

Abstract Listing for the 2014 Southern Division-American Fisheries Society

January 22-26th, 2014

Francis Marion Hotel

Charleston, South Carolina

The abstracts in this document were all of those submitted and accepted for presentation as part of the 2014 SD-AFS annual meeting that took place on January 22-26th in Charleston, SC. The abstracts are organized by the session in which they were presented and in the order in which they occurred in the Program. The Program Grid Schedule (also part of the document package on this flashdrive) has the listings by day, session, room and time for all talks presented with the first author. The complete author listing (if multiple authors) is in this document. This document does not represent any summary of the meeting, just a list of abstracts presented at the meeting for all posters and oral presentations. Additional organizational information can be found on the meeting website (<http://sdafs.org/meeting2014/>). This document may not be reproduced without the permission of the Executive Committees of the South Carolina Chapter: American Fisheries Society or the Southern Division: American Fisheries Society for any publication purposes.

The organizers and executive committee of the South Carolina Chapter were pleased to welcome all AFS members to the 2014 meeting and report that the meeting had 51 Poster Presentations, 204 Oral Presentations that occurred over 3 symposia (*Atlantic and Gulf Sturgeon Conservation, Reef Fish, and Gaining a Better Understanding of Population Demographics through Tagging*) and 10 technical sessions (*Black Bass, Freshwater Fisheries Management and Conservation, Population Dynamics, Pollution and Toxicology, Policy Education and Communication, Physiology and Ecosystems, Dams and Reservoirs: Fishery Challenges, Marine Fisheries Management and Ecology, Stream and River Fish: Assemblages and Movement, and Age & Growth in Fishes*).

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Sturgeon Symposium

An Overview of Population Structure in Gulf Sturgeon (Atlantic and Gulf Sturgeon Conservation)

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The anadromous Gulf sturgeon occurs along the north central coast of the Gulf of Mexico and is federally listed as threatened. We have genotyped over 1100 individuals from nine drainages for fourteen microsatellite loci. Multiple analyses provide clear evidence of strong population structure across its range. These groups mostly represented individual drainages (Pearl, Pascagoula, Escambia and Apalachicola) or drainages with a common estuary (Blackwater and Yellow). However, both the Choctawhatchee and the Suwannee Rivers seemed to possess two distinct stocks. This may represent spatial or temporal segregation in the spawning groups within these rivers. We also detected interdrainage movements by the adults as has also been found in previous studies using telemetry. Most of the interdrainage movements detected by the genetic data occur at a regional level. Both the reproductive fidelity and patterns of adult movements across the Gulf of Mexico have important implications for conservation efforts.

Identifying the fundamental unit of management in Atlantic sturgeon (*Acipenser oxyrinchus*) and other uses of molecular genetic tools (Atlantic and Gulf Sturgeon Conservation)

Tim King*, *US Geological Survey, tking@usgs.gov*

Sturgeons present significant challenges for investigating the evolutionary processes shaping the nuclear genomes of extant species due to the presence of polyploidy ranging in a series from 4N-6N times the haploid number. Nuclear microsatellite DNA (nDNA) markers have become a robust tool for investigating genetic variation and determining the fundamental unit of management in species of conservation concern. I will present the results of a range-wide survey of 12 disomic nDNA markers in 634 young-of-the-year and spawning adult Atlantic sturgeon (*Acipenser oxyrinchus*; 4N) sampled from 13 river systems. Results from a series of statistical analyses indicate that most, if not all, subpopulations are statistically differentiated ($P < 0.05$) based on allelic frequencies, AMOVA, F_{ST} and allocation analyses and that the river system should be considered the fundamental unit of management. For example, the average accuracy of determining a sturgeon's collection of origin was 90.2%. In addition to the delineation of population structure throughout the range of Atlantic sturgeon, nDNA allowed the confirmation of the presence of a reproducing population within the Chesapeake Bay (James River).

While nDNA analyses detected statistically significant differences in allelic frequencies between most collections, regional zones of genetic discontinuity were detected in the patterns of genetic variation across the range that likely delineate evolutionarily significant differentiation and adaptive potential for this species. These zones of genetic discontinuity, illustrated by high bootstrap support for nodes on the neighbor-joining tree of chord distance values (Figure 1), represented deeper levels of genetic differentiation, perhaps a higher degree of reproductive isolation than that usually attributable to population-level differentiation. These zones of

discontinuity delineate populations or groups of populations that likely warrant greater conservation considerations. I propose the designation of at least six evolutionarily significant lineages: 1) St

Lawrence; 2) Gulf of Maine (St John R, Kennebec R), 3) New York Bight (Hudson R, Delaware R) 4) Chesapeake Bay (James R, York R), 5) Carolina (Albemarle Sound), and 6) South Atlantic (Edisto, Savannah, Ogeechee, and Altamaha) This level of molecular differentiation has allowed assignment of individuals sampled from near-shore mixed-stocked collections to river or lineage of origin While a statistically significant, positive correlation exists between the measures of population differentiation (F_{ST}) for nDNA and that conducted by researchers that have surveyed genetic variation in the maternally inherited mitochondrial DNA (mtDNA), considerable differences of opinion exist as to what constitutes a DPS for Atlantic sturgeon

Vulnerabilities of Atlantic Sturgeon and Shortnose Sturgeon to Chemically-and Environmentally-Induced Early Life-Stage Toxicities (Atlantic and Gulf Sturgeon Conservation)

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Populations of most sturgeon species are severely depleted Overharvest, habitat alteration, and pollution are provided as primary reasons for this decline, however, demonstration and quantification of chemical toxicants effects are lacking Atlantic and shortnose sturgeon from several Atlantic coast estuaries are exposed to high levels of polychlorinated biphenyls (PCBs) and polychlorinated dibenzo-*p*-dioxins/furans (PCDD/Fs) in mixtures and in combination with other environmental stressors such as warming, hypoxia, and acidification in marine and estuarine waters Early life-stages (ELS) of many fishes are notoriously sensitive to toxicities from these compounds and some populations have been extirpated from environmental exposures However, the vulnerabilities of sturgeons ELS to these aryl hydrocarbon receptor (AHR) agonists have yet to be evaluated In this study, we initially partially characterized the AHR-activated cytochrome P4501A (CYP1A) gene and measured its expression in larvae of both species exposed under controlled conditions to graded doses of coplanar PCB126 congener and 2,3,7,8 tetrachlorodibenzo-*p*-dioxin (TCDD) We found that CYP1A expression was significantly inducible in Atlantic and shortnose at environmentally relevant water concentrations as low as 10 and 1 parts per trillion (ppt), respectively, indicating that the AHR was activated and suggesting that AHR-mediated ELS toxicities were co-occurring Survival to hatch and embryonic period duration decreased at the highest doses of TCDD and PCB126 in both species Morphological analyses showed alterations with dose reflecting shorter fish, yolk-sac edema, and retarded eye development at higher contaminant concentrations Post-hatching lifespan on yolk reserves alone (a food-free environment) declined in treated embryos of both species A preliminary analysis of thermal effects (10 constant temperatures from 7 to 20 °C) on shortnose sturgeon revealed maximum survival to hatch from 12 to 16 °C with precipitous declines above 16 °C, a linear relationship between developmental rate and temperature but a reduction in hatch size above 14 °C Hence, sturgeons may be at risk to direct effects of modest increases in their thermal habitat and temperature could be a significant co-stressor with contaminants ELS of both species are sensitive to AHR agonists at environmentally relevant concentrations and appear to be among the most sensitive of fishes These results set the stage for examining the interactive effects of PCBs and rising temperatures on the ELS of these sturgeons We will also determine Toxic Equivalency Factors for individual PCB congeners which will allow us to quantitatively evaluate the effects of environmental chemical mixtures on sturgeon ELS using a Toxic Equivalency Quotient approach

Attempting to Resolve Persistent Uncertainty in Gulf Sturgeon Stock Status (Atlantic and Gulf Sturgeon Conservation)

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Gulf sturgeon *Acipenser oxyrinchus desotoi* are a diadromous species that historically supported commercial fisheries throughout the northern and eastern Gulf of Mexico around the turn of the 20th century. In the subsequent years, several rivers supporting Gulf sturgeon spawning were extensively modified and the species was classified as threatened by federal and state laws in the early 1980's because of uncertainty in population viability. Working with a large group of cooperators, we have been attempting to help resolve this uncertainty in population status using data from a variety of tagging programs including long-term capture-recapture and, more recently, a large telemetry program designed to improve our understanding of natural mortality and river fidelity. We think our efforts have demonstrated stable or increasing population size in recent decades for river systems in the eastern Gulf of Mexico, but high uncertainty in stock status elsewhere due to very sparse capture-recapture information. We have also identified a little recognized finding that estimates of key demographic parameters, such as abundance and mortality, are likely more strongly influenced by changes in sampling programs than the bias caused by specific aspects of the assessment models used to determine stock status such as erroneous age-at-first-capture assignment. For long lived species with very low capture probabilities such as Gulf sturgeon maintaining robust monitoring programs for many years to estimate vital rates using traditional methods is likely difficult. We will briefly examine the tradeoffs in terms of information gained on stock status from the long-term passive tagging programs compared to the more recently implemented telemetry program.

Estimating Sturgeon Abundance in the Carolinas Using Side-Scan Sonar and Bayesian Models (Atlantic and Gulf Sturgeon Conservation)

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Populations of endangered Atlantic sturgeon (*Acipenser oxyrinchus*) in North and South Carolina have been significantly reduced from historic levels by a combination of intense fishing and habitat loss. The conservation status of this species creates a need for estimates of current abundance. Hydroacoustics, such as side-scan sonar, has advantages over traditional techniques, such as the ability to sample large areas efficiently and potentially survey fish without physically handling them – important for species of conservation concern. Our objective was to use data from side-scan sonar surveys to create estimates of abundance for Atlantic sturgeon. We surveyed lower reaches of six rivers in North and South Carolina, near the saltwater/freshwater interface, using a combination of side-scan sonar, telemetry, and video cameras (to sample jumping sturgeon) during summer 2011. We used both occupancy and N-mixture models with data acquired from side-scan sonar surveys to estimate abundance of sturgeon in each river. Estimated total abundance of sturgeon >1 m in length for all six rivers combined was greater than 600 individuals. The Pee Dee/Waccamaw and Santee Rivers in South Carolina had highest and lowest estimated abundances, respectively.

Atlantic Sturgeon Recruitment in the Savannah River, Georgia (Atlantic and Gulf Sturgeon Conservation)

Derek L Bahr, University of Georgia and Douglas L Peterson, University of Georgia*

The Atlantic sturgeon *Acipenser oxyrinchus oxyrinchus* was once abundant along the Atlantic Coast of North America from the St Johns River, Canada to the St John River, Florida. Severe overfishing, coupled with habitat losses during the 1900s, resulted in major population declines that eventually led to the species' listing under the US Endangered Species Act in 2012. Despite the endangered status of Atlantic sturgeon, quantified recruitment data are largely lacking for most systems, particularly among populations within the South Atlantic Distinct Population Segment (DPS). The objective of this study was to quantify annual recruitment of Atlantic sturgeon in the Savannah River, Georgia, by estimating annual abundance of age-1 river-resident juveniles. During the summer of 2013, we used anchored gill nets and trammel nets to sample juvenile Atlantic sturgeon throughout the Savannah River estuary. Ages of captured juveniles were determined by using a simple length-frequency histogram. Abundance of each age class was then estimated using the Huggins closed-capture model in Program MARK. In 2013, abundance estimates for age-1, age-2, and age-3+ Atlantic sturgeon were 527, 464, and 720, respectively. The results from the first year of our study suggest that the Savannah population is likely the 2nd largest within the South Atlantic DPS; however, additional recruitment estimates are needed in subsequent years to better understand the current status and trend of the population.

Multistate tagging models: accounting for spatial variation in Atlantic sturgeon migration and bycatch rates (Atlantic and Gulf Sturgeon Conservation)

William Smith, NCDMF and Michael Loeffler, NCDMF*

Models that estimate population rates using data generated from the recapture of tagged animals offer a more rapid, near real-time approach to population assessment and monitoring, compared to traditional population assessment approaches that require extensive data preparation over a period of several years. When applied to highly migratory species, traditional tagging models are frequently confounded by an inability to separate mortality from emigration; however, one class of tagging models has the capability to simultaneously estimate mortality and migration parameters: multistate or spatial tagging models. Model assumptions of multistate tagging models are identical to traditional tagging models, and data requirements are essentially the same. The main difference is that animals must be tagged and recaptured in all areas where they may migrate. This presentation documents a preliminary effort to construct a multistate tagging model for Atlantic sturgeon tagged throughout the East Coast of North America, from Georgia to Canada, and reported to the US Fish and Wildlife Service by a diverse group of many researchers. The model accounts for important assumptions by incorporating submodels to estimate tag reporting rate, tag retention, and bycatch mortality. Preliminary results indicate that on average, over the period from 1991–2012, bycatch rates were greater in the New England and mid-Atlantic regions than in the south Atlantic region. Tagged Atlantic sturgeon were generally more likely to move from south to north than from north to south. Future work on this dataset and model may incorporate estimated total bycatch in order to produce estimates of population abundance, individual body size data to explore changes in migration probability as fish grow, genetic data to explore variation in migration related to natal origin, and telemetry data to improve the resolution of migratory probability estimates.

Investigating Riverine Habitat of Gulf and Atlantic Sturgeon Populations: New Approaches to Address Information Gaps at the Meso-Scale (Atlantic and Gulf Sturgeon Conservation)

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Both Atlantic and Gulf sturgeon experience a variety of riverine environments and conditions during their life history. Investigations of microhabitat, such as grabbing ponar samples of substrate in a spawning area, or descriptions of landscape-level fish distribution via telemetry are typical, yet a variety of research and management questions target a scale that is logistically challenging to address in the large, and often turbid rivers inhabited by sturgeon. Developments in the field of sonar imaging, an active form of remote sensing, provide new techniques for characterizing the riverine habitat of sturgeon, describing the changes that occur to habitat over time, and even describing the distribution and abundance of sturgeon with respect to habitat at the meso-scale. Using low-cost equipment and available tools, we describe how sonar-based approaches in rivers can provide meaningful meso-scale information wherever sturgeons roam.

Habitat Preferences of Hudson River Atlantic sturgeon (Atlantic and Gulf Sturgeon Conservation)

Amanda Higgs, New York State Department of Environmental Conservation*

Little is known on detailed habitat use for Atlantic sturgeon in the Hudson River Estuary. Atlantic sturgeon were the most important commercial fish species in NY at the turn of the 20th century. Very high catches in the late 1880s collapsed the stock and fishing remained low until the 1980s and 1990s when an upsurge in harvest began. NY State closed the fishery in 1996 due to excessive harvest and efforts turned toward stock recovery. We sonic tagged both adults and juveniles to identify important areas used seasonally for essential activities: spawning, nursery and over-wintering. The technology used allows for pinpoint locations of fish. Locations are then compared to detailed benthic map recently completed for the Hudson. Sturgeon use areas of particular bottom types and not those most commonly found. Once identified, these areas can be protected to assist species recovery.

Do Macrobenthic Prey and Physical Habitat Characteristics Explain Differential Estuarine Critical Habitat Use Patterns in a Western Gulf Sturgeon Population? (Atlantic and Gulf Sturgeon Conservation)

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Gulf Sturgeon, *Acipenser oxyrinchus desotoi*, is listed as threatened under the United States Endangered Species Act throughout its range in the northern Gulf of Mexico; Mobile Bay, Alabama, is the recognized break between eastern and western populations. Although western populations of Gulf Sturgeon are low in abundance, population recovery requires not only protection of the species but also its critical habitat. We examined Gulf Sturgeon estuarine physical habitat attributes and infaunal macrobenthic prey density and composition both spatially and seasonally relative to acoustically-tagged Gulf Sturgeon occurrence in the Pascagoula River estuary, an important critical habitat conduit between freshwater and offshore marine habitats. Our occupancy index illustrated minimal use of the east zone of the Pascagoula River estuary compared to the west zone seasonally and ontogenetically. Gulf Sturgeon occupancy patterns also indicated adults move quickly through the system during fall and spring compared to longer but more spatially and temporally variable occupancy for juveniles and sub-adults in both seasons; sub-adults exhibited a less spatially and temporally variable occupancy pattern. These critical habitat conduits are comparable with data from eastern Gulf Sturgeon populations. Comparisons of infaunal macrobenthic

densities indicate that prey values are higher in the Pascagoula River estuary than those reported for Suwannee and Choctawhatchee Rivers, Florida, suggesting principal and secondary prey items are not limiting in western populations. Quantification of physical estuarine habitat and macrobenthic density characteristics partially explained Gulf Sturgeon spatial and temporal occupancy patterns; however, sediments in our system contained higher silt/clay fractions than those reported for eastern populations in Florida and have relatively high particulate organic carbon. These direct comparisons of physical drivers and macrobenthic density patterns (BEST procedures) were significantly correlated ($p < 0.01$) but weak (Global $R = 0.277$) and suggests alternate hypotheses to better explain the small-scale differential estuarine habitat use patterns. The most parsimonious explanation with multiple weights-of-evidence suggests reduced use of the eastern tributary habitat by Gulf Sturgeon based on synergistic effects of urbanization and industrialization such as bulkheading, channelization, dredging and related maintenance activities, and beach re-nourishment; all of which occur almost exclusively in the east zone of the estuary.

Estuarine Habitat Use in Connecticut Waters By Shortnose and Atlantic Sturgeon (Atlantic and Gulf Sturgeon Conservation)

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A natal population of shortnose sturgeon and non-natal Atlantic sturgeon were found to co-occur in the lower estuarine portion of the Connecticut River on a seasonal basis. Shortnose sturgeon typically move to the lower river (rkm 0 - 12) during the Spring freshet in April and May which displaces the salt wedge from the river out into Long Island Sound. Shortnose sturgeon reside in this area for 60 to 90 days before slowly moving northward to utilize other upriver areas. This northward movement can coincide with return of salt water into the river but shortnose sturgeon routinely experience 0 to 10 ppt and up to 25 ppt while in this area. Immigration of non-natal Atlantic sturgeon typically takes place during this same time period (June July) of increasing salinities but Atlantic sturgeon have moved into the area and co-occur with shortnose sturgeon as early as April. Atlantic sturgeon remain in the river through September in most years but some have been known to linger until October or November when some shortnose sturgeon move back into this estuarine area. Telemetry observations of tagged fish and collections of both species in single gill nets and trawl hauls indicate both species are sharing selected habitats and not that one species displaces the other. Both species are selecting for the deeper areas within the lower 15 kilometers of river, although there is foraging at shallower depths.

Salinity Effects on Atlantic Sturgeon Growth and Osmoregulation (Atlantic and Gulf Sturgeon Conservation)

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The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) is an anadromous sturgeon species, yet little is known in regard to its osmoregulatory ability and habitat use at early life stages. Therefore, juvenile Atlantic sturgeon (mean initial weight: 440 g) were acclimated to one of three salinity conditions (0, 10, or 33 ppt) representing the range of salinities they would be expected to encounter. Growth was measured over a 6-month period, and osmoregulatory ability (ie, blood plasma osmolality and ionic concentrations)

was measured after 4 months Mean weight and length increased in all treatments, but fish in 0 and 10 ppt grew more than fish in 33 ppt Blood plasma osmolality was regulated at similar levels regardless of salinity Therefore, juvenile Atlantic sturgeon have the physiological capability to move between salinity habitats, but grow faster in low salinities

Coast-Wide Movements of the Endangered Atlantic Sturgeon Indicate Need for Spatial and Temporal Protection (Atlantic and Gulf Sturgeon Conservation)

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In order to best manage human activities in a way that populations of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) may recover fully, it is necessary to understand the association between sub-adult Atlantic sturgeon and their ocean/estuarine habitat With the recent listing under the ESA, the identification of key movements and habitat use is essential for the declaration of critical habitats Between 2010-2012 we acoustically tagged a total of 429 sub-adult Atlantic sturgeon captured in aggregation areas off Rockaway, New York Movements of telemetered individuals were monitored by large acoustic arrays and gates located throughout the coastal mid-Atlantic, as well as cooperative partners in the ACT Network Results indicated repeated yearly spatial/temporal movements and habitat use which suggest that the development of spatial/temporal management plans could be implemented to limit sturgeon interactions with a wide range of anthropogenic activities

Legends of the fall; the evidence for fall spawning in Gulf of Mexico sturgeon (*Acipenser oxyrinchus desotoi*) (Atlantic and Gulf Sturgeon Conservation)

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Like other North American sturgeons, Gulf sturgeon suffered multiple insults leading to marked population declines In the case of Gulf sturgeon these declines ultimately ended with a threatened listing under the Endangered Species Act in 1991 It has been argued that the ESA listing provided much needed resources directed at conservation and recovery, resulting in a marked increase in Gulf sturgeon research efforts Today, Gulf sturgeon are believed to spawn in seven drainages ranging from Louisiana to Florida although the exact location of spawning is unknown in some systems Throughout its range, Gulf sturgeon are known to spawn in the spring although there is a growing body of evidence suggesting fall spawning in some systems On the Suwannee River, FL Sulak et al have examined the length frequencies of YOY Gulf sturgeon and have hypothesized that two distinct cohorts exist suggesting the presence of spring and fall groups More recently, work on the range-wide population genetics suggests the presence of distinct genetic groups within some drainages We have examined the behavioral basis for these genetic findings for the Choctawhatchee and Yellow Rivers, FL and although fall spawning has not been documented, we feel it is likely in some systems At present, conservation and recovery efforts for Gulf sturgeon are predicated solely on spring spawning Given predicted increases in human population growth in coastal communities, coupled with changes in flow regimes due to increased water withdrawals and climate change, we recommend that managers begin to factor in the needs of fall spawning individuals

Identification of Critical Habitat and Spawning Migrations of Atlantic Sturgeon *Acipenser oxyrinchus oxyrinchus* in the Altamaha River System, Georgia (Atlantic and Gulf Sturgeon Conservation)

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The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*, Acipenseridae) has declined throughout its range as a result of various anthropogenic factors and the species is now protected under the United States Endangered Species Act. Information on spawning migrations and spawning habitat is essential for effective recovery plans for Atlantic sturgeon. The objectives of our study were to document and describe (1) seasonal distribution and movements and (2) spawning migrations. We used a stationary array of acoustic receivers to monitor the movements of 30 adult Atlantic sturgeon in the Altamaha River system, Georgia, from April 2011 through March 2013. Telemetry data revealed that adult Atlantic sturgeon appeared to stage in the oligohaline habitats of the lower Estuary during the spring and early summer. In fall, the fish migrated at least 250 km upriver to suspected spawning habitats in Ocmulgee River, returning back to the ocean during the following winter. Similar studies of Atlantic sturgeon in northern river systems showed that spawning typically occurs in late spring and early summer. Our findings on the Altamaha River illustrate the clinal variation in the life history of Atlantic sturgeon and highlight the need to manage the species as distinct population segments with regionally specific recovery goals.

