effects on Egg Production, in Gag and Scamp Grouper Off the Southeastern USA (Population Dynamics - Marine)

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Stock assessments have historically used spawning stock biomass as a proxy for reproductive output in marine fishes, assuming an invariant number of batches spawned per female fish The number of batches spawned has been shown to vary with age and size, which invalidates this assumption, and assessments have begun to use total egg production (TEP) as a measure of reproductive output This study utilized samples collected by the Southeast Reef Fish Survey (n=8,683) to investigate the age- and size-dependency of spawning fraction, duration, and frequency in Gag (*Mycteroperca microlepis*) and Scamp (*M phenax*), and to estimate the effects of these dependencies on TEP estimates Spawning parameters had moderate to strong dome-shaped relationships with age and size (R^2=038-090) Generalized additive models (GAMs) showed that both age and size are highly significant predictors of spawning probability

(p<00001), with the smoother functions providing further support to the dome-shape of these relationships This can be explained by preparation for sexual transition; it may serve the lifetime reproductive success of the largest, oldest females to reduce their reproductive investment as females and invest in somatic growth to increase their future male reproductive success Including year as a covariate in the spawning models showed that there is significant temporal variation in these relationships (p<00001), which could be acting as a proxy for environmental variation or be a result of changes in the population demographics Age- and size-dependent TEP estimates were 3-99% lower than those based on a constant spawning frequency, with the largest differences in the youngest and oldest females Age-dependent population-wide TEP estimates were 37% lower for Gag and 30% lower for Scamp than age-independent ones Incorporating age- and size-based reproductive data into assessments can lead to more reliable stock productivity estimates, and potentially improved management

Using a Tag-Return Study to Estimate Natural and Fishing Mortality of Spotted Seatrout in North Carolina (Population Dynamics - Marine)

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Spotted Seatrout *Cynoscion nebulosus* is one of the most economically important sportfish in the US South Atlantic, including at its northern range in the coastal waters of North Carolina and Virginia Research recommendations in the 2009 North Carolina Spotted Seatrout Stock Assessment suggested using tagging studies to verify estimates of natural mortality (*M*) and fishing mortality (*F*) Recent Spotted Seatrout tagging studies have demonstrated high inter-annual variability in *M*, especially during years with "winterkill" events (periods of water temperatures <5°C), contributing to abnormally high annual total mortality (*Z*) Generally, *M* is both one of the most important and difficult parameters to accurately estimate in stock assessments Uncertainty in *M* may bias estimates of *F*, having major implications on fishery management In order to monitor Spotted Seatrout mortality for use in future stock assessments, a long-term, multi-year fishery dependent mark-recapture tagging study was established Since 2014, fish were tagged with either a single or double low-reward tag, or a single high-reward tag Tag-return data were collected from 2014-2016 and analyzed using an age-independent instantaneous rates model We attained bimonthly estimates of *Z, F, M*, and auxiliary parameters including tag-loss and reporting rates These data include the initial years of a multi-year tagging project, that will be used in an Spotted Seatrout integrated tag-return catch-at-age model for the state of North Carolina

Estimates of Discard Mortality Rates for Dolphinfish (Coryphaena hippurus) from the US South Atlantic Recreational Hook and Line Fishery (Population Dynamics - Marine)

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Minimum length limits are used to manage the dolphinfish *Coryphaena hippurus* in the US South Atlantic but rates of discard mortality of this species are unknown in this fishery and others throughout the worldwide range of this species We estimated rates of discard mortality in this recreational hook and line fishery using, 1) proportion-by-hooking-location data from dolphinfish collected from dockside sampling and, 2) mortality by-hooking-location data from satellite tagging and tank holding live dolphinfish, computer tomography scans of dolphinfish with roof-of-mouth hooking, and published studies on discard mortality for gill, stomach/esophagus and eye hooking locations in other teleosts A large percentage of dolphinfish in this study (39%) were deeply hooked (in the gills, stomach/esophagus, eye, or roof-of-

mouth) A multinomially-distributed model fitted using Bayesian methods estimated median proportional rates of discard mortality for all sized dolphinfish and sub-legal individuals to be 0252 and 0232, respectively These median rates are greater than a published maximum discard mortality rate above which minimum length limits are not effective at controlling fishing mortality for r-selected species (such as dolphinfish) Results from this study highlight the potential ineffectiveness of minimum length limits as a strategy to control rates of recreational fishing mortality of this important species