Fish Passage at the New Savannah Bluff Lock and Dam Augusta, GA (Atlantic and Gulf Sturgeon Conservation)

Jamie Sykes, USACE*

The Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*), an imperiled species occurs in the Savannah River Basin and historically used the shoals located almost 200 miles upriver near Augusta, GA as spawning habitat. Construction of the New Savannah Bluff Lock and Dam in 1937 has blocked yearly migrations to this important area for 76 years. Recently, as part of the Savannah Harbor Expansion Project, the USACE Savannah District has agreed to provide passage around NSBL&D using a rock arch ramp. The design costing \$XX will be similar to the one built by USACE Wilmington District for the Cape Fear River Lock and Dam #1 in NC. It will allow 100% of the river to flow through the by-pass ramp (up to 8,000 cfs), has a bottom width of 285ft, and a depth of at least 35ft throughout. This design should also meet swimming speed criteria for many fish species, not just the sturgeon during a variety of flows. Additionally, as part of this endeavor, SCDNR is currently monitoring Atlantic sturgeon movements with an array of ultrasonic receivers placed at strategic locations upstream and downstream of the dam. Information from this study will be gathered prior to and post completion of the fish passage facility. By evaluating sturgeon passage (both upstream and downstream) important information can be gathered which can be part of the larger goal of restoring this species.

Assessing Entrainment Risk, Take, and Impacts on Sturgeon Populations (Atlantic and Gulf Sturgeon Conservation)

Jan Jeffrey Hoover, USACE*

Water intakes, water diversions, and hydraulic dredges have entrained sturgeon for decades, prompting concern among resource agencies, but resulting in no established protocol for evaluation. We have adopted a group of techniques to quantify sturgeon susceptibility to entrainment (risk), estimate numbers entrained (take), and describe effects of those losses on populations (impacts) which can be used separately or in combination to effectively address such concerns by evaluating impacts of specific water operations and benefits of mitigation techniques. Risk is expressed as an index describing likelihood of swimming failure at a specific water velocity characteristic of an entraining flow field. Data required are flow fields, which are measured directly or estimated indirectly from simple hydraulic models, and swimming performance, which are readily measured in field or laboratory test chambers with hatchery-reared or field-caught fish. Take is estimated from expansions of direct counts of entrained fish based on statistics, hydrology, or fish density. Impacts are described from population viability models that forecast long-term changes in population size and probability of specific levels of decline. Data required are estimates of population size and life history parameters. We will present examples from our studies of Atlantic sturgeon, pallid sturgeon, and green sturgeon.

The current status of knowledge concerning use of hatcheries to assist in restoration efforts for Atlantic sturgeon (Atlantic and Gulf Sturgeon Conservation)

Jerre Mohler, USFWS*

Use of captive wild and hatchery-produced domestic Atlantic sturgeon could play an important role in restoration efforts for the species. If implemented, an Atlantic sturgeon hatchery program will likely be operated much differently from what has traditionally been instituted for other species such as salmon, shad, and striped bass. Limitations such as access to mature broodstock, proper hatchery conditions for successful gonadal development, and considerations of genetic diversity in stocked fish will be need careful consideration. Use of wild fish captured during spawning migration to obtain broodstock for short-term hatchery use and/or commitment to long-term maintenance of hatchery-produced F1 fish to develop domestic broodstock are strategies which can be employed. Lessons learned from results of experimental stockings of hatchery-produced fish in the mid-1990's highlight the current state of knowledge in the use of hatchery-produced Atlantic sturgeon as a tool for future recovery efforts. For the NY Bight DPS and those further north, long-term evaluation of twenty years or more will be required to determine survival and performance for each cohort of hatchery released fish. Given the necessary long-term evaluation efforts and shrinking federal and state budgets, the community of sturgeon researchers will need to continue cooperative efforts such as the Atlantic Coastal sturgeon tagging database and the Atlantic Cooperative Telemetry (ACT) to monitor hatchery-released fish.

What is sturgeon recovery? (Atlantic and Gulf Sturgeon Conservation (2))

Gail Carmody, USFWS and Sandra Tucker, USFWS*

How will we know when the Gulf or Atlantic sturgeon are recovered and no longer need the protection of the Endangered Species Act? Is it simply the total number of individuals? Do we need to consider distribution across range? Many integrated and site-specific actions are necessary to achieve recovery. Researchers, stakeholders, and managers must couple sound scientific and logistical decision-making throughout the process of planning for recovery: the most effective and practical path to success. The

information presented in the Sturgeon Symposium will seed this interactive discussion to identify the bricks in the road to recovery for the Gulf and Atlantic sturgeon

Integration of Acoustic Methodologies to Identify Atlantic Sturgeon (*ACIPENSER OXYRINCHUS OXYRINCHUS*) Distribution and Habitat Preferences (Atlantic and Gulf Sturgeon Conservation (2))

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A comprehensive understanding of Atlantic sturgeon habitat preference and use is key for successful conservation, restoration, and management of this endangered species. Traditional sampling techniques often require handling of sturgeon, which can lead to incidental injury or even mortality. However, acoustic technological advancements now allow for effective sampling of larger regions while eliminating risks associated with handling. In June 2013, through a combination of passive mobile telemetry and high-resolution side-scan sonar, we assessed Atlantic sturgeon distribution and habitat preference in a 10km region of the Hudson River near Hyde Park, NY. During the sampling period, a total of 212 mobile telemetry detections of 17 Atlantic sturgeon were recorded, and we imaged over 100 sturgeon targets using side-scan sonar. The 17 Atlantic sturgeon detected by mobile telemetry were originally caught and acoustically tagged between 2009-2013, with a majority tagged in coastal Delaware waters over 300 miles away. The imaged Atlantic sturgeon within the Hyde Park region of the Hudson River were generally heterogeneously distributed, however, three distinct concentration areas were delineated. Within our sampling region individuals were found utilizing benthic habitats characterized by bottom sediments of sands, muds, gravels, and combinations of the three sediment types. Habitat preference was then assessed with the use of a chi-square and bonferroni-z analysis. Our results demonstrate the utility of coupling non-invasive high-resolution side-scan sonar surveys and mobile telemetry to identify concentration areas of reproductively mature Atlantic sturgeon. This research is providing a foundation for the understanding of Atlantic sturgeon riverine habitat preferences, which will be used as a framework for conservation, restoration, and successful future management.

The Penobscot River Dam Removal and Sturgeon of the Gulf of Maine (Atlantic and Gulf Sturgeon Conservation (2))

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The presence of dams on Atlantic and shortnose sturgeon populations is primarily associated with the inability of individuals to reach suitable spawning habitat. The Penobscot River in Maine is no exception. Since 2008 we have been surveying the river to determine whether or not spawning occurs below the lowermost dam. To date these attempts indicate that sturgeon are not spawning there. For shortnose sturgeon (*Acipenser brevirostrum*) telemetry results indicate a high rate of movement to an adjacent river system, the Kennebec River. Most telemetered females with eggs in the late stage of development that overwintered in the Penobscot left the river system prior to suitable spawning conditions and females with late stage eggs were later detected at known spawning areas in the Kennebec complex (Kennebec, Androscoggin, and Sheepscot Rivers). The Kennebec River is also the only river system in Maine where mature Atlantic sturgeon have been documented. These results indicate that currently the Penobscot is unlikely to host spawning. However, the Penobscot River is the subject of an intensive restoration project.

involving the removal of the two lowermost dams at river kilometers (rkm) 46 and 58 We have documented the extent of suitable spawning habitat for sturgeon downstream of the lowermost dam and the effects of a legacy dam (downstream of the lowermost dam that will be removed) on spawning migrations A two dimensional hydrodynamic model was created and analyzed for spawning habitat suitability and passage at the dam using River 2D version 095a Results indicate that suitable spawning habitat is present in the river reach accessible to sturgeon and they should be capable of passing the remnants of the legacy dam during spring river conditions However, passage above the legacy dam remnants has not yet been observed in the spring and sturgeon with acoustic tags have not been detected above the remnants in the spring The importance of upstream spawning migrations of sturgeon cannot be understated, and passage at dam remnants requires empirical study at spring discharges to further assess the probability of water velocity barriers

Identification of Critical Habitat and Spawning Migrations of Shortnose Sturgeon *Acipenser brevirostrum* in the Altamaha River System, Georgia (Atlantic and Gulf Sturgeon Conservation (2))

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Spawning populations of shortnose sturgeon (*Acipenser brevirostrum*, Acipenseridae) have declined or been extirpated, particularly in rivers along the periphery of their range Understanding the spatial and temporal dynamics of spawning migrations within natal rivers is a critical information gap with regard to habitat protection and ultimately, species recovery The objectives of our study were to document and describe seasonal distribution and spawning migrations of shortnose sturgeon in the Altamaha River, Georgia Using passive acoustic telemetry, we monitored the movements of 40 adult shortnose sturgeon from April 2011 through March 2013 Telemetry data revealed that during much of the year, shortnose sturgeon resided within the tidally influenced portion of the river Upstream movements to spawning habitat occurred during winter and early spring, with the majority of fish returning to the lower estuary by March Unlike spawning migrations in some northern rivers, the pattern of movement observed in the Altamaha was a single step migration with no resting or staging period This study further illustrates the clinal variation in life history typical of the species that may have important implications on river-specific strategies to recover the species

Utilization of a High-Density Telemetry Array to Examine Gulf Sturgeon Foraging Habitat (Atlantic and Gulf Sturgeon Conservation (2))

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Gulf sturgeon (*Acipenser oxyrinchus desotoi*) inhabit riverine systems and waters in the Gulf of Mexico Federally protected since 1991, the recovery of Gulf sturgeon is closely linked to essential habitat usage The 1995 Gulf sturgeon recovery plan notes that threats to the population are not well understood and identification of essential habitats is key to the restoration of the species The plan also recommends the use of telemetry to track and identify Gulf sturgeon movement patterns in suspected foraging areas Understanding how the species uses the Choctawhatchee Bay system is essential to establishing successful management strategies for this species Our objective is to determine the fine-scale relationship between Gulf sturgeon and habitat utilization using a high-density array of acoustic receivers and VPS

synchronization transmitters Over the course of the study, 2011-2013, 208 Gulf sturgeon were fitted with acoustic tags as well as PIT tags for tracking through the river and bay systems Tagged fish included adult sturgeon (144-214 cm total length) and sub-adult sturgeon (76-152 cm total length) found within the Choctawhatchee river system Synchronization transmitters positioned within our array to monitor detection performance were well detected with 766% of sync tag transmissions logged on three or more receivers Overall the array performed well as evidenced by high detection rates, which provide fine-scale estimates of position Receivers were placed within an area hypothesized to be crucial foraging grounds encompassing 21 km² each year There were 133 unique ID tags detected from October 8, 2012 to May 10, 2013 with 99 telemetered sturgeon tracked by the VPS array This data can be used to provide a real-time representation of sturgeon movement in foraging habitat Using this method we can provide a snapshot of Gulf sturgeon movement and habitat usage by quantifying key habitat utilized by the telemetered Gulf sturgeon while they are residing in Choctawhatchee Bay

Improving the Likelihood of Successful Captures of Pallid Sturgeon (*Scaphirhynchus albus*) in the Lower Mississippi River (Atlantic and Gulf Sturgeon Conservation (2))

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The endangered Pallid Sturgeon *Scaphirhynchus albus* inhabits the flowing-water habitats in large rivers in the Missouri River and lower Mississippi River basins Effective restoration of this species requires information about population demographics and habitat use Obtaining the needed information requires effective sampling of this less-than-common fish in a challenging large-river environment Given this obstacle, this project proceeded with the objective to attempt to identify important environmental parameters to help increase sampling efficiency Pallid Sturgeon were captured with trotlines set in secondary channel and main channel border habitats in the lower Mississippi River The probability of capturing at least one Pallid Sturgeon was modeled by stepwise logistic regression analysis of five abiotic variables: river stage, change in stage, temperature, surface current velocity, and depth Stage ($P=001$), depth ($P=002$), and temperature ($P=003$) significantly affected capture probability Temperature and stage were inversely related to capture probabilities and depth was positively correlated with capture probabilities Our model indicates that capture probabilities are highest when trotlines are fished in water 10 m deep, when water temperature is 125°C, and when river stage is 3-6 m These conditions typically occur in November and December This information can be used to increase the efficiency of capturing Pallid Sturgeon in the lower Mississippi River and possibly other large rivers

Habitat Use of Shovelnose Sturgeon in the Lower Mississippi River (Atlantic and Gulf Sturgeon Conservation (2))

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Shovelnose Sturgeon *Scaphirhynchus platyrhynchus* are one of the more abundant and widely distributed freshwater sturgeon species in North America, but throughout the last century they have experienced population declines attributed to overharvest, localized pollution, and habitat alterations With these declines there is a need to identify habitats that may be significant for the conservation of Shovelnose Sturgeon under changing river conditions One hundred and twenty-two Shovelnose Sturgeon (656-852 mm FL) were implanted with acoustic transmitters at two study sites located at river kilometer (rkm)

1,120-1,065 (Tunica, MS) and rkm 751-695 (Vicksburg, MS) These sites were tracked monthly resulting in 80 and 250 relocations at Tunica, MS and Vicksburg, MS respectively, during March 2012 to March 2013 Habitat use was compared with habitat availability measured using bathymetric data provided by the US Army Corps of Engineers and satellite imagery from the US Geological Survey Habitat selection was measured separately for four separate time periods delimited by river stage and water temperature Shovelnose Sturgeon did not select habitat for the majority of the four time periods but habitat use changed with river stage The main channel was used more frequently at low river stages, when it composed roughly 60% of habitat at both study sites Sandbars, revetted banks, and wing dikes were all used frequently when available at high river stages Results suggest that Shovelnose Sturgeon are not selective of habitat at high river stage when a diversity of habitat is available It remains to be determined whether high use of the main channel during low river stages indicates positive selection or whether the fish are concentrated in the main channel because other habitats are not available

Gulf Sturgeon: Developing Monitoring Programs to Track Recovery Progress (Atlantic and Gulf Sturgeon Conservation (2))

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Integrated monitoring of the federally-threatened Gulf sturgeon has been ongoing for a number of years Monitoring is crucial to tracking progress toward recovery because it allows for 1) an assessment of progress associated with conservation actions, 2) an up-to-date evaluation of the status and threats associated with a given species and associated habitat, and 3) an assessment of species-level fitness Recovery goes beyond reducing and elevating threats, and achieving recovery is best allied with measures of species-level fitness that are indicative of species stability such as resilience, representation, and redundancy “Resilience” comes through population level capacity to positively respond from chaos caused by natural or anthropogenic threats, and periodic exchange of individuals between populations across the range of a species “Representation” refers to a species capacity to be naturally-represented within appropriate habitat settings across the landscape Such representation is likely to facilitate genetic diversity that allows a species to continue into the future, as well as fulfill a species role within the functioning ecosystem Lastly, “redundancy” (multiple occurrences within a geographic locality) across the landscape allows for improved connectivity between populations (ie reduced allee effects at local scales) and increased capacity to recovery from a locally catastrophic event In future evaluations of progress toward recovery, monitoring programs need to track not only individual fitness, estimate population metrics, habitat assessments, and success criteria for conservation actions, but also additional species level metrics Better evaluations of the relationship of individuals to populations, then to the species level are also needed, as well as identification of key benchmark species thresholds and ecological indicators of success

Dams: Impediments to Sturgeon Recovery in the Southeast (Atlantic and Gulf Sturgeon Conservation (2))

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Efforts by state and federal fisheries agencies are underway to restore Atlantic and shortnose sturgeon populations in Southeastern rivers However, dams can be significant impediments to successful restoration efforts by limiting access to historic spawning areas upstream of dams and altering habitat

quality below dams The ASMFC Interstate Fishery Management Plan for Atlantic Sturgeon recognizes the impacts of dams and calls for reestablishing access to historic spawning habitats for species recovery State Wildlife Action Plans from North Carolina, South Carolina and Georgia also recognize the effects of dams on sturgeon habitats

The vast majority of dams in Southeastern rivers do not generate hydroelectric power and many serve no present purpose They do, however, block sturgeon and other migrating fish from historic spawning and nursery habitats The most effective way to return sturgeon to upstream spawning habitat is removing dams Once achieved, fish passage is fully volitional with little or no maintenance required In the Carolinas, there are approximately 8,000 dams listed under state dam safety program databases and a band of dams approximate to critical sturgeon spawning habitat is present in both states An increase in dam removals has occurred in the Southeast, however, to date these dams have been on smaller rivers and tributaries of lower importance to sturgeon spawning

Hydroelectric dams range from low head diversions that shunt flows from rocky shoal spawning habitats to larger dams that substantially alter downstream flows for up to 90 miles While rarely good candidates for removal; there are opportunities to mitigate effects of these dams on sturgeon and their preferred habitats Promising innovations for fish passage are planned at the Santee-Cooper development (SC) and New Savannah Bluff Lock and Dam (GA) Natural flows patterns are being restored through hydropower dam relicensing processes required under the Federal Power Act Flow schedules that will enhance sturgeon spawning are either in place or part of relicensing settlement agreements at the Columbia Hydroelectric Project (SC), Augusta Diversion Dam (GA) and Saluda Dam (SC) Hypolimnetic releases from hydroelectric dams can result temperature alterations and precipitous drops in dissolved oxygen concentrations Substantial improvement in dissolved oxygen has occurred at the Saluda Dam and operations to mitigate temperature alterations are part of the settlement agreement for a new license

A comprehensive plan for sturgeon recovery in the Southeast must include removal and reoperation of dams that clog the region's rivers

Reef Fish Symposium

Incorporating Habitat Stratification into Reef Fish Survey Design: Applying Results from a Small-Scale Pilot Study Towards Broad-Scale Monitoring Efforts (Reef Fish Symposium)

Eric J Weather, Florida Fish and Wildlife Conservation Commission*

In 2008 the Florida Fish and Wildlife Conservation Commission initiated a Fisheries-Independent Monitoring survey of reef fishes on the west Florida shelf This survey employs a spatially-stratified, random sampling approach targeting high-relief and hard-bottom habitats through the use of chevron traps and stationary underwater video camera arrays Bottom habitat throughout the region is characterized as a mosaic of sand and hard bottom habitats covered by a thin sand veneer with small, mostly low relief, rock outcroppings scattered sparsely throughout Initial survey efforts relied on broad-scale and outdated habitat information; accordingly, analyses of early data require extensive post-stratification to identify and exclude the large proportion of sites that did not sample reef habitat Beginning in 2010, this survey was improved through the addition of dedicated acoustic mapping to identify and characterize reef habitat as well as guide sampling efforts Although this approach has greatly reduced the proportion of sites that fall

on non-reef habitat, post-stratification based on habitat type is still often required to maximize the precision of relative abundance indices. To optimize these indices and move towards more quantitative estimates of abundance through time, a transition to a habitat-based pre-stratification survey design is warranted. Results from a small-scale pilot study demonstrated the feasibility of such an approach; some taxa (eg, Scamp, Hogfish, and Gray Snapper) exhibited highest abundances at high-relief habitats, whereas others (eg, Red Grouper, Gag, and Gray Triggerfish) were more uniformly distributed among habitat types. Further, preliminary evidence indicates that demography of some taxa may also differ among habitat types. The complexity of interactions between reef-fishes and their associated habitats will be explored in an effort to understand how to maximize overall survey efficiency. Important implications of these results, specifically as they pertain to broad-scale monitoring efforts, will be discussed.

Citizen Science As an Integral Component of Reef Fish Research and Monitoring Efforts Along Florida's Atlantic Coast (Reef Fish Symposium)

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In response to a 2008 stock assessment indicating that the South Atlantic Red Snapper (*Lutjanus campechanus*) stock was overfished and undergoing overfishing, an emergency closure was implemented in 2009 that prohibited the commercial and recreational harvest of Red Snapper. This closure, which aside from extremely limited open seasons in 2012 and 2013 has remained in place, has significantly altered the availability of fishery-dependent data on which historical stock assessments of Red Snapper have largely been based. Accordingly, there has been renewed interest in recent years to develop alternate methods of assessing Red Snapper population dynamics. In 2010, scientists from the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute were approached by leaders of the commercial fishing industry to develop a cooperative tagging program to provide basic data on the distribution, movement, growth, and mortality of Red Snapper. Implemented in early 2011 with extensive support from various industry partners, this tagging program has relied heavily on the knowledge and experience of commercial, recreational, and for-hire anglers. Since its inception, a total of 3,083 Red Snapper have been tagged, of which 203 (66%) have been recaptured. Days at large for the recaptured Red Snapper have ranged from 0 to 887 days, and approximately 90% of the recaptured individuals were collected within 10 miles of their original tagging location. Although this program has provided useful data on Red Snapper, of significantly more importance has been our ability to establish effective partnerships with citizen stakeholders that have subsequently provided input and assistance with further research efforts. Information garnered and relationships forged with local stakeholders during this project have been instrumental in developing additional projects to assess the utility of various fisheries-independent sampling methodologies in complimenting ongoing trap and camera surveys of reef habitat as well as provide much-needed demographic data for Red Snapper.

Spatial Structure and Composition of Reef Fish Along Florida's Atlantic Coast (Reef Fish Symposium)

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Many exploited reef fishes along the southeastern United States coast are currently experiencing overfishing, due in part to increasing fishing effort in recent decades. Recognizing the need for broad-scale, fisheries-independent data and as an important step in the continued development of an offshore reef fish monitoring program, the Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission (FWC) conducted a study to compare and evaluate active and passive hooked gear types in their ability to efficiently and effectively characterize the distribution, abundance, and size-structure of reef fishes along Florida's Atlantic coast from April through October 2012. Monthly sampling was conducted along Florida's Atlantic coast. A fisheries-independent survey of reef fishes, using both actively and passively-fished hooked gears was conducted within three latitudinal and two depth strata. Red snapper and black sea bass comprised the majority of the catch across all strata. Larger and older red snapper were captured in the two northern most zones compared to the southern zone. The size-frequency distribution of black sea bass differed significantly among statistical zones. In general, black sea bass had a broader size-frequency distribution with a higher proportion of larger individuals to the north. For vermilion snapper, individuals collected in the northern-most statistical zone were significantly larger than those collected in the two southern statistical zones. The size-frequency distribution of all three species differed significantly between shallow and deep strata. Hook size was a significant factor in determining catch-per-unit effort for all species. PERMANOVA identified changes in assemblage structure that were significantly impacted by the interaction between statistical zone and stratum, as well as the main effects of stratum, statistical zone, and hook size. Length samples collected from fisheries-independent monitoring clearly show a bimodal distribution with the center of the first mode occurring at 350 mm fork length and the center of the second mode at 560 mm fork length. Fisheries-dependent data reflects the first mode but does not indicate the presence of the second mode. Overall, differences in species composition and size structure were found with respect to depth strata and NMFS statistical zone. These hooked gear types compliment data collected from camera and trap surveys currently used by NMFS and MARMAP by providing catch data of larger managed reef fish not collected in traps and demographic data (ie, age, sex, reproductive condition, mercury concentrations, etc) not obtained by cameras.

Comparison of Trap and Video Gears to Index Reef Fish Presence and Abundance from 2010–2012 (Reef Fish Symposium)

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It is challenging to manage reef fish species in the Southeast US Continental Shelf Large Marine Ecosystem (SUSLME) due to life-history strategies that make them vulnerable to overexploitation, difficulty of sampling reef fish in high-relief hard bottom habitats, and fluctuations in utility of fishery-dependent data. In response to declines in fishery-dependent data due to fishery closures, fishery-independent sampling of reef fish has become even more critical to stock assessment. Here we build on

previous work assessing whether a long-term chevron trapping survey could benefit from the addition of underwater video cameras. Sampling occurred on continental shelf and shelf break habitats (13 – 90 m deep) between Cape Lookout, North Carolina, and central Florida. Reef fish frequency of occurrence was 10% to infinitely higher on video compared to traps for a majority of species analyzed. Frequency of occurrence for a few species was not significantly different between traps and video, and one species (black sea bass) were more frequently caught in traps than seen on video. Although positive relationships were observed between log-transformed trap and video indices of abundance for five selected reef fish species, considerable amounts of unexplained variation existed and the relationship for most species was nonlinear. Further research to assess the relationship between true and trap- and video-measured abundance is needed. We conclude that underwater video can be a beneficial addition to a long-term trapping survey by increasing the frequency of occurrence for most reef fish species, which should translate into improved indices of reef fish abundance in the SUSLME.

Identification of Fixed Stations for the Southeast Reef Fish Survey (Reef Fish Symposium)

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During the spring of 2012 a panel of experts was assembled to review fishery-independent surveys of reef fishes in the Exclusive Economic Zone of the South Atlantic bight from Cape Hatteras, NC, to St Lucie Inlet, FL. One task was to provide guidance on optimal survey design strategies for maximizing data content of the Southeast Reef Fish Survey (SERFS) chevron trap survey with respect to detecting annual trends in abundance. The panel recommended identifying a core set of fixed stations to be sampled annually. Theoretically, by repeatedly sampling fixed stations one can minimize the spatial variance in relative abundance, thus increasing the signal to noise ratio when investigating annual abundance trends. During the process of identifying fixed stations we made an attempt to honor traditional survey sampling procedures. We also made attempts to ensure that identified stations represented the sampling universe, were routinely sampled historically, represented substantial reef areas, and did not represent an excessive percent of the universe stations in a given reef area. As of 2013 the SERFS chevron trap sampling universe consisted of 3,141 stations distributed across 178 reef areas (ranging in size from 31-670 km²; each containing 1-183 stations). Of these, we considered 3,065 as potential fixed stations as they were located in reef areas (n=130) with four or more universe stations. For these we calculated the percent of available years a sample was taken within 200m of that station (*% sampled*) and the number of years the station could potentially have been sampled (*sampling years*). By weighting based on *sampling years* and *percent sampled* we ranked all stations. Using this ranking we then identified all stations that met two criteria: further than 400m apart from any other higher ranked station and no more than 50% of universe stations in a reef area could be designated fixed stations. This resulted in a preliminary list of 711 fixed stations. Of these, 549 (772%), 509 (716%), 481 (677%), and 476 (669%) were sampled greater than 75%, 85%, 95%, and 100% of the time, respectively. These fixed stations represented the full latitudinal range of the SERFS, ranging from latitude 272°N (~64 nm ENE of St Lucie Inlet, FL) to 350°N (~128 nm SSE of Cape Hatteras, NC). Using this universe of fixed stations it will be possible to reconstruct “fixed station” abundance trends for historical sampling seasons, insuring continuity of the chevron trap survey into the future.

Distribution, Demographics, and Population Trends of Gag in the Northeast Gulf of Mexico, 2004-2012, As Revealed By a Fishery-Independent Trap and Video Survey (Reef Fish Symposium)

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The Panama City NMFS lab has used chevron traps and high-definition video or mpeg cameras to conduct fishery-independent reef fish surveys on natural reefs on the inner-mid shelf (8-47 m) of the NE Gulf of Mexico off N Florida since 2005. The chevron traps are identical to those used by MARMAP, except that the throat entrance is 50% smaller in area. Since 2009 stereo cameras have provided images from which fish sizes can be measured. Sampling design is stratified random, with proportional allocation by depth and area. Gag were commonly observed with video gear east and west of Cape San Blas, a zoogeographic boundary bisecting the survey area. Through 2011, annual frequency of occurrence ranged from 21 to 57% (mean=400%) east and 28 to 43% (mean=377%) west of the Cape, but in 2012 it fell to 10 and 12% in those respective regions. Traps were much less effective for sampling gag, with frequencies of occurrence of 2-25% (mean=118%) east and 0-38% (mean=87%) west of the Cape. Gag were distributed fairly uniformly between 8 and 34 m depths; frequencies of occurrence in 2 m depth bins ranged from 21 to 50%, with a slight peak at 18 - 24 m. Few gag were observed deeper than 34 m, possibly due to low sample size, lack of high relief sites in our sampling universe in those depths, and/or ontogenetic shifts in habitat preference. Gag taken in chevron traps, 2004-2012, ranged from 250 to 700 mm FL, with a mode of 400-450 mm. Pre-recruits dominated the trap catch - 93% were below the recreational minimum size limit of 540 mm FL. A comparison of trap size data with that from stereo images from the same years (2009-2012) indicated traps do select against most gag >600 mm FL. Gag ranged from age 1 to 5 in traps, but 90% (total n=147) were ages 1-3. Gag from east of Cape San Blas tended to be smaller and younger (mean=320 mm FL and modal age 2) than those west of the Cape (mean=425 mm FL and modal age 3). Delta-lognormal scaled indices of relative abundance derived from the video data, 2005-2012, peaked in 2006, fluctuated moderately 2007 through 2010, averaging 50% of the 2006 peak, and then dropped steadily through 2012 to a point 90% below the 2006 value.

Seasonal and Spatial Dynamics of Nearshore Reef Fish Assemblages on the West-Central Florida Shelf Characterized By Two Fish Trap Designs (Reef Fish Symposium (2))

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Reef habitats on the west-central Florida shelf, which largely consist of a mosaic of sand and hard bottom with sparse, scattered low-relief rock outcroppings throughout, support extensive, economically-important fisheries resources. While low-relief natural hard bottom comprise the majority of reef habitat, unique artificial reef habitats exist including wrecks, man-made reefs, and petroleum pipeline-associated material. Fisheries-independent surveys from 2009 through 2011 were conducted on three reef habitat types (natural, artificial and pipeline) in the nearshore area (<37 km from shore) off Tampa Bay. Two trap designs were used to sample nekton: 17 m chevron (38 cm mesh) and 11 m Z-traps (13 cm mesh). Both

trap types were successful in collecting reef fishes with a total of 41 species collected. Z-traps generally caught higher abundances of smaller individuals. Red Grouper *Epinephelus morio* were commonly collected in both trap designs, and had similar length frequency distributions. Overall assemblage structure was examined through permutational analysis of variance, and results identified significant differences between the two trap types as well as among the three habitat strata (PERMANOVA; trap type x habitat; pseudo-F = 45; p = <001). For Z-traps, fish assemblage differences were driven primarily by greater numbers of Sand Perch *Diplectrum formosum* and Tomtate *Haemulon aurolineatum* from artificial habitats while Red Grouper were most abundant from the pipeline habitats. Chevron traps collected greater numbers of Red Grouper from pipeline habitats and more Tomtate and White Grunt *Haemulon plumierii* from natural hard bottom habitats. Over all habitats combined, seasonal differences were evident, especially in winter (January – March); assemblage structure also differed between spring (April – June) and summer (July – September). Tomtate were absent from winter collections and most abundant during summer months. Although collected year-round, Red Grouper and White Grunt were most abundant during summer, while Black Sea Bass *Centropristis striata*, Pinfish *Lagodon rhomboides* and Pigfish *Orthopristis chrysoptera* were most abundant during winter. This study supports the model of utilizing multiple gear types to provide community-level data and biological samples within fisheries-independent, reef fish surveys on structurally complex habitats. Further, seasonal abundance trends provide insight into ontogenetic migrations and inshore/offshore connectivity for estuarine dependent species.

Fine-Scale Movements and Home Ranges of Red Snapper (Reef Fish Symposium (2))

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Few studies have examined fine-scale movement patterns of continental shelf marine fishes. For example, little is known about the fine-scale movement patterns of red snapper *Lutjanus campechanus*, around artificial reefs in the northern Gulf of Mexico. The present study examined fine-scale (~1 m accuracy) movements of red snapper ($N = 17$) with the VR2W Positioning System (VPS, Vemco Ltd, Nova Scotia). This system enabled the continuous monitoring of tagged fish over extended durations (100–694 d) with locations recorded approximately every 10 min, for over 19 million accurate locations of red snapper from Aug 2010 through June 2012. Red snapper showed close association with the reef structure (mean \pm SD distance = 263 ± 354 m), but differential habitat use patterns in relation to both diel and seasonal periods. Home range areas (95% kernel density estimates, KDE) were significantly larger during day than night periods, and showed the lowest area use at dawn and dusk. Monthly home ranges (95% KDE) and core areas (50% KDE) were significantly larger in spring, summer, and fall than winter, and significantly correlated with water temperature, suggesting colder winter temperatures reduced red snapper movement. Home range area was significantly correlated with fish size (407–590 mm standard length), and fish showed the highest site fidelity compared to any previous study (88 % still present after > 10 months). Red snapper also showed homing behavior, with quick emigrations to other reefs, followed by extended stays at the new reef site, and then a quick return over open habitat to the original release site, with particular individuals repeating this pattern many times. These consistent long term use patterns of artificial reefs confirm the importance of structured habitat for this species.

Defining within-Trap Species' Interactions Among Reef Fish in the Southeastern United States Using Underwater Video Based on a Fishery-Independent Trap Survey (Reef Fish Symposium (2))

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Dawn M Glasgow, Tracey I Smart, and Marcel JM Reichert

Defining Within-Trap Species' Interactions Among Reef Fish in the Southeastern United States Using Underwater Video Based on a Fishery-Independent Trap Survey

Results of stock assessments indicate that many economically valuable fish species are considered overfished and/or are undergoing overfishing in the southeastern United States. Traditional fisheries management typically focuses on single-species and does not reflect the complexity of marine food webs and species' interactions. In the southeastern United States many smaller economically valuable fish species, such as black sea bass (*Centropristis striata*) and vermilion snapper (*Rhomboplites aurorubens*), may serve as prey for other larger, often more valuable fishes such as red snapper (*Lutjanus campechanus*) and groupers. Fish traps utilized by both fishermen and fishery-independent surveys, create the potential to concentrate both prey and predator in a fixed space and provide opportunities for predation to occur. Predators may also be attracted to concentrations of prey within traps. Thus, any predator-prey interactions occurring within traps may impact estimates of abundance for both the prey and the predators utilized in stock assessments. This is the initial study in a 2-pronged approach in which a) trap catch data and b) underwater video are used to investigate predator-prey interactions within traps used to evaluate relative abundance of reef fish in the southeastern United States. As the initial step, this study utilized catch data from chevron traps deployed by the fishery-independent Southeast Reef Fish Survey on the continental shelf and shelf break from Cape Hatteras, NC, to Fort Pierce, FL in 2000-2012. The relationship between the abundance and/or presence/absence of predators and the CPUE of prey within the traps were examined using a generalized additive model (GAM) to determine if prey CPUE is influenced by potential predator-prey interactions within the traps. The ultimate goal of this research is to determine the relevance of species' interactions in abundance estimates and how they might influence efforts to standardize abundance for stock assessments.

Assessing the Habitat Value to Reef Fish Communities of Intertidal Eastern Oyster (*Crassostrea virginica*) Reefs Constructed Using Abandoned and Donated Crab Traps in South Carolina (Reef Fish Symposium (2))

*Benjamin Stone**, South Carolina Dept of Natural Resources and *Peter Kingsley-Smith*, South Carolina Dept of Natural Resources

Oyster reefs are broadly recognized as "ecosystem engineers" that form complex habitats utilized by numerous species of finfish, invertebrates, wading birds, and mammals. Furthermore, within the southeast US region, the South Atlantic Fishery Management Council (SAFMC) has designated oyster reefs as essential fish habitat. In addition to improving water quality and clarity, and protecting shorelines from erosion, oyster reefs provide essential habitat for a number of federally-managed species, such as red drum (*Sciaenops ocellatus*), which depend on the inter-relationships of oyster reefs and adjacent marsh habitats for their survival during vulnerable life stages. Other species of commercial, recreational, and ecological importance have also been documented to utilize oyster reef habitats, such as Atlantic croaker (*Micropogonias undulatus*), spot (*Leiostomus xanthurus*), blue crab (*Callinectes* spp), killifish (*Fundulus* spp), and stone crab (*Menippe* spp). These species in turn provide prey for SAFMC-managed species such as Spanish mackerel (*Scomberomorus maculatus*), king mackerel (*Scomberomorus cavalla*) and cobia

(*Rachycentron canadum*), as well as NOAA Fisheries-managed highly migratory species (HMS) such as sharks and billfishes. More than 95% of the South Carolina oyster populations are intertidal, compared to a greater prevalence of subtidal reefs in other states, presenting logistical challenges to sampling mobile fauna that utilize these habitats at high tide, but migrate to deeper waters as the tide recedes. For this presentation, we will present the application of a recently developed, non-destructive “drop-net” sampling method that is being used to evaluate finfish species utilizing oyster reefs constructed of alternative materials. The drop-net is installed around the study plot at low tide the day before sampling is to occur and then triggered to fall at high tide the morning of the following day, surrounding the sample area and preventing mobile fauna from leaving as the tide recedes. Organisms within the study plots are then collected using dip nets beginning 2-3 hours prior to low tide. Study plots are typically sampled concurrently as paired plots, comprising a reef plot and an adjacent control plot lacking any reef habitat. The focus of this talk will be on the most recent application of this drop net sampling method to intertidal oyster reef habitat constructed in Charleston Harbor and on Wadmalaw Island in South Carolina using “revitalized” abandoned and unwanted crab traps as substrate for oyster recruitment and growth through projects funded by the Southeast Aquatic Resources Partnership (NOAA) and the State Wildlife Grants Program.

Evolving from Deterministic to Probabilistic Fishing Level Recommendations (Reef Fish Symposium (2))

*Michael Errigo**, South Atlantic Fishery Management Council, mikeerrigo@safmcnet

Traditionally in the South Atlantic, stock status and fishing level recommendations are derived from a single model configuration, called a base run. This provides a simple deterministic view of stock conditions and potential, but in reality there are many uncertainties and unknowns that surround the base estimates. The recent reauthorization of the MSA mandates that uncertainty in the modeling process be considered when making fishing level recommendations. This spurred the development of many new techniques for characterizing uncertainty in assessment models. In the South Atlantic, a Monte Carlo Bootstrap technique (MCB) is used to project catches into the future and these probabilistic projections are now used to set fishing levels of ABC and ACL instead of the traditional deterministic estimates of MSY and yield at different percentages of F_{MSY} . The South Atlantic SSC is now considering using these probabilistic MCB runs, which characterize uncertainty in the model estimates by producing distributions for all the estimates based on the estimated uncertainty of the input parameters and input data, to estimate biological reference points and determine stock status.

Life History Trends of Gray Triggerfish in the US South Atlantic (Reef Fish Symposium (2))

*Amanda Kelly**, College of Charleston/SCDNR

Gray triggerfish *Balistes capriscus* is a commercially and recreationally important reef fish species, managed by the South Atlantic Fisheries Management Council (SAFMC) as part of the snapper-grouper complex. Annual landings in US Atlantic waters have increased from approximately 320,000 lbs in 2007 to nearly 490,000 lbs in 2011. Despite the economic importance of this species, no published information exists concerning age, growth, and reproductive biology in US Atlantic waters. The Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program at the South Carolina Department of Natural Resources has been collecting life history data for gray triggerfish as part of its reef-fish

monitoring program over the past three decades. The current study utilizes these MARMAP samples to investigate basic life history parameters for the US South Atlantic population. Specifically, we quantified size- and age-at-maturity, adult sex ratios, reproductive seasonality, and spawning frequency. Preliminary data indicate 50% of the females reach sexual maturity at a size of 172 mm fork length (FL) and males at 180 mm FL. Reproductive seasonality is estimated to be 115 days with females spawning up to 12 times per season. Fisheries-independent data indicate that spawning begins as early as April and continues through September. This information is being utilized in the gray triggerfish stock assessment efforts by the SAFMC and NOAA National Marine Fisheries Service (NMFS).

Age Estimation in Two Triggerfish (Balistes) Species: Preliminary Findings Concerning Vertebrae and Otoliths As Alternatives to the Dorsal Spine (Reef Fish Symposium (2))

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Age estimation is an integral component in determining and monitoring the stock status of fisheries species. The accuracy of available methods should be evaluated and compared when choosing a method to estimate age for a species. Currently, the only method used in the peer-reviewed literature to estimate age in queen triggerfish *Balistes vetula* and gray triggerfish *Balistes capriscus* is sectioning the first dorsal spine. However, otoliths have several properties that set them apart from other skeletal structures and are used in age estimation for almost all other reef-associated fisheries species. According to the literature, otoliths have not been used for age determination in triggerfish because they are small, hard to locate, and one study even reported that they do not contain increments. We developed a protocol for easily removing all three pairs of otoliths from the two triggerfish species. Upon close examination of the sagittal otoliths, we have documented increments that appear to be annual in nature. This led us to investigate the use of sagittal otoliths and vertebrae as alternative aging structures to the dorsal spine in queen and gray triggerfish. Preliminary analyses indicate that in both species, the dorsal spine underestimates age in the majority of samples compared to sectioned and whole sagittal otoliths and vertebrae.

Spatio-Temporal Reproductive Dynamics of Red Snapper (*Lutjanus Campechanus*) Along the East Coast of Florida (Reef Fish Symposium (2))

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Although red snapper have supported important fisheries along the southeastern United States since the 1950s, in 2010 the stock was determined to be overfished and undergoing overfishing. Red snapper maximum age is 55, but overfishing has led to juvenescence and potentially impacted reproductive potential. In this study, monthly hooked-gear surveys were conducted within three regions off of the East Coast of Florida from April through October 2012 and a total of 1,304 red snapper were captured, sexed and aged (589 males and 715 females). Fish ranged in size from 271 to 925 mm TL, with an average size of 578 mm TL. Fish size did not differ significantly with sex or gear. It was, however, clearly driven by

several strong year-classes, with the age distribution dominated by 2-year-olds (2010 year class), 3-year-olds (2009 year class), and 5-year-olds (2007 year class) Actively spawning females were collected from 19 April to 30 August, with larger individuals developing earlier than younger, smaller individuals These differences were significant, with the probability of a fish being in the spawning population differing by month and size class Spawning fraction differed significantly within the spawning season, peaking in June at 0.69, but not with fish size There was no clear diel periodicity to spawning activity, with active spawners collected throughout the day Spawning activity was also well-distributed throughout most of the study area and red snapper did not appear to aggregate to spawn, with 55% of active spawners being collected as the only active spawner in a sample (combination of date and location) Batch fecundities increased with size and age, ranging from 13,766 eggs to 4,240,404 eggs, but egg quality, as measured through egg dry weight did not show a significant relationship with fish age, month of collection or batch fecundity

Disparate Knowledge of Red Snapper Ecology in Gulf of Mexico Versus Southeastern US Atlantic Ocean Waters: Where Are the Red Snapper Juveniles? (Reef Fish Symposium (2))

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Red snapper (*Lutjanus campechanus*) populations support (or have supported) important commercial and recreational fisheries in Gulf of Mexico (GOM) and southeastern US Atlantic Ocean (SEUS) waters Red snapper populations are genetically indistinct between the two regions, indicating recent or ongoing population connectivity Relative to GOM waters, there is a dearth of information on red snapper in SEUS waters, where the fishery has been closed since 2010 to address historical overexploitation We assessed the disparity in knowledge between the two regions by comparing the number of region-specific red snapper-focused peer-reviewed publications, 94% of which were regionally focused in GOM waters We then assessed information on early juvenile (< 150 mm total length) red snapper in SEUS waters No publications or reports documenting the occurrence of juvenile red snapper in SEUS waters were identified A comprehensive search of fishery-independent survey databases (totaling >75,000 individual gear deployments) and institutional collections identified only 132 records of early juvenile red snapper from SEUS waters These results highlight the need for additional information on red snapper in SEUS waters to address questions regarding recruitment to the SEUS stock, population connectivity between GOM and SEUS regions and, in general, to support fishery assessment and management in SEUS waters

Spatial and Seasonal Differences in Spawning Fraction of Gulf of Mexico Red Snapper and Incorporation into Size- and Age-Based Models of Indeterminate Fecundity (Reef Fish Symposium (2))

*Gary R Fitzhugh**, NOAA Fisheries, *Clay Porch*, NOAA Fisheries and *Erik T Lang*, NOAA Fisheries Contractor

In 2011, a congressionally funded supplemental survey provided Gulf-wide synoptic sampling of red snapper (*Lutjanus campechanus*) throughout the reproductive period (April – October) A total of 2487 red snapper were caught; the sex ratio was 1F:1M Females were found in spawning condition throughout the US Gulf, primarily in outer shelf waters Western females exhibited higher spawning fraction signaling regional differences Spawning fraction results indicated that both the frequency of spawns and

the duration of spawning increased with age indicating older females spawn more batches of eggs within a year Gear related differences were evident in that females caught by long-line exhibited higher spawning fraction than catches from vertical-line gear, consistent with differences in size/age selection between the two gears A quality control study regarding the use of frozen ovaries indicated that freezing degrades the quality of reproductive information that can be obtained However histological detail from frozen tissue was sufficient to determine sex and identify spawning markers (postovulatory follicles and hydrated oocytes) The data suggest that spawning frequency increases with age and, as a result, that red snapper under 6 years contribute considerably less to the spawning population than was indicated by the maturity data alone However batch fecundity, determined in earlier work, and found to be low for the younger age classes mitigates the importance of age-dependent spawning fraction to the estimation of per capita egg production; the estimated relative per capita egg production at age being rather similar to that used in previous assessments

Enhancing Red Snapper Diet Analysis with the Addition of DNA Barcoding (Reef Fish Symposium (2))

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It is important to understand energy flow in marine food webs, and one way to do this is through the diet analyses For most fish diet analyses are difficult, because a large portion (many times > 50%) of stomach contents are unidentified due to advanced states of digestion Identifying these prey to genus or species could help answer long-standing questions about many important fishery species We examined the diets of red snapper (*Lutjanus campechanus*) with traditional stomach content analyses coupled with DNA identification (barcoding) of unidentified fish prey Fish were collected from October 2012 through October 2013 via hook-and-line or fish trap from randomly selected sites in the northern Gulf of Mexico Stomachs were removed and stored in 95% ethanol Prey items were identified to the lowest possible taxon using morphology Unidentified fish that could not be identified to family with traditional methods were examined with DNA analyses of the barcode gene, cytochrome oxidase subunit I (COI) DNA was extracted, amplified, and sequenced from unknown tissue samples (n=330) and known prey fish controls (n=45) Obtained sequences were compared to published sequences, and identified 91% of the control prey fish and 60% of the unknown prey fish This represents a 32% increase in identified prey items in red snapper diets These new DNA based identifications of prey fish are applicable for many other species, and may greatly improve our understanding of predator – prey dynamics

Status of the Red Porgy (*Pagrus pagrus*) Population after One Decade of Intensive Fisheries Management -- the Rebound Is Still Slow (Reef Fish Symposium (2))

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The red porgy, *Pagrus pagrus*, is a protogynous sparid that occurs in natural reef habitats (ie, rocky outcrops and rocky ledges) on the continental shelf and upper slope throughout the Atlantic Ocean and Mediterranean Sea Red porgy along the Atlantic coast of the southeastern US have been in the limelight

since 1999, when stringent regulations were put in place to reverse a population decline. Stock assessments of this population took place in 2002, 2006, and 2012. As of 2012, the stock is still overfished, but not experiencing overfishing. The stock has ceased rebuilding or perhaps even declined slightly due to weak recruitment (Age 0) during 2000-2009 and modest increases in fishing mortality. Temporal analyses of life history parameters revealed a contributing factor for the failure to rebuild. Data collected by the MARMAP Program during 1979-2011 was divided into seven periods. The proportion of mature females at age initially increased, as seen in 1984-1987, the expected response to the disproportionate removal of fast-growing/late-maturing individuals from the population through fishing. In the following decade, the proportion mature decreased dramatically, probably due to the loss of adult females that changed sex to become males in response to the disproportionate removal of males from the population through fishing. The effect of having fewer adult females at ages when maturity is reached is to reduce the percentage of mature specimens in those age classes, thereby increasing the estimate of A_{50} (age at 50% maturity) for the population. The trend toward an increase in age at female maturity corresponded to a general increase in the percentage of males observed at Ages 1-5. The shift toward later maturity and the tendency to maintain sex ratio resulted in an extended period of reduced female spawning biomass and thereby reduced the chance for strong year classes to occur during the 1990s and 2000s. That red porgy respond to fishing pressure in this manner is not unexpected because there is no evidence that red porgy segregate by sex for part of the year or that they form a small number of large spawning aggregations that are key to maintaining an effective sex ratio. By 2001-2006, there was a clear reversal of the trend, as the percentage of mature females at Ages 0-4 was increasing. The 2007-2011 data indicate that A_{50} has returned (decreased) to an historic value, whereas the percentages of males at Ages 3-5 are at historic high levels.