An Extension of the Stepwise Stochastic Approach to Estimate Life History Parameters for Sharks, Groupers, and Other Data-Limited Stocks (Population Dynamics - Marine)

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The limited resources available for coastal fisheries assessments, combined with the need to manage a large number of species, has made generating informed management decisions challenging Many data-limited stock assessment approaches are focused on catch data, but long time series of catch statistics are often unavailable Other parsimonious models rely on generally available size composition data, but they still require some life history parameter inputs Here, we expand a stepwise meta-analytical approach that uses statistical relationships between key life history parameters to generate estimates of missing life history parameters for growth, maturity, and longevity This approach has been successfully used to obtain local estimates for the assessments of data-poor stocks in Hawaii However, the original approach contained information for only six families of coastal fishes The goal of this work was to expand the approach to four other families To do so, we conducted a thorough meta-analysis of the life history literature for Serranidae (groupers), Labridae (wrasses), Haemulidae (grunts and sweetlips), and multiple families of sharks This life history data set was then used to generate family-specific relationships between life history parameters We tested these new relationships on five species (one grouper, two sharks, one wrasse, and one grunt) for which local life history parameters were available This study confirmed the usefulness of the stepwise stochastic simulation approach and expanded the tool for use with four more groups of exploited fish

Monitoring the Effects of Hydrilla Removal on the Fish Community of a Piedmont River in North Carolina (Fish Habitat 2)

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Hydrilla, a federally and state listed noxious weed, can negatively impact aquatic communities by altering available habitat and outcompeting native aquatic plants Hydrilla was first observed in the main stem portion of the Eno River, located in the upper Neuse River drainage of North Carolina, in 2005 To control the growing infestation, an herbicidal drip was installed to release a low concentration of Fluridone into the river on a yearly basis beginning in 2015 This drip successfully reduced hydrilla densities downstream of the injectors to negligible amounts The effects of hydrilla on fish communities in lentic systems has been widely studied, but little is known about the effects on fish communities in lotic systems The Eno River supports a plethora of fish species including the Roanoke Bass, a state listed species of concern The objective of this project was to evaluate possible responses of fish communities related to the removal of hydrilla that could indicate environmental changes, such as habitat availability, or changes in nutrient levels A Before and After, and Control and Impact (BACI) design was used to compare fish densities from five locations, two sites located upstream of the herbicidal drip system (control) and three located within the treatment zone This study was initiated three years prior to the start of the herbicidal treatment and concluded after the first two years of treatment Sites were comprised of riffle/run/pool complex

habitats and fish were collected using barge electrofishing Fish were pooled and evaluated based on North Carolina's Index of Biotic Integrity (NCIBI) parameters that account for overall abundance, trophic levels, habitat preference, tolerance levels, and recruitment potential Based on these parameters, BACI analysis determined that there was no significant (α = 005) effect of hydrilla removal detected within any fish community densities (fish/m^2) BACI analysis also determined that there was no significant effect detected in fish condition at various trophic levels This study was not able to detect acute changes in fish communities due to hydrilla removal in a lentic system, however, future studies should focus on possible chronic effects that were not captured during the first two years of treatment

Interaction of Temperature and Hypoxia on the Metabolism of Golden Shiners (Fish Habitat 2)