Goliath Grouper Reproduction in the Southeastern USA: Gonochoristic or Hermaphroditic? Protogynous or Diandric? (Reef Fish Symposium (2))

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Goliath Grouper *Epinephelus itajara* is currently listed globally as “critically endangered” and has been protected from both commercial and recreational fishing in US waters since 1990. In the past, virtually all of the goliath grouper catch in the US was landed in Florida. Recently there has been interest expressed by fishers to re-open a limited-type of harvest. However, the current lack of data on reproduction and life history of Goliath Grouper makes it difficult to determine both the level of the stock’s recovery and if there is a level of harvest it can sustain in the future if conservation goals are to be achieved and maintained. Fundamentally, it is still not known whether goliath grouper are primarily gonochoristic or hermaphroditic. In the most recent stock assessment for Goliath Grouper, they were considered to be gonochorists because an earlier reproductive study did not provide evidence of hermaphroditism. Our current research indicates that Goliath Grouper are hermaphroditic, but likely not totally protogynous. Biopsies of spawning males and females show complete size and age overlap between the sexes. However, gonadal histology indicates a high proportion (16%) of fish with both ovarian and testicular tissue. Fish that had relatively equal amounts of both male and female tissue comprised 4% of the fish biopsied. These fish had oocytes that were in all stages of development, including later vitellogenic stages, which indicated that they were spawning capable. These fish also had male spermatogenic tissue interspersed throughout the gonad, indicating that they were developing or mature males (ie, “bisexual” fish). The complete overlap in the age and size distributions of goliath grouper that were female, transitional, male,

and “bisexual” is at odds for classifying Goliath Grouper as protogynous. Having an accurate picture of the reproductive life style of Goliath Grouper is critical to providing insight into the vulnerability of the species to fishing pressure in any re-established fishery.

Decadal Fluctuations in Life History Parameters of Scamp (*Mycteroperca phenax*) Collected By Commercial Hand-Line Vessels from the West Coast of Florida (Reef Fish Symposium (2))

*Linda Lombardi**, National Marine Fisheries Service, LindaLombardi@noaa.gov, Beverly Barnett, National Marine Fisheries Service, Melissa Cook, National Marine Fisheries Service, Laura Thornton, Riverside Technology, Inc - contractor, Nancy Evou, Riverside Technology, Inc - contractor, Hope Lyon, Riverside Technology, Inc - contractor and Lew Bullock, FL Fish and Wildlife Conservation Commission

Scamp (*Mycteroperca phenax*) were collected from commercial vessels along the west coast of Florida during four decades (1980s, 1990s, 2000s, and 2010s) allowing for comparisons of life history parameters over time. Differences were found for age and length structure for scamp within these decades. Fish collected in the 1980s were larger with 52% of the length distribution > 550 mm, compared to about 30% from the other decades (1990s, 29%; 2000s, 30%; 2010s, 31%). Age interpretations were completed by counting opaque growth increments on thin sectioned sagittal otoliths. Scamp were determined to be between age 2 and 24 yrs; 63% of the fish were older than 10 yrs in the 1980s with the most recent decade having only 43% of the scamp of the same age classes (1990s, 28%; 2000s, 37%). Comparisons of observed size-at-age data revealed similar growth in scamp collected in the 1980s and 2000s. Scamp collected in the 1990s grew slightly faster (ages 7 - 10 yrs) and scamp collected in 2010s had the slowest growth (ages 5 - 11 yrs). Gonad tissues were histologically prepared and interpreted for stages of maturity. Data analysis revealed similar size at 50% maturity but younger age at maturity over time for females. Spawning seasons occurred during similar months (March - May); however, the 1990s reproductive season was prolonged (five months versus three months). Detecting real differences in life history parameters over several decades can be difficult given changes in fishery management, spatial and temporal changes in habitat, and the size-selective fishing pressures. Differences in otolith preparation, sampling procedures, and inter-reader variability in band counts and histological interpretation could produce variations that are not real. This study attempted to minimize most sources of bias by using the same technique for otolith sectioning and ageing, for the interpretation of the otoliths and histological slides, and for sampling scamp from the commercial hand-line fishery. This research provides the first description of detailed population parameters for scamp from the northeast Gulf of Mexico. This data is essential to properly assess this stock.

Gaining a Better Understanding of Population Demographics through Tagging Symposium

Evaluation of an Alternative Technique for Attaching External Transmitters to Blue Catfish: Methods for Improving Mortality Estimates (Gaining a Better Understanding of Population Demographics through Tagging)

*Kristopher Bodine**, Texas Parks and Wildlife Department and Paul Fleming, Texas Parks and Wildlife Department

Use of telemetry to estimate mortality rate in fishes is well documented and proven useful. Unfortunately, telemetry studies on catfishes (Ictaluridae) have historically been problematic because current attachment techniques produce low retention rates, high mortality, or cause altered physiological or behavioral effects. These problems introduce error and violate key assumptions of telemetry studies. We investigated an alternative attachment technique during three experiments in which external transmitters were fastened to the supraoccipital bone of Blue Catfish *Ictalurus furcatus*. We hypothesized that attaching a transmitter to the skeletal structure would improve retention rates and minimize negative health effects. In a two-month pilot study, retention was 100% ($N = 20$; total length [TL] range = 435–638 mm) and fish appeared to be in excellent condition. However, in a subsequent laboratory experiment, retention was poor (417% at 2 months and 0% at 6 months; $N = 24$, TL range = 600–995 mm), which may be attributed to excessive handling during the experiment. The attachment technique was also field tested as part of a larger telemetry study. Fifty Blue Catfish (TL range = 600–995 mm) were tagged and monitored for up to 17 months in Lake Buchanan, Texas. Retention in the field was 40% at six months and 19% at 12 months, which was comparable to current free-floating internal transmitter retention rates. Although our procedure produces lower retention than internal transmitters fastened to the pectoral girdle (60 to 93% annual retention), we believe this modified attachment procedure has future utility despite our mixed results. Our procedure avoids negative health effects (ie, transmitters absorbed in the intestine or stomach or passed through the body wall) associated with internal tags fixed to the pectoral girdle and has retention rates similar to free-floating internal tags without the need for surgical implantation. Our work demonstrates an alternative transmitter attachment method and suggests future direction (ie, attaching transmitters to the skeletal structure) in further improving attachment procedures for Blue Catfish. These potential advancements may increase accuracy when using telemetry techniques to estimate population characteristics.

Fishing and Natural Mortality Rates of White Bass in Jordan Lake, NC (Gaining a Better Understanding of Population Demographics through Tagging)

*Kelsey Lincoln**, North Carolina State University, *James A Rice*, North Carolina State University and *Derek Aday*, North Carolina State University

Little is known about fundamental aspects of the life history, ecology and population dynamics of White Bass, *Morone chrysops*, a popular sport fish in southern reservoirs. In addition, concern regarding possible declining White Bass populations in some North Carolina reservoirs has made the management of this species difficult. Fishing mortality and natural mortality directly affect sport fish populations and are important in understanding potential causes of a declining population. We used a telemetry approach to estimate the instantaneous monthly, seasonal and annual natural (M) and fishing (F) mortality rates of White Bass in Jordan Lake, NC. Acoustic transmitters were implanted into 50 White Bass collected at the confluence of the Haw River and Jordan Lake during their spring spawning run in 2012; an additional 25 White Bass were tagged in spring of 2013. Tagged fish were continuously monitored using an array of passive receivers throughout the reservoir and located monthly during active tracking surveys. A receiver was placed downstream of the B Everett Jordan Dam to detect any emigrating fish. Using the program OpenBUGS we created a multistate model using the capture history of individual fish from monthly tracking efforts. This model used detection probability to determine when fish no longer located in the system had been harvested. Fish detected in the same location three consecutive months were determined to have experienced a natural mortality. As expected, fishing mortality was the highest in spring of 2012 and 2013 during peak fishing season when White Bass made their spawning run from Jordan Lake into

the Haw River Natural mortality also peaked in spring of 2012 and 2013 during and after the spawning run Only one fish was detected emigrating from the system in spring 2012 The combination of passive and active tracking techniques aided in a high detection probability, increasing confidence in our mortality estimates Our research indicates that the exceptionally high seasonal fishing mortality may be a potential cause for the apparent decline in White Bass populations and may be important to consider in the development of future harvest limits and management strategies for this species in southeastern reservoirs

Dissecting Mortality Components for Recreational Fisheries with High Rates of Released Fish (Gaining a Better Understanding of Population Demographics through Tagging)

*Janice Kerns**, University of Florida, *Mike Allen*, University of Florida and *Joseph E Hightower*, US Geological Survey, North Carolina State University

Catch-and-release mortality has been exhaustively studied for many high-release recreational sport fish such as largemouth bass *Micropterus salmoides* However, little work has explored the cumulative impact of catch-and-release mortality on fish abundance We used a combined telemetry - tag return approach to estimate all components of total mortality including (a) natural mortality and (b) total fishing mortality sub-divided into harvest, catch-and-release and tournaments components within a popular fishing lake in north Florida Our analysis from this two year study was based on fates of 181 largemouth bass tagged with external high reward dart tags and/or internal radio transmitters tracked for a minimum of nine months and an additional 345 fish tagged with variable external reward tags Estimates of directed instantaneous fishing mortality were seasonal with an increase in mortality occurring in the spring in both years Annual instantaneous fishing mortality were relatively high with estimates ranging from 017 (SD = 004) to 060 (SD = 009) in the first and second year Mean estimates of instantaneous fishing mortality associated with tournament and catch and release ranged from 006 (SD = 003) to 004 (SD = 02), respectively Estimates of instantaneous natural mortality were also seasonal with annual estimates ranging from 029 (SD = 006) to 046 (009) and was within the expected range when compared to other published estimates Our results indicate that non-harvest sources of mortality can be a significant source of fishing mortality in high-release fisheries, even if overall discard mortality rates are not substantial

Estimating Fishing and Natural Mortality Rates of Albemarle Sound Striped Bass (Gaining a Better Understanding of Population Demographics through Tagging)

*Julianne Harris**, US Fish and Wildlife Service and *Joseph E Hightower*, US Geological Survey, North Carolina State University

We estimate fishing, catch-and-release, and natural mortality rates of striped bass in the Roanoke River and Albemarle Sound, NC, using multiple tagging methods that combine fisheries independent and dependent data sources During 2011-2012, we tagged over 100 striped bass each with a sonic transmitter and a \$100-reward internal anchor tag In addition, we tagged over 5,000 striped bass with a PIT tag We examine movements of 107 sonic-tagged individuals with receivers in Albemarle Sound and the Roanoke River and evaluate mortality rates by returns of \$100-reward tags and detections of PIT tags from fishhouses and creels Sonic-telemetry provides valuable information on individual and seasonal patterns of movement and mortality for a small sample size of fish over the lifetime of the sonic tag In contrast, PIT tags are small, inexpensive, and have no batteries, allowing for long-term monitoring of large

numbers of individuals; thus, the combination of methods can prove useful. Thus far, 16 sonic-tagged striped bass have been harvested and 12 have been caught-and-released, with one released fish experiencing immediate mortality, and 64 PIT tags have been detected in recreational creels and fishhouse sampling. Using a multistate model including data from sonic-tagged and PIT-tagged striped bass, we estimated seasonal rates of recreational fishing (F_{rec}), commercial fishing (F_{com}), catch-and-release (F_{cr}), and natural mortality (M) that were low except during the summers, when M increased. Using NC Wildlife Resources Commission creel survey data, we estimated the Roanoke River spawning population at ~755,000 in 2011 and 966,000 in 2012. When completed, this research will improve assessment and management of this economically valuable stock.

Estimates of Fishing and Natural Mortality Rates of Spotted Seatrout from Tag-Return, Telemetry, and Survey Data (Gaining a Better Understanding of Population Demographics through Tagging)

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Spotted seatrout, *Cynoscion nebulosus* (Sciaenidae), is one of the most economically important sportfish in the US South Atlantic and Gulf of Mexico, including North Carolina. The state's recent stock assessment concluded the population is overfished; however, the extent to which variability in natural mortality (M) affects annual estimates of fishing mortality (F) is unknown. This is potentially important because North Carolina is near the species' northern geographical limit, where spotted seatrout are particularly vulnerable to lethal winter conditions. Data from the first comprehensive tag-return and telemetry study of spotted seatrout in North Carolina, along with fishery-independent gill net survey data collected by the state, were used to estimate F and M . Both laboratory and field studies, including high-reward tagging and double tagging, were conducted to obtain estimates of auxiliary parameters (eg, reporting rate, tag retention, and tagging-induced mortality) necessary for the tag-return modeling. There was no measured mortality associated with tagging but reporting rate and loss of internal anchor tags significantly limited returns. From September 2008 through October 2012, our estimates indicate that bimonthly instantaneous rates of F were often lower than M . Water temperature strongly influenced M of telemetered spotted seatrout; M increased abruptly at temperatures below 5°C. Telemetry-based estimates of M during winter at a local scale were similar to those estimated from coastwide tag-returns. Our annual estimates of F were lower and M higher than those reported for spotted seatrout in North Carolina's recent age-based stock assessment, where M was fixed using general life-history relationships based on weight and longevity. Effective management of this valuable fishery resource relies on an accurate understanding of the relative importance of harvest and winterkill on population dynamics. Future assessments of spotted seatrout in North Carolina would be improved by consideration of more direct estimates of and annual variability in M .

The Use of Ultrasonic Telemetry to Evaluate Red Snapper, *Lutjanus campechanus*, Fishing Mortality in the Northern Gulf of Mexico (Gaining a Better Understanding of Population Demographics through Tagging)

*Laura Jay Williams**, Auburn University and *Stephen T Szedlmayer*, Auburn University

Red snapper, *Lutjanus campechanus*, support important commercial and recreational fisheries in the Gulf of Mexico. In recent years, extensive management efforts have been undertaken to safeguard the red snapper population for future generations. One life history parameter that has been particularly difficult to estimate yet critical for proper management is mortality (*ie* fishing and natural). In the present study, we used acoustic telemetry, VR2W Positioning System (VPS, Vemco Ltd, Nova Scotia) to examine the fine-scale movements (~1 m accuracy) of red snapper on unpublished artificial reef sites in the northern Gulf of Mexico. We used telemetry detection data to estimate fishing mortality rates of red snapper in 2012 and 2013. This method is unique in that it is entirely independent of fisher reported recaptures. In 2012, a high fishing instantaneous mortality rate of the transmitter tagged red snapper ($n = 17$) was observed ($F = 0.57$). Among the fish being tracked, 3 emigrated, 5 were captured and reported by fishers and 2 were captured based on telemetry but not reported. Following the 2012 sport fishing season, we tagged additional red snapper and were tracking the movements of 27 red snapper prior to the 2013 sport fishing season. During the June 2013 sport fishing season, 5 fish were reported caught by anglers for an estimate of $F = 0.20$. This 2013 F estimate is subject to change following an additional 2-week sport fishing season in October 2013.

Growth and Mortality of Hatchery-Reared Striped Bass Stocked into Non-Natal Systems (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Due to practical constraints (costs, hatchery proximity) and/or difficulties obtaining local broodstock (for imperiled populations), stocking programs often utilize fish from non-local sources for population enhancement. This practice of cross-stocking could be counter-productive; fish from different populations may be ill-suited for a given system whose environmental conditions differ from those of the natal habitat to which stocked fish are adapted. However, few studies have evaluated this possibility, especially in coastal environments. Here, we used tag-return data (1990-present) to compare the growth and survival of striped bass fingerlings of Albemarle Sound/Roanoke River (ASRR; North Carolina, USA) origin stocked into three different systems: (1) the ASRR (natal system), (2) the Tar-Pamlico River, and (3) the Neuse River. Growth in non-natal systems (Tar-Pamlico and Neuse) was similar to that in the ASRR (von Bertalanffy $K's=0.54-0.62$). Total instantaneous mortality was significantly higher in non-natal ($Z=0.48-0.51 \text{ year}^{-1}$) vs natal ($Z=0.33 \text{ year}^{-1}$) systems, but this could be due to greater anthropogenic stressors (eg, fishing mortality) rather than the population origin of stocked fish. Our results illustrate that depleted populations can be enhanced by stocking fish from nearby populations. Still, there are genetic concerns with this practice that need to be considered in the context of long-term population resiliency.

Ncwr's Roanoke River American Shad Stocking Program and Genetic Evaluation Program (Gaining a Better Understanding of Population Demographics through Tagging (2))

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North Carolina Wildlife Resources Commission (Commission) have stocked more than 57 million American Shad fry in the Roanoke River since 1998. Prior to 2010, stocking success was evaluated

through sacrificing a sample of juvenile and adult American Shad and processing otoliths to assess presence of oxytetracycline (OTC) marks applied at the hatchery Over time, challenges associated with OTC mark retention and complicated marking patterns to identify unique batches of stocked fish led Commission staff to consider available alternatives for mass marking of American Shad fry Advances in broodstock genotyping to establish a permanent and accurate connection between broodstock and returning progeny was explored in 2009 and implemented in 2011 A paired analysis of juvenile American Shad otoliths for OTC and fin clips to determine hatchery origin was conducted in 2011 Hatchery contribution in 2011 of juvenile American Shad on the Roanoke River as evaluated by genetics from fin clips (377%) was over twice as high as the estimate provided with OTC evaluations from otoliths of those same fish (144%) When compared to the parentage analysis, OTC evaluations failed to detect 25% of the hatchery fish in the sample In addition, stocking location assignments were based on specific tanks of broodstock rather than adding specific OTC marking patterns to increase efficiency during hatchery operations following the elimination of OTC marking With the marked difference associated between the two techniques for stocking evaluation, the Commission genotyped available fin clips from 2010 and 2012 broodstock Similar to the 2011 genetics analysis, juvenile American Shad fin clips collected during fall outmigration were assessed with a more reliable contribution estimate of 145% and 27% The Commission incorporated broodstock genotyping as the current non-lethal method to evaluate American Shad contribution to the spawning grounds of the Roanoke River Implementation of genotyping broodstock will be beneficial to the restoration goals of this and other stocking programs in the state of North Carolina

Evaluating the Potential of Spatiotemporal Closures for Protecting Migratory Mature Female Blue Crabs (Gaining a Better Understanding of Population Demographics through Tagging (2))

Eric Johnson, University of North Florida, Rob Aguilar, Smithsonian Environmental Research Center, Mike Goodison, Smithsonian Environmental Research Center and Paige M Roberts, Smithsonian Environmental Research Center*

Marine spatial planning, including spatial and temporal closures, is an increasingly utilized approach to fishery management, particularly for species whose abundance and distribution are predictable in time or space The efficacy of spatial management approaches for conservation and sustainability of coastal fisheries can only be evaluated with a detailed understanding of the spatial dynamics, movement patterns and population connectivity of a fishery stock We worked cooperatively with local watermen and fishery managers to conduct a mark-recapture study to quantify the spatiotemporal distribution of mature female blue crabs during the annual fall migration period in the Potomac River, USA The data was integrated with existing fishery-dependent data on harvest and effort to evaluate four spatiotemporal closure options under consideration by regional managers that were designed to reduce exploitation of mature female blue crabs Specifically, we evaluated the impact of each management option with respect to three criteria (1) effectiveness (magnitude of reduction in annual mature female blue crab harvest), (2) consistency (the expected variability of annual harvest reductions among years), and (3) equitability (the extent to which harvest reductions were evenly distributed across fishers within the management jurisdiction) Our analysis was further integrated with consideration of human dimensions (socioeconomics, law enforcement) during public stakeholder meetings with managers, scientists, and fishermen before changes in management were selected and implemented This case study highlights (1) the critical role of rigorous scientific data in underpinning management and policy decisions (2) the value of combining directed field

experiments with long-term fishery-dependent data streams, and (3) the importance of active stakeholder involvement in research activities

Comparison of Mummichog Abundance Among Anthropogenically Altered Saltmarsh Creeks in Coastal North Carolina, USA (Gaining a Better Understanding of Population Demographics through Tagging (2))

*Paul Rudershausen**, Center for Marine Sciences and Technology, North Carolina State University, *Jeffrey A Buckel*, Center for Marine Sciences and Technology, North Carolina State University, *Joseph E Hightower*, US Geological Survey, North Carolina State University, *Marissa Dueker*, North Carolina State University, *Todd Dubriel*, USGS Conte Anadromous Fish Research Center, *Matt O'Donnell*, USGS Conte Anadromous Fish Research Center, *Stephen Poland*, North Carolina State University and *Benjamin Letcher*, US Geological Survey

Saltmarsh creeks are important sources of biological production along the rapidly developing US South Atlantic coast. We used the mummichog *Fundulus heteroclitus* as a test species for examining the extent of human impact to these areas because of its trophic importance, fidelity to individual marsh creeks, and small home range. We compared monthly abundance of mummichogs among saltmarsh creeks in coastal North Carolina that had variable levels of intertidal vegetation and human alteration. Adult mummichogs (>40 mm total length) were marked with passive integrated transponder (PIT) tags during spring and summer of 2012 and 2013. Tagged fish were autonomously resighted with antenna arrays and physically recaptured with minnow traps. A Cormack Jolly Seber model was fitted to resight data to estimate daily apparent survival; survival was then used to estimate the number of tagged fish at risk before each monthly recapture sample. A formulation of the Jolly Seber model was fitted to numbers-at-risk and recapture data to estimate monthly abundance. Generalized linear models (GLMs) were used to examine the relationship between abundance and potential explanatory variables: percent watershed imperviousness, creek cost score, high tide wetted area, high tide vegetated area, and month. All creeks experienced high loss rates (mortality plus emigration) of mummichogs throughout the spring and summer growing season. Highest monthly abundances were associated with greater percent imperviousness and smaller wetted areas, but also greatest vegetated area. The results; 1) suggest that mummichogs are a tolerant species capable of inhabiting impacted saltmarsh creeks at high densities, and 2) emphasize the importance of vegetated marsh in supporting populations of this species.