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The golden shiner, *Notimigonus crysoleucas*, is a common bait minnow that often experiences hypoxia events within its freshwater habitat, and also encounters many microhabitats of varying temperatures In this experiment, golden shiners were exposed to severe hypoxia (175±012 kPa) for 1 h at two environmentally-relevant temperatures (14 and 24°C), and then allowed to recover for 7 h at 24°C Standard and maximal metabolic rates and blood plasma parameters were assessed before hypoxic exposure, immediately following exposure, and post-recovery We hypothesized that cold temperature in combination with severe hypoxia may create a protective effect with respect to the metabolic response Standard metabolic rate was significantly decreased during hypoxia in the fish exposed to 14°C, but was not affected at 24°C Accumulation of oxygen debt and time required to return to pre-exposure SMR was not significantly affected by exposure temperature Blood plasma lactate concentrations were significantly elevated in golden shiners immediately following hypoxia at both temperatures, and returned to baseline levels after the 7 h recovery period in both groups Fish exposed to hypoxia in low temperature displayed significantly lower plasma lactate accumulation immediately following hypoxia exposure than fish exposed at 24°C Similarly, plasma pH was reduced following hypoxia exposure, but only in the fish held at 24°C during hypoxia exposure These results suggest that, consistent with other cyprinids, golden shiners demonstrate extensive hypoxia tolerance, which is enhanced by reduced temperature, but hypoxia tolerance may also be enhanced by acclimation to warm temperatures

Habitat Use and Movement of Shovelnose Sturgeon Scaphirhynchus Platorynchus in the Arkansas River, Oklahoma (Fish Habitat 2)

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Abstract - Shovelnose Sturgeon, a migratory species, and a species of special concern to Oklahoma, is native to the Arkansas, Little, and Red rivers and major tributaries in Oklahoma Habitat fragmentation has limited the distribution and overall success of this species in Oklahoma Drought conditions and additional dam proposals have highlighted the necessity of increasing our understanding of Oklahoma's Shovelnose Sturgeon populations We implanted 25 Shovelnose Sturgeon with ultrasonic transmitters in October 2014 Implanted sturgeon were passively and manually tracked from October 2014 through September 2015, although unprecedented flooding limited both forms of tracking during late spring and summer 2015 Submersible ultrasonic receivers (SURs) were strategically placed throughout the study reach for passive tracking, and manual tracking employed the use of both directional and towable hydrophones Most individuals were quite sedentary during the study, traveling < 25 km from their original capture location The greatest distance traveled was 97 km Fifty-two percent of Shovelnose Sturgeon locations were in sand substrate, followed by 31% in a mixture of sand and cobble, and the remainder in cobble or a

mixture of sand and bedrock The mean velocity at Shovelnose Sturgeon locations was 014 m/s; however, velocities at locations ranged 001-026 m/s Mean depth at Shovelnose Sturgeon locations was 118 m, and depths ranged 04-25 m These results will be used to initiate management efforts for Shovelnose Sturgeon populations in Oklahoma, as well as to inform decisions and guide mitigation efforts for future projects that may further fragment riverine habitat throughout the state

Syngnathidae Assemblages and Seagrass Species Utilization in Northeastern Florida Bay: Implications for Management in a System Under Restoration (Fish Habitat 2)

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Seagrass habitat is very important to the life history and health of many fish taxa, including the Syngnathidae family Syngnathids have been shown to differentially utilize seagrass species and their abundances could be useful as an indicator for seagrass health For this study, specimens were collected seasonally from 2006-2009 in northeastern Florida Bay using 213-m seines to sample shallow habitats (≤15-m) and 61-m otter trawls to sample deeper regions (10-76-m) Seven Syngnathid species (N=2,446) were collected; the Gulf Pipefish, *Syngnathus scovelli* (N=1,322) and the Dwarf Seahorse, *Hippocampus zosterae* (N=752) were the most abundant species collected Multivariate analyses were used to assess relationships among Syngnathid assemblages and available habitat, such as composition and coverage of submerged aquatic vegetation (SAV), bycatch type and quantity, water quality, and other environmental variables Syngnathid abundance and diversity increased with salinity, and the majority of Syngnathids (775%) were collected in areas dominated by turtle grass, *Thalassia testudinum* Syngnathid communities also differed between otter trawls deployed in deeper habitats with large volumes of SAV bycatch, and seines deployed over shallow habitats with smaller bycatch volumes Overall, the distribution and abundance of Syngnathids in northeastern Florida Bay are not only based on SAV composition, but on other habitat variables, which may be affected by restoration efforts Our insights into habitat preferences of Syngnathids in Florida Bay may be used to inform management and conservation decisions affecting seagrass habitats and associated fauna in various estuaries

The Importance of Mesoscale Oceanographic Features in Determining Biodiversity Hotspots for Pelagic Fish Larvae (Fish Habitat 2)

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Species richness and biological diversity in marine environments enhance ecosystem services and stability, increasing the health of the ecosystem overall The aim of this study was to describe epipelagic fish assemblages in the northern Gulf of Mexico (NGoM) and identify environmental conditions associated with areas of increased species richness and diversity Summer ichthyoplankton surveys were conducted in epipelagic waters (0-100 m) of the NGoM in June and July 2015 and 2016 using surface neuston net and 100m oblique bongo net tows conducted during the daytime (0700 – 1800 h) Overall, fish larvae from 99 families were collected, with 29 of these families consisting of greater than one percent of the catch during each survey Catch composition in the neuston net samples was relatively similar to the composition in the oblique bongo net samples with the primary taxa including carangids (jacks), scombrids (mackerels, tunas), and exoceotids (flyingfishes); however, deep pelagic taxa, including myctophids (lanternfishes), gonostomatids (bristlemouths), and sternoptychids (marine hatchetfishes),

were predominately collected in bongo tows, suggesting that some degree of connectivity between the deep and epipelagic fish assemblages occurs in the mixed layer Generalized additive models (GAMs) indicated that areas of high diversity were correlated with mesoscale oceanographic features, particularly sea surface temperature (°C), sea surface height (m), and salinity (ppt)

Implications of Silver Carp Invasion on the Food Web of a Freshwater Mussel Biodiversity Hotspot in Tennessee (Nonindigenous Fishes 2)

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Planktivorous Silver Carp *Hypophthalmichthys molitrix* have potential to compete with native filter feeding aquatic fauna Declines in Gizzard shad *Dorosoma cepedianum* and Paddlefish *Polyodon spathula* condition have been described in systems where Silver Carp have established populations Recent invasions of Silver Carp into the Tennessee River system have created concerns regarding competition with native freshwater mussels and their host fish We collected mussels, representative glochidia host fish, and Silver Carp from the Duck River, Tennessee, which is one of the most biodiverse mussel communities in the world We used stable isotope samples to compare food web overlap of Silver Carp to evaluate how foraging by invasive Silver Carp could potentially disrupt energy flow across the complex life cycle of freshwater mussels Identifying potential negative impacts of Silver Carp to freshwater mussels is critical to informing Asian carp control needs and conserving native aquatic fauna

Ecological Differences in Native Fish Assemblages in Relation to Silver Carp Establishment in the White River, Arkansas (Nonindigenous Fishes 2)

Cody Salzmann, University of Arkansas at Pine Bluff*

Abundances of Silver Carp *Hypopthalmichthys molitrix* have grown tremendously within many US river systems during the past decade Multiple user groups and management agencies have expressed concern about the potential impacts of carp establishment on native fishes This research aims to quantify relationships between native fish assemblages and recently established Silver Carp in oxbow lakes of the lower White River Oxbow lake fish assemblages were sampled using experimental gill nets, mini-fyke nets, and boat-mounted electrofishing during July-August and October-November 2017 In addition, current assemblages were compared with historical data collected during 2002-2005, prior to Silver Carp establishment Using 15 study lakes, a carp density gradient was established using average rank abundances from multiple gear types (ie, gill nets, boat-mounted electrofishing, visual counts, and GoPro camera counts) Results suggested comparable richness and diversity between historical and current periods Although current assemblages have lost up to 12 species compared to historical datasets, missing species were all rare historically (ie, <1% of the total catch) and may not be truly absent However, 13 new fish species also were recorded from these oxbow lakes Impacts of further range expansions by Silver Carp in Arkansas are unclear, though this study suggests possible negative influences on native fish assemblages

"Possible Influences of Invasive Carp on Age-0 Fish Characteristics in Oxbow Lakes of the White River, Arkansas" (Nonindigenous Fishes 2)