Investigation of Movement Patterns of Lake Sturgeon in the Upper Tennessee River (Gaining a Better Understanding of Population Demographics through Tagging (2))

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We established an array of acoustic monitoring receivers in the upper Tennessee River and large tributaries to study the movement patterns of resident lake sturgeon reintroduction program. In August 2013 we deployed, mapped, and range tested acoustic monitoring receivers at select locations around known concentrations of lake sturgeon, at locks/dams, and along tributary streams in eastern Tennessee. In November 2013, we surgically implanted resident lake sturgeon ($n=42$) of wild, hatchery origin with

acoustic acoustic coded tags that send acoustic pings at 69 kHz Acoustic coded tags have a battery life expectancy of 5-6 years Acoustic monitoring receivers will be checked and data offloaded regularly in order to map the gross movement patterns of lake sturgeon Additional data will be gathered with a mobile acoustic receiver from a roving boat We are eager to identify the daily, seasonal, and annual movement patterns of individual sturgeons in the upper Tennessee River Because the earliest stocked fish are approaching reproductive age/size classes, we anticipate upstream spawning behaviors and associated movements The lake sturgeon reintroduction program is an interagency cooperative project initiated in 2000, with releases of juveniles and fingerlings from wild broodstock Since that time, over 140,000 fish have been stocked Recent monitoring, captures, and angler reports indicate these sturgeon are surviving, growing, and dispersing throughout the accessible mainstem Tennessee River and large tributaries

Residency Patterns and Habitat Utilization of Largemouth Bass and Common Snook in a Riverine System: Exploring the Connection Between Freshwater and Marine Habitats Using Acoustic Telemetry (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Acoustic telemetry studies are used to elucidate movement patterns and habitat utilization of aquatic species A complex acoustic telemetry study was conducted to measure fine scale and long-term movements of two species frequently found together in Florida coastal rivers: Largemouth Bass (LMB, *Micropterus salmoides*) and Common Snook (CS, *Centropomus undecimalis*) The aim of this study was to describe the daily, seasonal, and yearly movement patterns, exchange rates between different habitats, and habitat utilization by both species in the riverine habitat

We implanted acoustic pingers in 36 LMB (320-590 mm TL) and 60 CS (425-1100 mm TL) in the upstream St Lucie River and monitored their movements for four years (2008 to 2012) using an extensive array of stationary acoustic receivers deployed along the river and the adjacent southeast Florida coast Based on the acoustic tags detections, the maximum days of freedom for LMB was 1079 days (29 yr), and for CS, 1605 days (44 yr) Both species utilize identical upstream riverine habitats, although LMB demonstrated high levels of site fidelity by remaining near their original tagging location, except for small-scale movements during reproductive season Tagged LMB appear to avoid locales and spend less time within the acoustic receiver's detection range area when tagged CS are nearby Common Snook residence within the river is highly variable: some mature CS (68%) demonstrate seasonal migrations to / from higher salinities areas during the spawning season, while others (30%) remain in the freshwater habitats during the entire tracking period, indicting some snook may be skip spawners Those CS that made seasonal migrations to spawning areas followed a pattern of moving during spring and summer to known spawning sites immediately followed by the same snook returning upstream to previously occupied habitats during the fall and winter seasons This study provides insights to unique habitat use by

two of Florida's iconic species that could be incorporated into critical fish habitat conservation models, management plans, and habitat restoration. Most importantly, assessment biologists can apply spatial exchange rates and skip-spawning metrics to their routines to arrive at more robust stock assessment and appropriate regulations.

Movement, Site Fidelity and Connectivity in a Catadromous Fish (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Spatial and temporal patterns of habitat utilization have important consequences for population structure and therefore the conservation and management of a species. Among fish, habitat shifts can result from seasonal migrations to specific spawning sites. The requirement by many species for multiple habitats reinforces the need to understand movement, site fidelity and connectivity to better protect key habitats at appropriate time scales. Common snook are known to undergo significantly longer migrations in the summer months during the spawning season and exhibit site fidelity to spawning aggregations and overwintering sites. Using network analysis techniques, where nodes represent physical locations of receivers and edges are movements between locations, we explored the connectivity of habitats during the spawning and non-spawning seasons among 280 common snook surgically implanted with acoustic transmitters along the east coast of Florida. Absolute values of the number of movements between two nodes were used to describe and quantify spatial connectivity over time. Centrality (k), the measure of edges to nodes, was used to indicate the level of site fidelity and overall importance of a location to home range. Gateways to spawning sites were determined by the number of edges entering (k^{in}) and exiting (k^{out}) nodes. Comparison of these factors across time revealed differences in habitat use and connectivity between spawning and non-spawning seasons. Low network centralization (<2%) and high node size and edge weight suggest common snook utilize a greater area during the spawning season but movements were not focused. Locations qualifying as gateways were generally confined to the estuary adjacent to the spawning sites. Interestingly, k^{in} and k^{out} were higher at nodes just north of the spawning sites, suggesting common snook move south to join spawning aggregations. During the non-spawning season, common snook were detected on significantly fewer receivers; combined with a marginally higher network centrality (<3%) and lower node size and edge weight this suggests that movements are smaller and more localized during this time period. Overall, spatial utilization of the population changed dramatically between seasons; this result emphasizes the importance of understanding temporal shifts in habitat prioritization for spatial management of catadromous species.

Factors Influencing Movement and Habitat Use of Red Drum and Southern Flounder in Estuarine Seascapes (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Acoustic telemetry was used to examine and compare patterns of fine-scale habitat use and movement for sub-adult (age-1 and -2) red drum *Sciaenops ocellatus* and southern flounder *Paralichthys lethostigma* in

the northern Gulf of Mexico Two arrays of acoustic receivers were deployed in Christmas Bay, Texas, a semi-enclosed secondary bay of the greater Galveston Bay estuary containing multiple habitats (seagrass, oyster, salt marsh, mudflat, tidal creeks) A VR2W Positioning System (VPS) was used to assess movement at the habitat scale (meters), while a larger grid of receivers were used to examine movement at the bay scale (kilometers) Sub-adult red drum (n=14) and southern flounder (n=8) were fitted with Vemco V9 acoustic transmitters and released into the VPS array in January 2012 A total of 9,214 fish positions were estimated by the VPS, and Euclidean Distance-based Analysis (EDA) was used to determine use of specific habitat types (shoal grass, turtle grass, oyster reef, marsh edge, and sand) General additive models (GAMs) were then used to examine relationships between habitat and fish presence as well as the effect of environmental variables on movement at the bay scale Results from EDA analysis indicated that both species demonstrated a high affinity for turtle grass ($p < 0.05$), with red drum also being associated with sand ($p < 0.05$) and southern flounder with oyster habitats ($p < 0.05$) Distributions for red drum and southern flounder at each spatial scale were closely linked to the interface of two or more habitats (edge effect) Results from this study demonstrate that habitat use differs between important fishery species within the same seascape, and the implementation of multi-species and multi-spatial scale approaches may be needed to more effectively identify and prioritize the conservation of essential fish habitats

Presence and Habitat Preferences of Juvenile Coastal Sharks in the Hatteras Bight (Gaining a Better Understanding of Population Demographics through Tagging (2))

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The Hatteras Bight lies on a major migration corridor for Atlantic coastal sharks and may function as important secondary nursery habitat for some species These species, some of which are of conservation concern, are also common bycatch in the region's commercial and recreational fisheries To determine patterns of presence and environmental preferences among these species within the Hatteras Bight region, juvenile coastal sharks were sampled using short soaks with commercial gillnet gear in winter and autumn of 2013 Sharks were identified, measured, and released, and acoustic transmitters with temperature and depth sensors were surgically deployed on selected individuals Tagged sharks included young-of-year and age-1 sandbar sharks, and young-of-year dusky sharks These transmitters were detected by an acoustic array extending 193 km into the ocean off of Hatteras, NC Sandbar sharks were detected from February to mid-April, were present at temperatures ranging from 14.5-16.7 °C, and showed a general pattern of remaining near the bottom of the water column during daytime and rising to midwater at night Other encountered species included spiny dogfish, smoothhound, Atlantic sharpnose, scalloped hammerhead, and thresher sharks

Discard Mortality of a US South Atlantic Reef Fish Estimated from Surface and Bottom Tagging (Gaining a Better Understanding of Population Demographics through Tagging (2))

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We estimated survival rates of discarded black sea bass in various release conditions using tag-recapture data. Fish were captured with traps and hook and line from 29 - 34 m off the coast of North Carolina, USA, marked with internal anchor tags, and observed for release condition. We also tagged fish on the bottom using SCUBA; these fish served as a control group for which we assumed survival was similar to fish that were never captured. Discard survival for the hook and line and trap fisheries in this region was estimated by applying condition-specific survival rates to fish released in each condition during non-tagging recreational and commercial fishing operations. Relative return rates for trap-caught fish released at the surface versus the bottom provided an estimated survival rate of 0.87 (95% credible interval 0.67 – 1.18) for surface-released fish. Adjusted for results from the underwater tagging experiment, fish with evidence of external barotrauma had a median survival rate of 0.91 (0.69 – 1.26); fish with hook trauma had a median survival rate of 0.36 (0.17 – 0.67); and floating/presumably dead fish had a median survival rate of 0.16 (0.08 – 0.30). Applying these condition-specific estimates of survival to non-tagging fishery data, we estimated a discard survival rate of 0.81 (0.62 – 1.11) for 11 hook and line data sets from waters 20 to 35 m deep and 0.87 (0.67 – 1.17) for 10 trap data sets from 11 to 29 m deep. The tag-return approach using a control group with no fishery-associated trauma represents a powerful method to accurately estimate absolute discard survival of physoclistous reef species.

Ultrasonic Acoustic Telemetry Reveals Delayed Mortality Estimates and Post-Release Behavior Patterns in Gulf of Mexico Red Snapper (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Red snapper (*Lutjanus campechanus*) is the most economically important reef fish species in the Gulf of Mexico. Despite being heavily managed, stocks have not rebounded as quickly as initially projected and the population remains low. One possible reason for the slow recovery is that red snapper are susceptible to pressure-related injuries (ie barotrauma) that compromise the chance of survival post catch-and-release. Barotrauma afflicted fish may not only experience immediate mortality at the surface but also delayed mortality after returning to depth due to lingering barotrauma symptoms that reduce fitness, predator avoidance capability, or ability to forage. Significant amounts of delayed mortality may result in underestimations of total mortality in stock assessment models. To determine the extent of delayed mortality and post-release behavior, we tagged 100 red snapper with Vemco V9AP ultrasonic acoustic transmitters and released them on several oil/gas platforms. Fish were rapidly (1-3 min) tagged externally without anesthesia to best replicate normal fishing practices and minimize artifacts associated with tagging related surgeries (ie venting and use of only survivors). Acoustic receivers attached to the platform recorded acceleration and depth data for approximately 45 days. Using these data, unique acceleration and depth profiles were generated for each fish allowing estimation of survival and delayed mortality events. The severity of barotrauma and likelihood of survival were influenced by sea surface temperatures, depth of capture, and release treatment. Survival was greater in colder months than in warmer months, and in shallower depths compared to deeper depths. Additionally, venting and rapid recompression strategies showed greater survival than non-vented, surface released fish. Depth profiles showed that survivors took between 3-10 days to resume “normal” demersal behavior and this was also influenced by release treatment. These results suggest that temperature, depth, and release method are important factors in the fate of regulatory discards. Results from these experiments enhance our understanding of delayed

mortality and post-release behavior of red snapper and provide useful information that documents the fate of regulatory discards Estimates of delayed post-release mortality from this study can be integrated into stock assessment models to achieve better calculations of overall mortality and ultimately more accurate estimates of population size

Using Passive Integrated Transponder (PIT) Technology to Assess Species-Specific Estuarine Fish Movement through Water Control Structures in Managed Salt Marshes (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Many species of nekton inhabit estuaries during one or more life history stages for critical functions such as foraging, refuge from predators, and reproduction The use of structural marsh management practices (eg, water control structures, WCSs) to stabilize and enhance managed marshes has altered structure and function of many marshes, particularly in the northern Gulf of Mexico While habitat use by nekton has been studied in managed and unmanaged marshes, species-specific nekton movement patterns through WCSs have not been examined To address concerns that WCSs may affect the ability of nekton, particularly juveniles, to access critical estuarine nursery habitats, we employed passive integrated transponder (PIT) technology at two identical slotted WCSs (approx 10 km apart) in the Calcasieu Lake estuary of southwest Louisiana Antenna arrays covering both sides of the WCS slots were installed in March 2012 to monitor movement of abundant species (eg, red drum, spot, Atlantic croaker, striped mullet, black drum, spotted seatrout) tagged with 12 or 23 mm PIT tags As of May 2013, a total of 602 individuals of 13 species have been tagged, 373 small juveniles (120 - 220 mm) and 229 large juveniles and adults (230 -500 mm), split equally between the two WCSs Of the total number of individuals tagged, 18% (n = 108) were later detected at the WCSs The mean number of days at large was 20, with a large degree of variation (SE = 66 days) due to some individuals remaining at large for long periods (max = 420 days) Two juvenile Atlantic croaker (total length = 98, 112 mm) were tagged at one WCS and later detected at the other As has been observed at WCSs in similar salt marsh habitats, relatively few individuals (n = 44; 7%) were detected transiting the WCSs Rather, most individuals were detected on multiple occasions over hours or days as they congregated on a single side of a WCS

Acoustic Telemetry of Gray Triggerfish in the Northern Gulf of Mexico (Gaining a Better Understanding of Population Demographics through Tagging (2))

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Little information is available on the movement and habitat use patterns of Gray Triggerfish, *Balistes capriscus*, despite its importance for both commercial and sport fisheries in the Gulf of Mexico Although Gray Triggerfish are known to associate with structured habitat little information is available on residency time, home range or any other habitat specific behavior Recent advances in fine scale tracking with acoustic telemetry (VR2W Positioning System, Vemco Ltd, Nova Scotia) can be used to provide this important information about Gray Triggerfish and its habitat associations This is the first study to attempt to acoustically track Gray Triggerfish and assess the use of telemetry methods for this species The present study tagged Gray Triggerfish with transmitters (V13-1L; n = 16) in 2012 and 2013 on two artificial reefs After an initial tagging loss of 3 fish within 8 days, 13 fish survived and were successfully

tracked for extended periods: 7 are presently active and still being tracked (53.84%; 2-11 months), 3 fish have emigrated (23.07%; after 3-7 month residency), 2 fish were caught by anglers (15.38%; after 4-5 month residency), and 1 fish died (7.69%; after 11 days residency) One fish emigrated and returned to its release site on 3 separate occasions This fish was continuously detected for 4 months prior to its first emigration It was at liberty for 11 days and returned to its release site for 2 days It emigrated for a second time for 9 days, and returned to the reef for 40 days prior to its final emigration At present, these telemetry methods have proved highly successful for Gray Triggerfish and have provided new data on continuous movement patterns of individual fish for up to 11 months Tagging and tracking is ongoing and expected to provide significant long-term habitat use patterns for this important species

Use of Acoustic Telemetry to Determine Seasonal Movements of Walleye in a Hydropower Reservoir (Gaining a Better Understanding of Population Demographics through Tagging (2))

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In recent years the walleye fishery in Cheat Lake, West Virginia has been improving owing to management efforts and improving water quality However, improvements to the fishery have been slow and natural reproduction still appears to be limited It is unclear whether impacts of current hydropower operations and lingering effects from upstream acid mine drainage (AMD) are limiting the walleye fishery Of particular interest are the influences of natural and anthropogenic (ie, hydropower operations) abiotic factors on the seasonal movements and habitats used by walleyes, and specifically the movements during the spawning season We began an acoustic telemetry study monitoring adult walleye movements in Cheat Lake in December 2011 Walleye movements and locations were determined both by manual tracking and with submersible, stationary receivers placed throughout the lake Preliminary results suggest that adult walleyes move to the head of the lake to spawn in late winter/early spring and remain near spawning areas for up to several months Increases in incoming river flow, sharp changes in lake elevation, and water temperature appear to trigger walleye movements to spawning areas Movements during non-spawning seasons appear to be largely influenced by incoming river flow, water temperature changes, lake elevation changes, and possibly available dissolved oxygen Additionally, movements and habitats used appear to differ between male and female fish Further statistical analyses on walleye movements will help in determining significant factors influencing seasonal movements

Poster Submissions

The Effects Of a Sublethal Dose Of Botulinum Serotype E On The Swimming Performance Of Channel Catfish Fingerlings (Poster Session)

Rachel Beecham, Mississippi Valley State University, Patricia Gaunt, Mississippi State University and Torri Thomas, Mississippi Valley State University*

Visceral toxicosis of catfish (VTC) is a disease of market-sized cultured channel catfish (*Ictalurus punctatus*) in the MS Delta The etiology of VTC is associated with botulinum serotype E (BoNT/E) which causes blockage of acetylcholine release at the neuromuscular junction leading to weakness and paralysis of skeletal muscles including those involved in swimming It was hypothesized that during a

VTC outbreak, botulinum killed fish not only directly but also indirectly by decreasing the fish's ability to swim and flee from predators. This study attempted to determine if sublethal exposure to purified BoNT/E caused reductions in swimming performance and metabolism of channel catfish. Catfish swimming performance was assessed on stocker sized channel catfish (mean weight 6235 ± 25 g) with 10 control (sham-injected) fish and 10 fish injected with a sublethal dose of BoNT/E. A modified Blazka type swim chamber filled with dechlorinated well water was used to assess swimming performance. We injected catfish with either trypsin or 400 pg trypsin digested purified BoNT/E intracoelomically, then acclimated an individual catfish in the swim chamber for 17 hours prior to swimming. Water temperature was maintained at $\sim 28^{\circ}\text{C}$ and dissolved oxygen was between 4 and 7 mg/L. A critical swimming speed (Ucrit) protocol was followed during which the fish was acclimated at 10 cm/s for one hour and then the swim speed was increased by 10 cm/s every 30 min until fish fatigued. Dissolved oxygen and temperature were monitored every 2 minutes throughout the swim trial. Metabolic rate and cost of transport were calculated from the oxygen consumption at each test speed (10-70 cm/s). There was a statistical difference between the Ucrits ($p = 0.0034$), but no differences were found between the metabolic rate ($p = 0.69$) or cost of transports ($p = 0.67$) between the sham injected and BoNT/E groups. There was a difference in the cost of transport as it relates to the various speeds tested ($p < 0.00001$). These results indicate that botulinum E interferes with the swimming speed of the catfish which could contribute to the mortality from the disease of VTC and potentially make the fish more susceptible to predation.

Feeding Habits of Red Snapper, *Lutjanus Campechanus*, in the Southeastern United States (Poster Session)

*Sarah Goldman**, SC Dept of Natural Resources

Although the red snapper, *Lutjanus campechanus*, is a very popular commercial and recreational finfish, little is known about its trophic ecology in the southeast. There is great demand for trophic data by fisheries managers who are working on the recovery of this fish population, which has experienced nearly half a century of overfishing. The diet of red snapper was investigated by examining stomach contents of specimens collected from live bottom reef habitats in the South Atlantic Bight. Specimens were collected from May 2010 to October 2013 via chevron trap and hook- and-line sampling efforts during fishery independent surveys. Red snapper fed almost exclusively on Portunid crabs and fishes. Over 73 prey taxa were identified, including rock shrimp, pteropods, and octopus. Identified fish prey of commercial importance included black sea bass and vermilion snapper. Tomtate was the numerically dominant fish prey. Some instances of in-trap predation were observed. Based on the ecology of the prey items, red snapper are feeding on reef-associated fishes, epibenthic invertebrates and zooplankton.

Effects of Low Salinity and High Temperature on Spat, Seed, and Market-Sized Oyster (*Crassostrea virginica*) Growth and Mortality (Poster Session)

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Eastern oyster (*Crassostrea virginica*) population dynamics are critically dependent upon water salinity and temperature which are predicted to change with climate and local management activities. Changes in the timing of seasonal highs and lows, and the interaction of seasonal high temperatures and low salinity as predicted by climate change models, could dramatically alter oyster population dynamics. Little is known explicitly about how low salinity and high temperature combinations affect spat (<25 mm), seed (25-75 mm), and market (>75 mm) sized oyster growth and mortality. Using lab and field studies, this project quantified the combined effects of extremely low salinities (1, 5) and high temperatures (25⁰C, 32⁰C) on growth and survival of spat, seed, and market sized oysters. In 2012 and 2013, hatchery-produced oysters were placed in open and closed bags at three sites in Breton Sound, LA, along a salinity gradient which typically ranges from 5 to 20. Growth and mortality were recorded monthly. Regardless of size class, oysters at the lowest salinity sites (annual mean = 48) experienced significantly higher mortality and lower growth than oysters located in higher salinity sites (annual means = 111 and 130); furthermore, all oysters in open bags at the two higher salinity sites experienced higher mortality, likely due to predation. To explicitly examine oyster responses to extreme low salinity and high temperature combinations, a series of laboratory experiments were conducted. Oysters were placed in 18 tanks in a fully crossed temperature (25⁰C, 32⁰C) by salinity (1, 5, 15) experiment with 3 replicates, and repeated twice for each oyster size class. Regardless of temperature, seed and market oysters held in low salinity tanks (salinity = 1) experienced 100% mortality within seven days. In contrast, at salinity = 5, temperature significantly affected the mortality rate; all size class oysters experienced >50% at 32⁰C, <40% mortality at 25⁰C. In higher salinity tanks (15), only market-sized oysters held at 32⁰C experienced significant mortality (>60%). These experiments demonstrate that high water temperatures (ie, 32⁰C) and low salinities (≤5) negatively impact oyster growth and survival, and that high temperatures (32⁰C) alone may negatively impact market-sized oysters. It is critical to understand the potential impacts of climate and abiotic changes on oyster resources in order to better adapt and manage these resources for long-term sustainability.

Temporal and Spatial Distribution of Atlantic Sturgeon (*Acipenser oxyrinchus*) in US Territorial Waters off South Carolina and Georgia (Poster Session)

*Michael Arendt**, South Carolina Department of Natural Resources, *arendtm@dnrscgov*, *Bill Post*, South Carolina Department of Natural Resources, *Paulette Mikell*, South Carolina Department of Natural Resources, *Jeffrey Schwenter*, South Carolina Department of Natural Resources, *Chris Kalinowsky*, Georgia Department of Natural Resources, *Pat Geer*, Georgia Department of Natural Resources and *George Sedberry*, National Marine Sanctuary Program

Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*) were recently listed (6 April 2012) as “Endangered” per the Endangered Species Act (ESA). Spawning occurs in freshwater habitats; however, continental shelf habitats are also thought to be important for growth and maturity. Unfortunately, the geographic extent of this species’ spatial and temporal distributions on the continental shelf remains largely unknown, particularly in areas where seasonal commercial harvest of this species historically occurred.

In July 2013, we began a three-year study (funded by the NMFS Grants to States Program) to monitor the temporal and spatial distribution of Atlantic sturgeon in US territorial waters off South Carolina and Georgia, using acoustic telemetry. To date, more than 1,000 Atlantic sturgeon have been acoustically-tagged throughout the US east coast, approximately 10% of which were captured and tagged in South Carolina and Georgia river systems since 2010.

In fall 2013, four VR2W receiver arrays consisting of 12 receivers apiece will be deployed off four beaches, from north to south, as follows: Cape Island, SC; Fripp Island, SC; Wassaw Island, GA; Sea Island, GA. These locations were selected to be sited in relatively close proximity to rivers where Atlantic sturgeon have been acoustically-tagged, as well as to provide similar geographic spacing between receiver arrays. Within each array, VR2W receivers will be spaced 2 km apart between 1 and 23 km offshore and perpendicular to the beach. This monitoring design will provide continuous (but porous) listening coverage through spring 2016 to answer the following question:

- 1) Is there a seasonal component to coastal marine occurrence of Atlantic sturgeon?
- 2) Does distance from shore influence detection probability?
- 3) Do geographic origin or genetics influence occurrence in coastal marine waters?
- 4) Does fish size influence occurrence of in coastal marine waters?
- 5) Do *in situ* conditions such as water temperature, salinity, conductivity, barometric pressure, or chlorophyll a concentrations influence occurrence in coastal marine waters?

In addition to the fixed receiver arrays, opportunistic receiver monitoring will also occur in conjunction with fishery-independent trawl (Florida to North Carolina) and long-line (South Carolina only) research surveys conducted in coastal marine waters by the South Carolina Department of Natural Resources.

Because receiver array data will be uploaded quarterly, which may not occur prior to the Southern Division meeting, our poster will primarily emphasize data collection methods as well as characterizing effort and detection records from the trawl and long-line sampling in fall 2013.

Hydrilla and Rare Species Management in Lake Waccamaw, North Carolina (Poster Session)

*Ryan Heise**, North Carolina Wildlife Resources Commission, ryanheise@ncwildlife.org and Ed Corey, North Carolina Division of Parks and Recreation

Lake Waccamaw is a 3,615 hectare Carolina bay lake located in North Carolina that is unique because of its water chemistry (near-neutral pH), large size, and endemic fauna. There are 17 species of rare fish and mollusks that have been documented from the lake. In October 2012, Hydrilla was discovered in the northwestern side of the lake which poses a significant threat to these species. The initial surveys documented Hydrilla in about 246 hectares, while native vegetation accounts for 1470 hectares. A Technical Advisory Committee consisting of state and federal agencies, universities, non-governmental organizations, and other stakeholders was formed to provide management options. The Committee decided that a chemical treatment (Fluridone) was the most appropriate and to not utilize grass carp for control. Treatment of hydrilla began in early-June 2013 with a subsequent application in late June. In a collaborative effort, NC Wildlife Resources Commission and NC Division of Parks and Recreation are continuing our long-term monitoring surveys of the fish and mollusks to ensure that populations remain viable and to help refine our management strategy. Because of the early detection and treatment, we believe that control efforts should be highly successful in this unique natural lake.

Assessing Variation in Recruitment Seasonality of Sciaenids Along the Texas Coast (Poster Session)

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Fisheries managers regularly monitor trends in recruitment (via abundance of juvenile/larval finfish and invertebrates) as this can be used as an indicator of the future health of the fishery. It is important for managers to understand recruitment seasonality and to monitor variation in seasonality both spatially and temporally as this may be closely related to success of recruitment events and may impact how recruitment data are interpreted. While the timing of these events for most species tends to remain consistent from year to year, this seasonal consistency of recruitment could be impacted by long term changes in the environment such as climate change or large scale meteorological events. Additionally, recruitment seasonality may differ at relatively small spatial scales based on differing climate, geography, and hydrology. It is important that fisheries managers have tools to assess this temporal and spatial variation. Here, methods are presented for assessing spatial (latitudinal) and temporal variation in recruitment seasonality with multivariate statistical routines available in PRIMER and using juvenile abundance data from Texas Parks and Wildlife Department bag seine surveys for five species of sciaenids along the Texas coast (*Cynoscion nebulosus*, *Leiostomus xanthurus*, *Micropogonias undulatus*, *Pogonias cromis*, and *Sciaenops ocellatus*). *C. nebulosus* were found to possess predictable variation in seasonality of recruitment with upper coast bay systems generally possessing a slightly shorter recruitment season than that of lower coast bay systems. *P. cromis* and *M. undulatus* also showed some latitudinal spatial variation in recruitment seasonality. No predictable linear trend in temporal variation was observed for any of the species examined suggesting that seasonality may be more impacted by localized meteorological cycles (eg drought-rainfall events) along the Texas coast. Nonetheless, the methods presented herein allow managers to rapidly address such questions of spatial and temporal variability in a non-parametric framework.

A Consistent Method for Rapidly Assessing the Conservation Status and Survey Needs for Large Numbers of Aquatic Species (Poster Session)

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Information on the range and conservation status of large numbers of aquatic species is needed for state wildlife action plans, assessments of species petitioned for listing under the US Endangered Species Act, and other reviews carried out by groups such as NatureServe and the American Fisheries Society. A major challenge for these assessments is the lack of comparable data across taxa, which is often limited to presence-absence data or in some cases presence-only data with limited knowledge of areas that have been surveyed. We developed a method to assess the current range and survey needs of aquatic species using a combination of presence-only and presence-absence data. Our method uses a simple GIS algorithm to identify the most recent occurrence record for USGS Hydrologic Unit Code (HUC) 10 digit watersheds and then classifies all watersheds into 5 year intervals. Occurrence records as well as locations of recent surveys where the target species was not detected are then overlaid to produce a conservation status map. This map serves as the key resource for targeting areas in need of additional sampling and can be updated periodically to incorporate new survey results. Maps can also be used as a foundation for

assessing conservation status by providing comparable metrics across taxa, such as the number of occupied watersheds (index of range size), proportion of potential watersheds currently occupied (index of range stability) and watershed landcover (index of threat) We are currently applying our method to all imperiled Georgia freshwater fishes While more detailed monitoring and assessments may be required for some species, our method has the potential to provide useful and consistent information for large numbers of aquatic species

Survival and Habitat Use during First Year Dispersal of Neosho Smallmouth Bass (Poster Session)

*Brandon Brown**, Oklahoma Department of Wildlife Conservation, *streamthings@gmail.com*, Shannon Brewer, US Geological Survey, Oklahoma Cooperative Fish and Wildlife Research Unit, Jim Burroughs, Oklahoma Department of Wildlife Conservation and Josh Johnston, Oklahoma Department of Wildlife Conservation

Few studies have addressed first year survival and dispersal patterns in streams, especially for genetically-distinct sportfish populations such as Neosho smallmouth bass *Micropterus dolomieu velox* We measured survival and dispersal of young -of-year Neosho smallmouth bass in two Ozark streams during summer 2013 Mortality over the first growing season was determined via snorkel surveys beginning at nest dispersal and continuing bi-weekly through early October Beginning and end of growing season abundance estimates were approximately 17,000 and 600 fish per kilometer in Buffalo Creek and 43,000 and 250 fish per kilometer in Spring Creek Survival from the time fry dispersed the nest until early October was 340% and 056%, respectively for the two streams Dispersal was estimated by recording the number of young found in each channel unit for the duration of the study As expected, abundance estimates were much greater in the spawning channel unit, particularly pools, during the first several weeks following dispersal from the nest Abundances increased in runs, backwaters, and slow riffles as fish grew and overall abundances declined over the summer We observed differential use of low velocity off-channel habitats when discharge increased during particular sampling periods This study suggests habitats perceived as unimportant to smallmouth bass may be very important to first-year survival during elevated discharge conditions

"Preliminary Evaluation of Sampling Methods for Monitoring the Sicklefin Redhorse *Moxostoma* Spp in Georgia " (Poster Session)

*David Atwood, Young Harris College and Johnathan Davis**, Young Harris College

The sicklefin redhorse (SFR) *Moxostoma spp* is a rare, candidate species of sucker (Catostomidae) found in moderate-sized streams of western North Carolina and north Georgia that migrates upstream to Brasstown Creek in Towns County, Georgia in late spring To establish consistent monitoring of this fish in Georgia, we evaluated four sampling strategies (streamside visual surveys, upstream and downstream underwater observation, and seining) at six 100-m representative sites from April to June 2013 Streamside surveys were conducted using binoculars; underwater observation occurred with two snorkelers moving systematically upstream and then floating downstream; seining was implemented by pulling a seine net quickly downstream Additionally, an approximately 8-km section of Brasstown Creek was canoed to observe SFR abundance and occupancy All captured redhorses (including *M anisurum*, *M carinatum*, *M duquesnii*, and *M erythrurum*) and additional data on occupied habitats were recorded Throughout the study, 37 SFR were captured with the majority (59%) observed through visual surveys SFR capture in

seines ranged in total length from 43 to 55 cm and consisted of only males. The first and last SFR capture occurred on 24 April and 23 May 2013, respectively. Regardless of method, predicted capture probabilities are low (<20%), but streamside visual surveys were most likely (~15%) to detect SFR. Although sample size is small, SFR presence and abundance was most significantly correlated to small boulder ($r = 0.68$; $P = 0.04$) and cobble ($r = -0.83$; $P = 0.04$) substrates. We also report a potential upstream record for this fish. Further research will occur in spring 2014 at additional sites along Brasstown Creek and will include the use of block nets to prevent SFR migration during sampling.

Fish and Invertebrate Mapping Methods for Environmental Sensitivity Index (ESI) Atlases (Poster Session)

*Jennifer Weaver**, Research Planning, Inc, *Christine Boring*, Research Planning, Inc, *Lincoln Smith*, Research Planning, Inc and *P Lauren Szathmary*, Research Planning, Inc

NOAA Environmental Sensitivity Index (ESI) atlases depict the distribution, seasonality and concentration of resources at risk of being impacted by oil and other chemical spills. Resources mapped include coastal habitats, human-use areas, and biological resources. A semi-quantitative method has been developed to incorporate fishery-independent monitoring data into recent atlases. In this methodology, state agency representatives assist by dividing state waters into water bodies and creating a list of species of interest. Available monitoring data are summarized to provide rates of occurrence and catch per unit effort (CPUE) for each species by water body. Monthly occurrence rates are used to define seasonal presence and CPUE is used to derive a categorical concentration for each combination of species and water body relative to other water bodies in the area of interest. Fishery-independent data is combined with other datasets and sources to create a draft product. Stakeholders and data providers are given the chance to review the draft, in order to ensure consistency among compiled datasets and supplement quantitative data with expert knowledge. Final ESI atlases are distributed by NOAA in both digital and hardcopy formats. Examples from the recent Texas and Louisiana atlas updates will be presented.

"Habitat Preferences of a State-Endangered Crayfish *Cambarus Parrishi* in the Upper Hiwassee River" (Poster Session)

Brittany Henry, Young Harris College and *Johnathan Davis**, Young Harris College

Crayfishes are keystone species in headwater aquatic ecosystems that process organic material, increase nutrient availability and engineer complex benthic stream habitat. This study defined habitat preferences of a state-endangered, data-deficient crayfish species, *Cambarus parrishi* in the upper Hiwassee River watershed in northeast Georgia. Crayfish were collected at 12 sites in the watershed over a two year period, and multiple habitat parameters including substrate size, depth, water velocity, and stream roughness were measured at a microhabitat scale. Correlation analysis identified habitat variables associated with presence which were incorporated into logistic regression models. *C. parrishi* (n=108) were less abundant at lower elevation sites than *Cambarus bartoni*. *C. parrishi* prefer slower water velocities, cobble substrates and shallow depths whereas *C. bartoni* preferred faster velocities and tolerated greater depths. In particular, young-of-year *C. parrishi* were found only in shallow side pools near undercut banks. Continued research will focus on higher elevation, smaller order streams and will provide distributional data and conservation information for evaluating the status of this species. In addition, various population characteristics related to growth and reproduction will be evaluated.

"Using Angler Tournament Catch Data to Assess Black Bass Populations and Sportfishing Opportunities in Chatuge Reservoir" (Poster Session)

Furman Thompson, Young Harris College and Johnathan Davis, Young Harris College*

Chatuge Reservoir is a popular sportfishing and recreational destination for black bass *Micropterus spp* in north Georgia. An introduction of spotted bass in the early 1990s has resulted in a decrease of smallmouth bass but the development of a widely popular spotted bass fishery due to an aggressive nature and high catch rates. Black basses (n=503) were collected from a weekly night tournament from April thru October. Although largemouth bass (Wt=1329 g; TL=4425 mm) were heavier ($P=0005$) and longer ($P=005$) than spotted bass (Wt=1014 g; TL=4209 mm), only 83 percent of the catch consisted of largemouth bass. No smallmouth bass were caught although one hybrid smallmouth/spotted bass was caught. Condition factor (mean=13; SD=016) and relative weight (mean=874; SD=106) of spotted bass was highest during spawning although condition improved during blueback herring spawning before declining until late September. Stock indices for spotted bass were estimated from using a back-calculated regression model constructed from length-frequency data. PSD, RSD_p, RSD_m, and RSD_t was 519, 402, 203, and 27, respectively, although procedures for estimating the values from tournament data require further exploration. Further research will analyze seasonal catch rates by anglers. Many biases exist when using tournament-caught fish to assess sportfishing stocks, but tournament data can be cheaply collected, supplement data collected by resource agencies, and provide an inclusionary role for anglers. Additionally, multi-year tournament data sets can provide surrogate measures of population change and will be valuable in future consideration of smallmouth bass restoration efforts in Chatuge Reservoir.

Can Rugosity be Used As a Management Tool to Reliably Characterize Oyster Habitat Vertical Complexity in South Carolina? (Poster Session)

Andrea Margiotta, College of Charleston, margiottaam@gcofcedu, Nancy Hadley, South Carolina Department of Natural Resources and Dara Wilber, Bowhead Science and Technology*

Habitat vertical complexity is an important physical feature of many marine systems (eg, rocky intertidal, coral reefs, and bivalve communities) that can influence factors such as predator-prey interactions and recruitment. High vertical structure on intertidal Eastern oyster, *Crassostrea virginica*, reefs is beneficial to both fishery and habitat functions. Quantifying related parameters, however, such as oyster size frequencies and associated fauna, typically requires destructive sampling (eg, excavating quadrats). Measuring reef rugosity (Rq) is an alternative, non-destructive method that entails placing a chain (1 m long with 1 cm links) across the reef surface so that it conforms to the reef substratum and calculating Rq as $1 - d/l$, where d is the horizontal distance covered by the conformed chain and l is the length of the chain when fully extended. I am investigating the relationship between rugosity and factors that may be related to habitat vertical complexity, such as oyster size frequencies, recruitment, and associated faunal assemblages. In July 2013, an experiment was deployed at two locations near Grice Marine Lab, Charleston, SC to examine whether factors such as oyster recruitment and associated faunal densities are related to vertical complexity treatments (standardized by rugosity measures). I am also measuring rugosity on natural and restored reefs at several locations to document variation in vertical oyster habitat complexity in South Carolina. Results of the present study will indicate whether the rugosity metric can serve as a management tool that characterizes the vertical complexity of oyster habitat and related reef attributes.

Distribution and Migration Patterns of Spotted Seatrout, *Cynoscion nebulosus*, in a Louisiana Estuarine Lagoon (Poster Session)

*Ashley M Melancon**, Louisiana State University and *James H Cowan Jr*, Louisiana State University

Although spotted seatrout are generally considered to be well managed and sustainably fished according to the most recent state stock assessment (2011), we still lack information about the spatial ecology and population dynamics of this important gamefish. Technological advances, such as acoustic telemetry, enhance our understanding of both abiotic and biotic influences on distribution patterns of spotted seatrout. Telemetry provides information about large-scale emigration events, seasonal migrations, and habitat preferences. Our preliminary study used acoustic telemetry to examine the behavior of 79 telemetered fish (307 – 546 mm TL) in Lake Pontchartrain, LA (1630 km²) between November 2012 through June 2013 using a 90 receiver array (Vemco, VR2W). We plan to acoustically tag 120 additional fish in the subsequent year. Logistic regression analysis shows a strong seasonal influence on migration patterns within the estuary ($p < 0.0001$), especially between fall-winter and spring-summer seasons. Results indicate that during June, the likelihood of an individual being present in the lower estuary is 6-times higher than an individual being present in the upper estuary. During December, the probability of being present in the lower estuary as compared to the upper estuary decreased by 91%. Furthermore, emigration to the nearshore Gulf of Mexico was observed between April and June (36%), with two emigrants recaptured approximately 100 km and 50 km from respective release locations. The eastward migration observed is presumably due to the prolonged freshet event that began in April 2012, causing significant declines in salinity (upper estuary: < 2 ppt, lower estuary: < 5 ppt). Results also show that males are 3-times more likely than females to be present in the upper estuary, indicating a lower salinity tolerance for males. Further analyses will determine correlations between abiotic explanatory factors and migration patterns to enhance our understanding of the spatial distribution of spotted seatrout in Louisiana estuaries.

Stone Crab (*Menippe* spp) Demographics in the Atlantic Coast Hybrid Zone and the Effect of Claw Removal on Mortality and Feeding Ability (Poster Session)

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Stone crabs (*Menippe mercenaria*, *M adina*, and hybrids) are commercially and ecologically important, supporting a fishery that is considered renewable because crabs are returned to the water after their claws are harvested under the assumption that new claws will be generated and perhaps reach a marketable size. Little is known, however, about the effects of claw removal on stone crab mortality and feeding ability. My research has three main objectives: 1) determine whether field survival and claw regeneration rates following the fishery practice of forced claw removal suggest a “two claw” fishery is viable in SC, 2) examine the effect of claw removal on feeding ability and mortality, 3) assess crab size, sex ratio, hybrid form frequency and ovigery in the Kiawah and Stono Rivers, Charleston County, South Carolina. From March to October 2013, nearly 1200 crabs have been measured in the Kiawah River and 579 crabs have been measured and tagged in the Stono River, with an initial recapture rate of 91% and additional recaptures reported by fishermen. As this study proceeds, recapture frequencies will be related to claw loss status to provide valuable information on survival during this year-round study of stone crabs in South

Carolina Laboratory results suggest mortality for crabs up to 14 days following claw removal may be higher for crabs with one (500%) and two (588%) claws removed compared to intact control crabs (143%) In addition, control crabs consumed more mussels and oysters than crabs with one or two claws removed Demographic differences between the Stono and Kiawah Rivers include claw regeneration rates, hybrid form frequency, and sex ratio and will be related to physical parameters of the rivers, such as depth and bottom composition This research will help inform best fishery management practices in South Carolina, where the stone crab fishery is growing in importance

The Fishes of St Catherines Island (Poster Session)

*Charles Best Jr**, Georgia Regents University, *cbest@gruedu*, *Kelley Jonske*, Georgia Regents University, *Amanda Hurst*, Georgia Regents University, *Gwendolyn Carroll*, Georgia Southern University, *Jason Moak*, Georgia Regents University, *Chuck Lambert*, Georgia Regents University and *Bruce Saul*, Georgia Regents University

The effects of global climate change are being felt in ecosystems around the world Our oceans and fish stocks may be facing threats from changing water temperatures It seems likely that as temperatures change, conditions will change and fish assemblages will move Vulnerable marine species will be subjected to increased pressure The full impacts of these changes are not yet known Monthly ichthyofaunal research utilizing beach seining and trawling has been conducted on St Catherines Island since 1996 to the present The purpose of this research was to collect data on the current fish assemblages surrounding the Georgia barrier island of St Catherines and compare it to a similar study conducted in 1967-68 by M Dahlberg and E Odum This same data has been used to compare modern fish assemblages to archaic fish populations Archeological data was collected from 19 sites throughout the Georgia bight and spanned almost 5,000 years This continuous data set can be very useful when looking for trends or changes within these fish populations It is important to gain insight into this dynamic ecosystem so that we may understand possible climate change effects on fish populations and work towards the protection of this valuable natural resource

Effects of Salinity on Growth and Behavior of Invasive Rio Grande Cichlids (*Herichthys cyanoguttatus*) in Louisiana (Poster Session)

*Sierra Riccobono**, University of New Orleans, *O Thomas Lorenz*, University of New Orleans and *Manalle Al-Salamah*, King Abdullah University of Science and Technology

The spread of non-native Rio Grande cichlids (*Herichthys cyanoguttatus*) in the Greater New Orleans Metropolitan Area (GNOMA) has included the brackish habitats of Lake Pontchartrain and the La Branche Wetlands To determine the potential spread of this species in brackish habitats, we studied the effects of three different salinity levels on the biology of *H cyanoguttatus* The highest salinity tolerated, before cessation of feeding & eventual death, was 300psu No cichlids survived to the acclimation point of full seawater (350 psu) Body mass increased significantly less with this higher salinity treatment Interestingly, aggression levels were higher with brackish versus freshwater conditions After a period of six months, the difference in growth between fresh and brackish conditions became significant, indicating a potential detriment to juvenile fish living in brackish conditions for long periods of time The significance of this study is that most higher-salinity habitats in Louisiana, even those approaching sea water, can be tolerated by this species

Genetic Characterization of Blue Crab (*Callinectes sapidus*) from the Charleston Harbor Estuary, South Carolina and Optimization of Molecular Markers for Responsible Stock Enhancement Research (Poster Session)

*Elizabeth Cushman**, South Carolina Department of Natural Resources, *John Leffler*, South Carolina Department of Natural Resources and *Tanya Darden*, South Carolina Department of Natural Resources

The Atlantic blue crab (*Callinectes sapidus*), a common decapod crustacean found in estuarine and nearshore waters of the Gulf of Mexico and the eastern coast of the United States, supports valuable commercial and recreational fisheries. South Carolina landings have shown a steady decline in abundance over the past decade, making *C. sapidus* a species of concern for fisheries managers. Knowledge of blue crab biology is lacking in regard to offshore population composition, overwintering behavior, reproductive output, mortality drivers, recruitment bottlenecks, and settlement cues; and the South Carolina Department of Natural Resources (SCDNR) is considering initiating a responsible stock enhancement research program that will use cultured animals to address these questions and provide information for management decisions. Six molecular markers were optimized and tested for their ability to serve as non-lethal and permanent genetic tags to identify hatchery individuals. A total of 116 blue crabs from the Charleston Harbor (CH) estuary, collected June 2012-May 2013, were genotyped with our microsatellite marker suite, and genetic diversity parameters and effective population size were calculated to characterize the CH estuary *C. sapidus* population and to provide an initial examination of genetic health. The markers amplified well, were polymorphic, and had a high probability of being able to distinguish between individuals and correctly match offspring to their parents, demonstrating that they would be valuable as genetic tags for experimental stock enhancement research. The CH estuary was found to have moderately high levels of genetic diversity and relatively low levels of inbreeding; effective population size was on the order of a few thousand individuals, indicating that the current CH blue crab population is genetically 'healthy' despite recent declines. This study provides a base-line genetic characterization of blue crab, which furthers our knowledge of *C. sapidus* in the CH estuary. Applications of this approach, possibly in conjunction with experimental stocking, will provide valuable information on blue crab ecology and life history that can be incorporated into management decisions to monitor and preserve the blue crab fishery.