Joseph Kaiser, University of Arkansas at Pine Bluff, Cody Salzmann, University of Arkansas at Pine Bluff, Shannon Smith, University of Arkansas at Pine Bluff and Michael Eggleton, University of Arkansas at Pine Bluff*

During the past decade, Silver Carp *Hypopthalmichthys molitrix* have become highly abundant in the lower White River, Arkansas Carps are assumed to be more detrimental to juvenile fishes due to their high degrees of planktivory However, research on the effects of carp invasions and establishment on age-0 fishes are lacking This study aims to quantify the possible effects of invading Silver Carps on age-0 cohorts of several resident fish species in oxbow lakes of the lower White River Using 15 study lakes that have been studied historically, age-0 fishes were collected with mini-fyke nets and boat-mounted electrofishing during summer (July-August) and fall (September-November) 2017 Collections targeted four piscivores, three omnivores, and two planktivores Catch-per-unit-effort (CPUE) of Largemouth Bass *Micropterus salmoides* (*P*=00176), Spotted Bass *Micropterus punctulatus* (*P*=00077), and Gizzard Shad *Dorosoma cepedianum* (*P*=00014) differed between summer and fall seasons with electrofishing Bluegill *Lepomis macrochirus* (*P=00149*) and White Crappie *Pomoxis annularis* (*P*=00275) CPUE differed between summer and fall with both electrofishing and mini-fyke nets Future analyses will quantify size, condition, weight-length coefficients, and growth of age-0 cohorts of target species in relation to lake water quality, morphometry, river-lake connectivity, and carp densities quantified from a companion study

Oral presentation - Student

NAS FaST: a New Tool to Track the Possible Spread of Nonindigenous Aquatic Species from Flood Waters of Hurricane Maria (Nonindigenous Fishes 2)

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Storm surge and flood events can assist the expansion and distribution of introduced aquatic species (IAS) through a connection of adjacent watersheds, backflow of water upstream of impoundments, increased downstream flow, and creation of freshwater bridges along coastal regions During these flooding conditions, IAS can spread to new areas, including to new drainages where they could otherwise not gain access The USGS Nonindigenous Aquatic Species (NAS) program along with USGS's Advanced Applications Team have developed the NAS Flood and Storm Transport (NAS FaST) mapper to allow managers to view which drainages may have IAS spread due to flooding from adjacent drainages The NAS FaST mapper can help natural resource managers determine potential new locations for individual species, or to develop a watchlist of possible new IAS within a watershed Current NAS FaST maps include all flooded areas from Hurricanes Harvey, Irma, Maria, and Nate The NAS program plans to continue to create individual maps and provide information on potential IAS spread for all future storms or hurricanes that cause flooding conditions significant enough to breach drainage divides For this presentation, we will present the results of the NAS FaST mapping of flood waters of Puerto Rico from Hurricane Maria We will highlight the areas that had inland and coastal flooding conditions of sufficient height to potentially connect adjacent drainages We will also provide lists of IAS that may have invaded new areas due the flood connections between adjacent drainages When dealing with new introductions of IAS it is critical to respond rapidly before the species has the ability to become established, the NAS FaST mapper represents a new tool for assisting in early detection

Current Knowledge of Pteroinae: Trade Pathways and Risk Assessment for 18 Species of Ornamental Lionfish (Nonindigenous Fishes 2)

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Invasive lionfish (*Pterois volitans*/*P miles*) are highly successful marine invaders that have generated widespread and severe ecological consequences throughout their invaded range The spread of these species has generated a large body of literature in recent years However, the occurrence of several additional species of globally traded lionfish have raised concern that they may pose similar risks as potential invaders Here we (1) characterize the current body of literature for the invasive lionfish complex and 16 other species of lionfish to determine what is known about potentially invasive species prior to exhibiting an invasion history and see how this compares to our knowledge of two known invaders within the same subfamily, (2) evaluate the trade pathways of ornamental lionfish using the US Fish and Wildlife Service LEMIS database to identify species that are heavily imported and determine the most likely areas of introduction, and (3) apply the Aquatic Species Invasiveness Screening Kit (AS-ISK) as a semi-quantitative evaluation of invasion risk for the state of Florida Because this group of fish has prior invasion history in the Atlantic Ocean, Gulf of Mexico, and Mediterranean Sea, a proactive approach towards future establishment by screening species that exhibit similar characteristics is a viable tool that can inform policy

Comparative Caribbean and Western Atlantic Spatial Distribution of the Invasive Lionfish Pterois Volitans (Nonindigenous Fishes 2)

Rebecca Becicka, University of Puerto Rico*

The invasion and subsequent proliferation of the lionfish *Pterois volitans/miles* within the western Atlantic has gained much attention from both the scientific community and public in the last 2 decades Much is now known regarding lionfish biology, yet several regional variations exist in regards to their habitat selectivity and preferences, and there is still much to learn when considering spatial variability in life history parameters as they change during ontogeny from larval settlement to adult phase Although many regions studied to date exhibit dissimilar habitat characteristics and availably, generalizations can be made to describe lionfish preferences throughout the region and how these relate to life history characteristics, ontogenetic shifts and life history strategy on a broader scale The lionfish have established populations across variable seascapes and this may allow for insight into what they ultimately respond to in their new environment, which has not been done for their home range There are several key observations that have been documented since the initial invasion that will allow for a better understanding of possible behavioral changes throughout the lionfish's life history that may, in turn, allow for a more informed approach to management, removal efforts and to the environmental impacts that are likely to progress into possible detriment to already fragile reef systems This report aims to compare and contrast what is known regarding lionfish spatial distribution and habitat selectivity in order to disseminate general similarities applicable among regions, and illustrate discrepancies between regions This will serve as a baseline for comparisons among areas, leading to a more synthetic understanding of lionfish distribution and the mechanisms that influence regional variations and encourage further studies needed to fill existing gaps

Detection and Removal Efficiency of Invasive Lionfish on Natural and Artificial Reefs in the Northern Gulf of Mexico (Nonindigenous Fishes 2)

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Mitigating the negative impacts of lionfish is a top priority for the ocean management community, with human removal currently the only viable method of biocontrol Harvest tournaments and the establishment of a commercial lionfish fishery have successfully removed thousands of lionfish from the northern Gulf of Mexico (nGoM); however, removal efforts have lacked important economic and ecological metrics to

evaluate the efficacy of removals nor estimate the level of effort required to mitigate lionfish impacts in this region The incorporation of incomplete detection and removal efficiency is critical for evaluating efficacy of removals and for determining goals for managing invasive lionfish populations This study (Q1) evaluated how time-of-day affects detection of lionfish and (Q2) estimated removal efficiency of lionfish on natural and artificial reef structures in the nGoM First, to assess detection based on time-of-day (Q1), paired surveys were conducted during midday and crepuscular (dawn or dusk) periods on 8 artificial reefs and 9 natural reef sites Time-of-day sampling was conducted via two survey methods: video surveys from a remote operated vehicle (ROV) and lionfish count surveys made by SCUBA divers Contrary to what we expected, more lionfish (mean of 2 – 3 fish per site) were observed on artificial reef structures during the midday period by both diver and ROV surveys On natural reefs, there was no significant difference in detection based on diel period Our results suggest that research surveys and removal efforts for lionfish on nGoM reefs are best achieved during the midday diel period Second, we developed models for removal efficiency (Q2) – ie the proportion of the reef site's initial lionfish population removed – for targeted removals via spearfishing Removal efficiency models were developed based on Leslie depletion models of 6 artificial reef sites and 6 natural reef sites Leslie depletion models were made using changes in CPUE in 3 – 4 serial removal passes conducted within a relatively short time period (6 – 25 hours) On artificial reefs, mean removal efficiencies for first-, second- and third-pass removals were 0873, 0980, and 0996, respectively On natural reefs, mean removal efficiencies per pass were considerably lower: 0545, 0773, 0886 These findings can aid management by facilitating estimates for (1) cost and efforts required and (2) likely outcomes for removal efforts aimed to reduce lionfish densities

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