Maturation and Fecundity of the North Carolina Central Southern Management Area Striped Bass Stock (Poster Session)

*Evan Knight**, East Carolina University and *Roger A Rulifson*, East Carolina University

The largest stock of striped bass (*Morone saxatilis*) in North Carolina is the Albemarle/Roanoke stock; however, other populations inhabit North Carolina's coastal and riverine waters. The Central Southern Management Area (CSMA) consists of the waters of the Tar/Pamlico River, Neuse River, Cape Fear River, and Pamlico Sound. Striped bass populations have been sustained in the CSMA by stocking (Roanoke River broodstock) from the North Carolina Wildlife Resources Commission (NCWRC), but the goal from the fishery management plan is to establish self-sustaining spawning populations of striped bass in these coastal rivers. The NCWRC instituted an endemic stocking program in 2011 using fish collected on the spawning grounds in the Tar/Pamlico and Neuse River for broodstock in hopes that endemic broodfish will produce offspring that are genetically suited for each individual river system. A maturation and fecundity schedule is needed for stock assessment models and effective management of the CSMA.

striped bass population Striped bass were sampled (n=60) on and near the spawning grounds in the Neuse and Tar/Pamlico River by electroshocking during the pre-spawn, spawning, and post-spawn period (March-May 2013) Each fish was measured (fork length and total length, mm) and weighed (g) Otoliths were removed for ageing and otolith chemistry Sex was determined, and gonads were removed and weighed to determine the GSI and stage of reproduction Ovaries were preserved in cold formalin for histological examination Livers were weighed to determine the liver somatic index (LSI) and K factor, two indicators of fish condition or well-being A maturation and fecundity schedule was determined based on results from analyzing otoliths, gonads, and histological samples of individual fish

A Meristic and Morphometric Assessment of Roanoke Bass, Rock Bass, and Their Hybrids (Poster Session)

*Brandon Plunkett**, Virginia Tech and *James H Roberts*, Virginia Polytechnic Institute and State University

The Roanoke bass (*Ambloplites cavifrons*), a sport fish native to several Atlantic-slope drainages of Virginia and North Carolina, has experienced population declines and extirpations over the past century, in part due to competition and hybridization with introduced rock bass (*A rupestris*) We sampled *Ambloplites* specimens from rivers throughout the historical range of Roanoke bass, in order to determine the present status of the species and the extent of its hybridization with rock bass For comparison, we also included known rock bass specimens from nearby Gulf-slope drainages Specimens were examined for six meristic and seven morphometric characters and these data were analyzed using multivariate statistics Results showed clear separation of the two species in multivariate space, and most rivers appeared to contain one species or the other, but not both Furthermore, most individuals could be accurately statistically assigned back to their putative species, and in many cases, to their river of capture However, some rivers exhibited ambiguous classification and appeared to contain both species and/or hybrids These results will be compared to upcoming genetic analyses, which will be used to confirm species identities and corroborate hybrid assignments Outcomes of the study will help managers assess the status of Roanoke bass and prioritize rivers for Roanoke bass restoration and rock bass eradication

Feeding Patterns of Spotfin Mojarra (*Eucinostomus argenteus*) over a Tidal Cycle in a Florida Estuary (Poster Session)

*Annabella Panaro**, Flagler College, *apanaro128@flagleredu* and *Ed McGinley*, Flagler College

Spotfin mojarra (*Eucinostomus argenteus*) are a common seasonal fish in the rivers and estuaries of eastern Florida Their primary diet consists of worms, crustaceans, isopods, and gastropods that inhabit the substrate Specimens were collected over a complete tidal cycle and measured, weighed, and then euthanized and dissected The stomach contents were removed and identified to order using a microscope Data will be presented in regards to when in relation to tide level the mojarra are eating This information can provide valuable information when constructing food webs for estuarine systems that have large populations of generalist consumers like mojarra

Analyzing the Diversity of Fish and Crabs in the Guana Tolomato Matanzas National Estuarine Research Reserve (Poster Session)

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The health and maintenance of marine estuaries are of a vital importance to ensure populations of both crustaceans and fish are thriving. These systems represent important nursery and forage areas for many marine species. The measure of biodiversity is one such way to evaluate the overall health of the estuarine ecosystem. For this project, fish and crabs were sampled with a 50 X 4 ft seine net with ¼ inch mesh. Total biodiversity was measured monthly for ten sites located within the Guana Tolomato Matanzas National Estuarine Research Reserve (GTMNERR). Temperature, dissolved oxygen (DO), and salinity was measured in conjunction with biotic sampling. Data collected from the seine net was analyzed and interpreted for biodiversity. Water quality variables were analyzed with vertebrate/invertebrate data to determine if these factors correlated with the change in biodiversity.

The Effect of Feeding Frequency on Growth and Cannibalism in Juvenile Hatchery Reared Spotted Seatrout *Cynoscion nebulosus* (Poster Session)

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Larval and juvenile spotted seatrout *Cynoscion nebulosus* are known to exhibit highly cannibalistic behaviors in aquaculture production. Cannibalistic behaviors are thought to occur due to limited resources in predatory species. Determining methods to reduce cannibalism is an important step in increasing aquaculture production. This study tested the effect of feeding frequency on growth and cannibalism in spotted seatrout.

A total of 4,200 56-day-old hatchery reared spotted seatrout (332 ± 30 mm TL, 028 ± 008 g) were harvested from outdoor production ponds and randomly placed into six round 182m diameter tanks in a recirculating system so that each tank held 700 fish. Each tank was then fed one of two feeding frequency regimes; a low frequency treatment in which rations were divided into two daily feedings at 0630 and 1630 hr or a high frequency treatment in which rations were divided into 6 daily feedings starting at 0630 hr and continuing every 2 hours until 1630 hr. Fish were fed a pelleted commercial diet at 18% BW/d to ensure satiation and tanks were siphoned twice daily to remove waste and enumerate dead and partially consumed fish. At the end of three weeks, percent survival was calculated from the number of fish remaining in each tank. All fish larger than 110 mm TL were considered cannibals and individually weighed and measured while a subsample of 50 smaller fish from each tank were also weighed and measured to determine growth.

Growth data indicated no significant difference in total length (917 ± 33 mm vs 909 ± 14 mm, $p=0691$) or final weight (666 ± 095 g vs 615 ± 027 g, $p=0401$) of spotted seatrout in the low and high feeding frequency treatments, respectively. Percent survival in the low feeding frequency treatment was significantly lower than in the high feeding frequency treatment ($411 \pm 56\%$ vs $517 \pm 31\%$, $p=0046$) and there was a significant correlation between the number of fish consumed in each tank and both the total length ($p=0002$) and weight ($p=0007$) of the cannibals in each tank at the end of the study. There was no significant difference between treatments ($p=0830$) in the number of cannibals per tank, however. The results of this study indicate there is a positive feedback loop between the growth of the cannibals and rate

of cannibalism and that cannibalism of spotted seatrout juveniles can be significantly reduced in aquaculture systems by increasing feeding frequency

Genetic Population Structure of Spotted Seatrout *Cynoscion nebulosus* Along the Southeastern United States (Poster Session)

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Spotted seatrout, a recreationally important fish in SC, has recently suffered substantial population declines during the cold winters of 2000, 2009, and 2010 when water temperatures dropped substantially below long term averages. These winter-kills appear to result in population bottlenecks and their repetitive occurrence over a short time scale has prompted the SCDNR to consider a stock enhancement program. The SCDNR follows a responsible approach to marine stock enhancement, which necessitates a current evaluation of the genetic population structure of spotted seatrout in SC prior to stocking. Analyses of the genetic population structure of spotted seatrout *Cynoscion nebulosus* along the southeastern US coast using 13 microsatellites suggest significant population differentiation between fish in NC compared to SC and GA, with New River, NC serving as an area of integration between northern and southern spotted seatrout. Although there is a significant break in gene flow between these areas, the overall pattern throughout the sampling range represents a gradient in genetic diversification with the degree of geographic separation. Latitudinal distance and estuarine density appear to be main drivers in the genetic differentiation of spotted seatrout along the southeastern US coast. The isolation-by-distance gene flow pattern creates fine-scale differences in the genetic composition of proximal estuaries and dictates that stocking must be confined to within 100 km of the location of broodstock collection in order to maintain the natural gradient of genetic variation along the southeastern US coast.

Impacts of off-Road Vehicles (ORV) on Biological Assemblages and Habitat in the Comite River, Louisiana (Poster Session)

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The Comite River is a coastal plain tributary of the Lake Pontchartrain Basin in southeastern Louisiana and is registered with the State as a Scenic and Historic Stream, giving it some protective status. The Louisiana Department of Wildlife and Fisheries (LDWF) manages the Scenic Streams program and, in October 2013, took steps to ban off-road vehicles (ORV) in all Scenic Stream beds (channel bottom between the banks at low water mark). The Comite River was cited as an example of a stream that has been incurring heavy amounts of ORV traffic during warm, low water periods (May-October) for the purposes of recreational riding. However, the Louisiana Wildlife and Fisheries Commission requested to see data that supported the stance taken by LDWF that ORV riding had a negative impact on the ecological integrity of the Comite River. We present data collected during 2009-2013 from unimpacted sites, low impact, medium impact, and high impact sites during warm months that suggest ORV riding degrades the ecological integrity of this system. Data were collected on the presence/absence and relative abundance of benthic macroinvertebrates (including unionid mussels and crayfishes) and fishes. Reach lengths (40 x wetted width) were delineated and 30 seine hauls were taken to sample fishes, ten hand grabs were collected at each site (leaf litter, woody debris, and rootwads) then put in plastic bags on ice,

and mussel surveys were conducted at 1 m wide intervals along both banks and at mid-channel Instream habitat data were also collected at these sites using standard US EPA Environmental Monitoring and Assessment Protocols (EMAP) for low-gradient, glide-pool streams Although stream dwelling crayfish were found at unimpacted sites (*Orconectes palmeri palmeri*), none were collected at the remaining impacted sites Greater numbers of pollution-tolerant invertebrate taxa were found at sites with increased ORV impact For fishes, 18 species were found at unimpacted sites, 14 at medium impact sites, 8 at low impact sites, and only 4 at high impact sites The high impact sites contained no predators, including Spotted bass (*Micropterus punctulatus*), which is the dominant predator at other less impacted sites Only 4 species of mussel were found at unimpacted sites, 1 at a medium impact site, and 0 at high impact sites Habitat trends included a decline in rapid habitat assessment scores (RHA) from unimpacted to impacted sites, lower dissolved oxygen, lesser overhanging vegetation cover, lower large woody debris volume, and increases in human debris

Status and Life History of the Snowy Grouper Population off the Atlantic Coast of the US after 10 Years of Intensive Management (Poster Session)

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Snowy grouper, *Hyporthodus niveatus*, is a commercially valuable deepwater grouper species that has been under intense management by the South Atlantic Fisheries Management Council (SAFMC) since 2006 Snowy grouper are captured primarily in commercial fisheries using snapper reels and bottom longlines Starting in 2006, the SAFMC phased in over a three year period an increasingly restrictive trip limit and annual quota (Amendment 13C) The effects of regulations on the Snowy grouper population along the Atlantic coast of the southeastern United States were evaluated during the recent SEDAR 36 standard stock assessment In preparation for the stock assessment, otoliths and samples of reproductive tissue were collected annually by two collaborating fishery-independent programs, Marine Resources Monitoring Assessment and Prediction (MARMAP) and South East Fishery Independent Survey (SEFIS) Additional samples were obtained in 2008 through a Cooperative Research Program (NOAA/MNFS) contract with a commercial bottom longliner from South Carolina (n~1,100) All samples were analyzed by MARMAP biologists During 1979-2012, Snowy grouper were obtained from commercial boats, research vessels, and headboats, primarily off North Carolina and South Carolina All specimens (n = 5,314) were collected between 29°66' and 34°73'N at depths of 18-302 m, but only seven specimens were collected south of 31°N Fishery-independent samples were collected with bottom longlines, Kali poles (an off-bottom longline), snapper reels, rods and reels, and chevron traps The study provided updated information on life history parameters such as size at age, age at maturity, spawning seasonality, and age at sex transition We also compared new data with data provided for an earlier assessment in 2004 to determine what effects the management measures implemented since 2006 have had on the population Results from statistical analyses of these data showed distinct temporal trends in size at age, female age at maturity, and age at sex transition Histological analysis confirmed the presence of hermaphroditism in Snowy grouper and provided evidence of a longer spawning season (Jan-Oct vs Apr-Sep) Lastly, results of a recent age validation study based on measurement of bomb radiocarbon in otolith cores has confirmed the maximum age of 35 yr derived from examination of otolith sections under a light microscope

Muskellunge in Tennessee: History, Management, and Recent Research (Poster Session)

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Native Muskellunge *Esox masquinongy* in Tennessee were nearly extirpated in the 1970s due to overfishing and habitat loss, principally from coal mining. Muskellunge were first introduced into the Caney Fork River system in the Cumberland River drainage in the 1950s and in 1976 an annual stocking program commenced to hedge against the loss of native Muskellunge elsewhere in Tennessee. A trophy fishery subsequently developed and fish longer than 1,300 mm have been caught in recent years. The post-stocking fate of two cohorts of radio-tagged advanced fingerlings was monitored in a tributary of the Caney Fork River in 2012. Mortality pooled over both cohorts was 79% after 56 d and the cohort that dispersed the farthest suffered the highest mortality. Predators of stocked fish included River Otters *Lutra canadensis* and Great Blue Herons *Ardea herodias*. Seine and electrofishing surveys of nursery habitats documented natural reproduction by Muskellunge in three of four Caney Fork River tributaries and that stocking program is now under critical review. In Melton Hill Lake, a mainstem impoundment in the headwaters of the Tennessee River system, a trophy Muskellunge fishery developed fairly quickly after a fingerling stocking program commenced in 1998. No natural reproduction has been documented and that reservoir fishery relies on an annual stocking program. Some biologists and anglers are concerned Muskellunge may be overexploited when they congregate in the heated thermal discharge of a steam plant in winter. Managers are already seeing more anglers from around the country travelling to Tennessee to target Muskellunge in both of these systems.

Exploring Trophic Relationships of Several Sciaenid Fish Species (Poster Session)

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Between 2008 and 2010, Weakfish (*Cynoscion regalis*), Southern Kingfish (*Menticirrhus americanus*), and Atlantic Croaker (*Micropogonius undulatus*) were collected by the SEAMAP-SA (Southeastern Monitoring and Assessment Program-South Atlantic) Coastal Survey between Cape Canaveral, FL and Cape Hatteras, NC, and their stomach contents were identified, enumerated, and weighed. The Amundsen Method (modified from the Costello Method) was used to determine feeding strategy. All predator populations examined in this study displayed generalist feeding strategies, with the exception of some individuals from each species that displayed mixed to specialist feeding strategies. The Weakfish population showed slightly more mixed to specialist feeding strategies than the other predators species. Potential for trophic overlap between predator diets was analyzed using the simplified Moriseta-Horn Index. Results indicate a diet overlap between Southern Kingfish and Atlantic Croaker, which suggests a potential for competition between these species, should shared food resources become scarce. Currently, there is no indication of competition between these species. Further diet analysis of fishes sharing the same or similar niche(s) would provide a clearer picture for fisheries managers as a move toward ecosystem-based fisheries management is pursued.

Linking Population Dynamics, Angler Responses, and Optimal Pricing to Evaluate a Potential Goliath Grouper "Big Game" Tag Fishery (Poster Session)

Ryan Jiorle*, University of Florida, rpjiorle7@ufledu, Nicholas Ducharme-Barth, University of Florida and Zach Siders, University of Florida

As Goliath Grouper (*Epinephelus itajara*) continue to recover in the Gulf of Mexico and South Atlantic, some stakeholders are expressing interest in having the recreational fishery reopened. However, an open access fishery has the potential to re-deplete this slow growing, late maturing stock. Thus we present a conceptual management scheme analogous to terrestrial big game hunting, where recreational anglers would purchase a “big game tag” in exchange for the privilege to harvest one goliath grouper. We constructed a simulation model to evaluate the optimal price-per-tag based on biological, economic, and social factors. Our framework accomplished this by linking an age-structured yield per recruit model to angler response dynamics and an optimal pricing and distribution model. We assumed stock levels were influenced by three processes: 1) tag allocation numbers; 2) discard mortality; and 3) non-compliance rate (poaching). The types of users were broken down into four categories in our framework: charter boat captains, spear fishermen, private hook-and-line anglers, and NGOs/special interest groups (who buy tags with the intention of non-use). Each group except NGOs were assumed to have independent poaching and discard mortality functions dependent on price. Given supply and demand dynamics, we expected poaching levels and discard rates to be driven by tag price. At low tag prices, tag demand was assumed to exceed tag supply where anglers are more likely to engage in poaching because there are no tags available. Also, we assumed some anglers would not be able to afford tags at high tag prices and would engage in poaching due to their inability to purchase a tag. This framework can then be used to search for optimal tag numbers, tag allocation, and tag prices that maximize compliance among various users while maintaining a sustainable population of Goliath Grouper. Additionally, we will use this framework to investigate the potential impacts of non-optimal scenarios commonly evoked by “big game” managers.

Examining Fine-Scale Movement of Estuarine Southern Flounder (*Paralichthys lethostigma*) Using a Combination of Active and Passive Acoustic Techniques (Poster Session)

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Identifying critical habitat of an organism can elucidate important aspects of their life history, but is difficult to measure for highly mobile species in open marine environments. This study applied a combination of three different telemetry approaches to examine fine-scale habitat use of southern flounder (*Paralichthys lethostigma*) in a tributary (Northeast Creek) within the New River estuary, North Carolina. Twenty fish (mean TL \pm sd = 347 \pm 37mm) were implanted with acoustic transmitters (VEMCO V9) from June-August 2013. First, passive acoustic monitoring was accomplished through an array of eight stationary acoustic receivers (VEMCO VR2W) which enabled calculation of the duration of residence within and emigration from the creek by each individual. Second, weekly active tracking was completed by transecting the creek using a manual hydrophone (VEMCO VR100) along predetermined listening stations to examine habitat use patterns at a broad scale and to identify potential abiotic predictors of fish location. Finally, continuous active tracking, during which fish position was recorded every ten minutes, was conducted on a fine spatial scale for a subset of individuals.

The number of days fish were detected (more than one VR2W detection per day) within the creek ranged from 0-41 days with an average detection of 109 \pm 134 SD days. A single fish which remained stationary for several weeks at the release site was presumed to have died shortly after surgery, and four fish were

reported as fishery captures having never left the creek. One fish emigrated from the tributary in late August, twenty days after being tagged.

Beginning mid-June through early October, twelve transects were completed. On average, 75% (\pm 24% SD) of the fish for which we had no evidence of emigration or removal from the creek were detected. All fish were detected within 100 meters of the shoreline and most fish (all but two) were found near the mid-creek. One fish was detected near the creek mouth before being captured, while another fish was detected near the upper reaches of the creek.

During summer, six individuals were actively tracked continuously at a fine spatial scale; four fish were tracked for 36 hours while two were tracked for 48 hours. Preliminary analysis indicates that all six fish remained in an area of 46,000 m² during the track duration. All habitat tracks occurred within 100 meters of shore, in water less than 2 meters deep (mean abiotic measure \pm sd: temperature=28.7 \pm 1.2 °C, dissolved oxygen=4.9 \pm 1.6 mg/L, salinity=10.1 \pm 2.1 psu).

Diet of Invasive Rio Grande Cichlids (*Herichthys cyanoguttatus*) in Louisiana: Habitat Effects and Overlap with Native Species (Poster Session)

*Maiadah Bader**, *University of New Orleans - Nekton Research Laboratory* and *Tom Lorenz*, *Georgia Southwestern State University*

When an invasive species becomes established, there are a variety of impacts it can have on native species. These impacts include competition for territory, disruption of parental care, and competition for prey items. Rio Grande Cichlids (*Herichthys cyanoguttatus*) are non-native fish that have been established in southeastern Louisiana's urban lagoon systems. They were first collected in the Greater New Orleans Metropolitan Area (GNOMA) over 20 years ago. In my previous research, I analyzed the gut content of this species to examine their diet and determine whether there is an overlap in diet with native species. I collected both *H. cyanoguttatus* and Bluegill (*Lepomis macrochirus*) fish from concrete canals and earthen bottoms canals. Three sets of Hester-Dendy invertebrate traps were deployed at each site and re-collected a month after deployment for sampling microorganisms in the water columns. These measured available prey for these fishes. Cichlids collected from concrete canals exhibited a narrow diet consisting mostly of algae. The native Blue-gill, exhibited a diet of minimum amounts of algae. Cichlids from more natural habitats exhibited more varied diets which included prey such as crayfish, fish scales, fish eggs, various arthropods, and mollusks. Bluegill gut content consisted of organisms such as ostracods, amphipods, nematodes, insect larvae, amphipods, crustaceans, arthropods, fish eggs, and mollusks. Prey species were identified to the lowest possible classification. This same method of analysis was conducted for both species. While the primary diet item of most cichlids was algae, there was some overlap in diet between these species with insects and, to a lesser extent, arthropods and mollusks. Insects were found in a majority of cichlid stomachs and were found in most Bluegill stomachs. In particular, insects from the order Odonata were found in both species' stomach contents. These data indicate that the diet of cichlids is variable and that this species consumes native organisms such as crayfish and other fishes. Also note that the diet of some co-occurring native fishes overlaps with that of the non-native cichlids suggesting that they may be impacted by this invasive species.

Validation and Verification of the Age and Growth of Gulf of Mexico Gray Triggerfish, *Balistes Capricus* (Poster Session)

Ashley Pacicco, NOAA Fisheries Contractor-Riverside Technology, inc, Carrie Fioramonti, Gulf Coast State College, Robert Allman, NOAA Fisheries Service and William F Patterson III, University of South Alabama, Dauphin Island Sea Lab*

Gray triggerfish (*Balistes capricus*) are among the most difficult of reef fish to assign an age with high reader error among Gulf of Mexico production ageing laboratories Average percent reader error (APE) for a reference set of sectioned dorsal spines ranged from 73%-214% To validate the annual formation of translucent increments, gray triggerfish were injected with oxytetracycline (OTC) and held in 600 gallon tanks A single translucent increment was visible distal to the OTC mark in dorsal spines and pectoral fin rays after a winter in captivity As a method of verification, marginal increment analysis of sectioned spines was examined for the two most common age classes by month Smaller mean monthly relative marginal increments were noted from April to October for age 3 and February to May for age 4 fish A comparison of the number of translucent increments in dorsal spines and fin rays indicated that fin rays were on average assigned an age 101 years greater than that of spines A preliminary comparison of increment number from dorsal spine sections and abdominal vertebrae sections suggests good agreement between these hard-parts.

Field Testing of Smith-Root Vvp-15B Electrofisher Output within a Boat Electrofishing Fleet: Efforts to Improve Standardization (Poster Session)

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We examined a fleet of boat electrofishing systems used to sample catfish populations in segments of the Missouri and Mississippi rivers The objectives of this evaluation were to (1) measure electrode arrangements and test the continuity on all major components of the electrical circuitry, (2) check the calibration of the Smith-Root VVP-15B electrofisher output meters and waveform (ie, pulse shape, duty cycle, and frequency) using pulsed-DC, and (3) measure total electrode resistance (anodes plus cathode, collectively) for each boat electrofishing system at a single location on the Missouri River Electrofishing boats that were evaluated (58–67 m hull length, flat bottom, aluminum hull) served as the cathode with two booms each supporting an anode array (61–66-cm diameter ring) with 3-7 stainless-steel droppers (19–44-cm diameter, 229–61 cm in length) attached External metering and digital oscilloscopes were used to measure peak voltage and peak current for each VVP-15B control unit Continuity checks of electrical circuits identified issues with faulty wiring and oxidation of anode or cathode surfaces Electrofisher output meter calibration results allow biologists to more accurately estimate their peak power applied and can be used to achieve a target output goal when sampling Electrode resistance measurements provided an analytical understanding of the power allocated to the anodes and cathode These results will provide quality assurance of field equipment and aid development of a standardized electrofishing protocol for sampling catfish populations in large rivers

Range Determination of *Cynoscion Arenarius* and Characterization of *Cynoscion Spp* Hybridization in Near Shore Habitats Along the Southeastern US Atlantic Coast with Implications for Management of *Cynoscion Regalis* (Poster Session)

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Weakfish, *Cynoscion regalis*, is a federally regulated, priority species, and comprises an important recreational and commercial fishery along the US Atlantic coast. A potential range expansion of a closely related Gulf species, sand seatrout (*C. arenarius*), along the US Atlantic coast as well as the occurrence of *Cynoscion spp* hybrids are causing difficulties in morphological field identification, which is a critical foundation of stock assessment. Genetic markers were optimized to genetically identify all *Cynoscion spp* and their hybrids found in the Atlantic. The resulting genetic tool was used to verify past and current collections of *C. regalis* along the southeastern US Atlantic coast. Additionally, these collections were used to preliminarily investigate the extent and timing of *C. arenarius*' possible range expansion as well as the degree of hybridization among *Cynoscion spp*. Initial results indicate that only a small correction factor is needed for *C. regalis* datasets from the southeastern US since 933% of *C. regalis* morphological identifications are accurate and hybridization is occurring with two out of the three *Cynoscion* species found in the Atlantic. Preliminary work supports the establishment of a northern *C. arenarius* range along the US Atlantic coast to southern Georgia. However, samples from the previous work focused on problematic specimens and do not represent a random sample of the community. Samples randomly selected by SEAMAP-SA 2013 and the SCDNR Inshore Fisheries spring collections (n= 927) were analyzed to further investigate the range expansion of *C. arenarius* and degree of hybridization of *Cynoscion spp*, particularly with *C. regalis*. Results provide valuable information regarding *C. arenarius* distribution, the mechanisms and occurrence of hybrid zones, interspecific hybridization as a potential impact on *C. regalis* stocks.

"Reintroduction Status of Native Mussels in the Pigeon River, Tennessee" (Poster Session)

Chloe Ridings*, University of Tennessee, Knoxville and Michael McKinney, University of Tennessee, Knoxville

A history of habitat degradation due to water diversion and toxic effluents caused native freshwater mussel populations to be completely extirpated from the Pigeon River in Tennessee. In the late 1980s, the paper mill in Canton, NC modernized their production and greatly reduced their waste, getting rid of the main source of pollution. For over 10 years now, there have been various attempts to reintroduce several species of native mussels into the river. This effort has been motivated by significant improvements in water quality and the hope that this would promote population growth of reintroduced mussels. However, until recently there has been relatively little monitoring of these relocated populations to see if they have been successful. We report the results of several monitoring efforts to find and identify relocated individuals. Unfortunately, to date, we have found only a small proportion of the many hundreds of individuals released into the river. While some or much of this may result from sampling error, some lines of evidence may indicate a lack of success: significant numbers of dead individuals and, most importantly, indications of poor growth rates and lack of reproduction. A potential reason for any lack of success could be the lack of food in the Pigeon relative to the source rivers. Large dams (as present on the Pigeon above the reintroduced populations) have been known to reduce available food supplies to mussels. Other factors affecting the success of these mussels could be agricultural runoff from upstream properties,

temperature, or the high water velocity the river experiences due to the dam Silos containing *Lampsilis fasciola* and *Medionidus conradicus* have been planted in both the Pigeon River and a control stream, the Nolichucky River These contain juveniles of the two species and will be monitored monthly for growth and glycogen content These results will help in identifying the potential for mussel reintroduction success in the Pigeon River

Determining Long-Term Movement and Residency Patterns of the Atlantic Stingray *Dasyatis Sabina* in Two Tidal Creeks in Savannah, Georgia Using Acoustic Telemetry (Poster Session)

*Sarah Ramsden**, Savannah State University, *Mary Carla Curran*, Savannah State University and *Charles F Cotton*, Florida State University

The Atlantic Stingray *Dasyatis sabina* is common in many coastal habitats, although it is unknown if this species is a year-round resident There is anecdotal evidence that Atlantic Stingrays leave near-shore waters in the winter and return in late spring off the coasts of South Carolina, Florida, and Texas The purpose of this study was to determine the residency and long-term movement patterns of the Atlantic Stingray in two tidal creeks near Savannah, Georgia Atlantic Stingrays (n=16) were surgically implanted with acoustic transmitter tags in Romerly Creek starting in December 2012 and in Country Club Creek starting in April 2013 The percentage of tagged animals detected each month within the passive acoustic receiver array in each creek system was calculated In Romerly Creek, Atlantic Stingray presence remained high through September 2013, with 60% of the rays (n=5) detected In Country Club Creek, presence also remained high with 100% of the rays (n=2) detected in April and 82% (n=11) detected in September Changes in the number of rays detected in the creeks could indicate migration into or out of these areas We are continuing to monitor these two receiver arrays to detect any seasonal changes in fish movement and to determine whether temperature plays a role in these long-term patterns

Abundance and Distribution of Fishes at Estuarine and Coastal Sites Near the Mouth of the Savannah River, Georgia (Poster Session)

*Jennifer A Gut**, Savannah State University and *Mary Carla Curran*, Savannah State University

Estuaries and surf zones along the East Coast of the United States are dynamic environments that serve as crucial nursery habitats for numerous marine fish species Approximately 60% of the commercial species in the North Atlantic are dependent on estuaries at some point during their life cycle Accurate assessments of fish abundance and patterns of habitat use are necessary for the development of better management practices for commercially and recreationally important species The purpose of this study was to characterize multiple life-history stages of the estuarine and shallow surf-zone fish assemblages near the mouth of the Savannah River over a temporal and spatial scale Three different types of sampling gear were used: a seine net, a beam trawl, and a zooplankton net Carangids were the most abundant group with 5,828 individuals collected, and they were mostly collected in the surf-zone area More species in the family Sciaenidae (n=12) were collected throughout the study than any other group and were found mostly in the estuarine sites The estuarine area was more diverse (109 ± 004) than the surf-zone area (058 ± 030) Overall, this work supports the findings of previous studies in which sciaenids were commonly the most represented group in estuaries on the East Coast, and that surf zones are important nursery areas for some carangids

A Photo Guide to Aid in the Identification of Priority Fishes from Underwater Video Assessments of the Snapper-Grouper Complex of the Southeastern US (Poster Session)

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This work represents a preliminary photographic guide to aid in the identification of priority western North Atlantic reef fish species observed from underwater video assessments made by NOAA surveys and other programs. The primary purpose for assembling this guide is for use in ongoing, underwater video surveys conducted by the NOAA SouthEast Fishery-Independent Survey (SEFIS) and Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program, which target reef fishes of the Snapper-Grouper Complex in southeast US continental shelf waters. This guide will facilitate video footage analyses for reef fish surveys that deploy video camera arrays, trap video and still cameras, and ROV, but will also prove useful in most underwater visual surveys. The need for such a guide has become apparent since standard identification techniques by physical examination, such as counts of fine-scale morphological features, cannot be relied on from underwater observations. In addition, sampling conditions, including turbid, low-light water, as well as limitations due to camera view and placement in relation to fish distance and movement away from the camera, can make underwater identifications even more challenging. Other difficulties related to underwater fish identification include variation in morphological features, color, and body pattern phases due to ontogeny, secondary sex characteristics, behavior, and habitat. Many of these morphological variations have not been documented and are very important in discerning species. Information used in this guide was compiled from underwater photographs and video footage (from SCUBA, submersible, ROV, and towed and stationary video and TV) as well as physical specimens and literature. Each species presented will include several photos that describe documented and undocumented observations of color morphs or phases displayed in relation to varying secondary sex characteristics, life history stages, habitats, and behaviors, which will aid in identification as well as separation from other species. This visual guide should improve the accuracy, reliability, and standardization of underwater identifications from ongoing video analyses as well as historic, archived video tapes. Further documentation of body morphological features, behaviors, and field characters will not only increase the proficiency of identification but will result in greater accuracy in fishery-independent data used for stock assessments and ecosystem-based management of reef fishes in the Snapper-Grouper Complex in southeast US continental shelf waters.

Using Side Scan Sonar to Improve Fishery Independent Reef Fish Monitoring in the Northeastern Gulf of Mexico (Poster Session)

*Patrick S Raley**, National Marine Fisheries Service, Southeast Fisheries Science Center, Riverside Technologies Panama City Lab, *patrickraley@noaa.gov*, *Chris L Gardner*, National Marine Fisheries Service, Southeast Fisheries Science Center, Riverside Technologies Panama City Lab and *Douglas A DeVries*, National Marine Fisheries Service Southeast Fisheries Science Center

High resolution habitat maps are essential for maximizing efficiency, accuracy, and precision in fishery-independent reef fish surveys. Such maps are also invaluable for marine spatial planning and for predicting, assessing, and modeling impacts of many natural and anthropogenic events and actions. Little is known, however, about the quantity, distribution, and types of hard bottom habitats – essential to reef fish populations – on the inner- and mid-shelf in the northeastern Gulf of Mexico (Gulf). In 2002 the Panama City NMFS lab began development of a fishery-independent trap and video survey of natural

reefs on the inner shelf of the NE Gulf, primarily to establish age-based annual indices of abundance for pre-recruit economically important reef fish. In 2009, we purchased a Marine Sonic side scan sonar to locate, quantify, and classify hard bottom habitats in our survey area and expand our then very limited sampling universe of ~260 sites. Since then, we have mapped approximately 220 km², and located over 2700 previously unknown patches of hard bottom habitat. The addition of so many sites to our sampling universe allowed us to move from a systematic to a stratified random sampling design. The high resolution sonar data allowed us to accurately measure reef traits such as maximum relief, area, length, and distance to nearest neighboring reef, as well as provide information on basic morphology and rugosity (eg, scattered, solid, ledge) and density of reef patches. Many of these variables are used in a weighting scheme in the random site selection process, and are valuable for post-stratification during data analysis. This presentation will show the results of recent cross-shelf side scan mapping in the northeastern Gulf, and demonstrate the value of that acoustic data in improving fishery independent monitoring on the west Florida shelf.

Atlantic Sturgeon, *Acipenser oxyrinchus*, Population Estimate for the Edisto River, SC Using Program MARK (Poster Session)

Bill Post, South Carolina Department of Natural Resources and Jonathan Watson, South Carolina Department of Natural Resources*

The South Carolina Department of Natural Resources (SCDNR) has conducted sturgeon monitoring in the Edisto River continuously since 1994 using monthly gill net surveys. Recently, due to the designation of Atlantic Sturgeon, *Acipenser oxyrinchus*, as an endangered species, there has been a greater focus on population abundance estimation throughout their range. A paucity of information on movement patterns and an uncertainty over the extent of migration presents challenges for accurately assessing population size. SCDNR's consistent long-term monitoring efforts produced a dataset that provides a unique opportunity to apply mark-recapture modeling techniques. The Robust Model in Program MARK was used to analyze these data and resulted in an average abundance estimate of 884 ± 281 (95% CI) individuals from 1996-2012 for the Edisto River. Such estimates have important implications for measuring the recovery of this species and provide benchmarks for future comparisons.

What Is Low-Cost Sonar Habitat Mapping? (Poster Session)

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Low-cost sonar habitat mapping is a method developed by Adam Kaeser (US Fish and Wildlife Service) and Thom Litts (Georgia Department of Natural Resources) for producing high resolution maps of physical habitat features in navigable systems using inexpensive, off-the-shelf sonar and GPS equipment. Associated tools and techniques enable the generation of rectified image mosaics from sonar image snapshots obtained with the Humminbird® Side Imaging system. Physical habitat elements are manually digitized via interpretation of sonar imagery within a GIS. Sonar habitat mapping can be used to quantify the distribution and extent of habitat, investigate terrestrial-aquatic linkages, study patterns of habitat use by resident organisms, and monitor change over time. By providing a unique, rapid, and flexible means to visualize and characterize the underwater environment at the landscape scale, this method can be used to fill critical information gaps in a wide variety of aquatic systems.

Greater Amberjack *Seriola Dumerili* Findings from a Fishery-Independent Trap and Video Survey in the Northeast Gulf of Mexico (Poster Session)

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The NMFS Panama City lab has been conducting a fishery-independent chevron trap and stationary video camera survey of natural reefs on the inner shelf (8 - 50 m) of the eastern Gulf of Mexico between Destin and Cedar Key, FL since 2004. Objectives include establishing age-based annual indices of abundance of pre-recruit exploited reef fish; examining regional catch, recruitment, demographic, and distribution patterns; and determining habitat associations. Stereo camera systems, introduced in 2009, provide images from which fish measurements can be obtained with the Vision Measurement System (VMS) software.

Greater amberjacks have consistently been observed with stationary video gear across the northern portion of the inner and mid- West Florida shelf since 2006, although they have been much more common west of Cape San Blas (a zoogeographic boundary bisecting the survey area) than east. Annual frequency of occurrence 2005-2012 ranged from 21 to 55 % (= 33 %) west of the Cape compared to 2-32 % (= 12 %) in the east. Greater amberjack were not uniformly distributed across all depths sampled east of the Cape, but were in the west. None were observed shallower than 101 m.

The video survey strongly targets pre-recruit greater amberjacks - during 2009-2012 about 98% were <762 mm FL, the recreational minimum size limit. Greater amberjack east of the Cape tended to be smaller than those in the west (= 383 vs 475 mm FL), with 87% <450 mm in the east vs 53% in the west. Although sample sizes were small in 2010 and 2011, annual size structure data did hint at the progression of a modal group from 350-500 mm in 2009 to 500-650 mm the following year. There was no apparent relationship between size and depth in greater amberjack observed in the video survey.

Overall nominal mean min count indices and frequency of occurrence data from the video survey, 2005-2012, revealed considerable annual fluctuations in the abundance of younger (ages 0-2 yr but likely primarily age 1) greater amberjack on the northern portion of the west Florida shelf, and both metrics showed similar trends 2008-2012. During 2006-2010 the trends were opposite east and west of Cape San Blas.

Results provide valuable insight into pre-recruit greater amberjacks unavailable through traditional means and the indices are currently being incorporated into the SEDAR 33 stock assessment of Gulf stock greater amberjack.

Tidal and Diel Movement Patterns of the Atlantic Stingray *Dasyatis Sabina* Along a Stream-Order Gradient (Poster Session)

*Cameron P Brinton**, Savannah State University, *Mary Carla Curran*, Savannah State University and *Charles F Cotton*, Florida State University

Fish behavior can be affected by a number of external cues in the environment such as temperature and tide Stream geomorphology can further influence how fish respond to these stimuli The purpose of this study was to determine how tidal stage and diel period affected the movement patterns of the Atlantic Stingray *Dasyatis sabina* in tidal creeks along a stream-order gradient Two estuarine creek systems near Savannah, Georgia were selected to determine stingray movements in low order creeks (first-third) and middle order creeks (fourth-fifth) based on the Horton method for stream-order classification This method assigns unbranched tributaries to the first-order and when two identically classified streams combine, they form a stream of the next higher order Twenty-three stingrays were tagged internally with VEMCO coded acoustic transmitters and were tracked by 20 VEMCO VR2W data-logging acoustic receivers starting in December 2012 Each tidal cycle was divided into 8 equal bins in order to differentiate among high, low, ebb, flood and the 4 transitions between these tidal stages Atlantic Stingrays were found most often in third-order creeks, as 862% of stingray detections were recorded in this habitat Detections were uniformly distributed throughout the 24 h cycle except in third-order creeks, where average hourly stingray detections were highest during dusk (40 ± 16 detections/receiver) and lowest during the day (31 ± 04 detections/receiver) Within third-order creeks, stingrays were most prevalent during high tide (151%) In contrast, stingrays were detected most frequently within fifth-order creeks at both the ebb and low tide (217% and 158%, respectively) The reduced detection frequency in higher order creeks at high tide and simultaneous increased detection frequency in low order creeks indicates that stingrays may have moved into lower order creeks with the flood tide

Assessment of Watershed-Based Restoration Plans Developed to Maximize Ecological Recovery of AMD Impaired Streams (Poster Session)

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There is a critical need for evaluating watershed-based restoration efforts developed to maximize the ecological recovery of AMD impaired streams in central Appalachia A strategic watershed-based restoration plan was implemented for the Abram Creek watershed to mitigate the effects of AMD in 2007 The objectives of our study were to assess the current chemical and biological conditions of the watershed, and identify specific attributes that have and have not been completely restored In 2013, we sampled sites for water chemistry, and benthic macroinvertebrate and fish assemblages Sites were strategically selected based on treatment locations, and resampled from 2008 to compare post-restoration with pre-restoration ecological conditions Water chemistry, invertebrates, and fish varied widely throughout the watershed, but we observed some significant improvements in water quality and biota at treated locations For example, pH and alkalinity increased at five out of the six treatment locations, and dissolved aluminum, manganese, and iron concentrations decreased downstream at all of the AMD treatment locations We found fish in almost all sites that lacked them previously Specifically, we found fish at nine sites that previously had none, two of which had brook trout Also, benthic macroinvertebrate scores increased, but were still somewhat low, indicating that recovery is still taking place Watershed-based restoration efforts are suffering from lack of evaluation This base-line watershed remediation data can be used by water resource management agencies to adjust the number of treatment locations, improve design of existing technologies, and update GIS-based watershed models that manipulate the watershed restoration master plan This general framework for adaptive watershed management developed for mined watersheds can also be applied to other anthropogenic impacted watersheds in this region

The Abundance and Size Distribution of Flatfishes in a Shallow Estuarine Creek in Georgia (Poster Session)

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Temperature and seasonal changes may play crucial roles in the selection of nursery habitats by flatfishes. The purpose of the present study was to investigate the patterns in use of a shallow estuarine creek by flatfishes to determine the effect of season on species composition and abundance over multiple years. Monthly samples were collected during ebb tide in Wylly Creek (31°59'52"N, 81°03'18"W) in Savannah, Georgia beginning in January 2004. Three replicate tows were conducted for 2 minutes each using a 1 m-wide beam trawl with a 3 mm mesh net. Means were calculated as the number of individuals per sample date by season. Six species were collected throughout the study: the Blackcheek Tonguefish *Symphurus plagiusa*, the Bay Whiff *Citharichthys spilopterus*, the Fringed Flounder *Etropus crossotus*, the Summer Flounder *Paralichthys dentatus*, the Southern Flounder *Paralichthys lethostigma*, and the Ocellated Flounder *Ancylosetta quadrocellata*. The flatfish species used the creek at different times of the year. The most abundant species was *Symphurus plagiusa* (660 ± 077 individuals d^{-1}), with peak abundance during summer (1196 ± 214 individuals d^{-1}). *Citharichthys spilopterus* was most abundant during winter (1228 ± 454 individuals d^{-1}) when mean size was shortest (181 ± 04 mm) and least abundant during fall (110 ± 051 individuals d^{-1}) when mean size was longest (819 ± 53 mm). The major finding of this study was that recently settled *Citharichthys spilopterus* used Wylly Creek as a nursery in early winter while the other species utilized this creek in later juvenile stages.

Assortative Mating Based on Coloration in the Freshwater Platyfish (Poster Session)

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For any given species, survival is highly dependent upon the maintenance of genotypic variation, which allows for populations to remain adaptive to dynamic environments. The loss of such variation has been shown to have various detrimental effects including inbreeding depression, decreased disease resistance, and developmental instability. One of the proposed ways in which populations can maintain such variation is through a negative assortative mating strategy, where individuals would be expected to reproductively select for members of the opposite sex that exhibit novel phenotypes. Research examining sexual selection in fishes has focused on the family Poeciliidae, which exhibit a wide range of fin and body morphology. In this study, the effect of male coloration on female mate choice in the platyfish (*Xiphophorus maculatus*) was examined using three distinct color morphs (red, blue, and yellow). Adult platyfish (N=140) were obtained from a local supplier and quarantined for two weeks. Sexes were housed separately, and males sorted based on total body length (mm). To prevent body size from influencing female choice, males measuring more than 1 SD from the total population were not used for the study. Experiments were conducted using a 57 liter aquarium, with two clear Plexiglas® partitions dividing the aquarium into three chambers. To prevent potential pheromonal interactions, the partitions were sealed with silicone sealant to eliminate water exchange between the chambers. For each trial, one homologously colored male was placed into either the left or right holding chamber using a random number generator to account for side bias. A male of alternative coloration was placed into the opposite chamber. Females (n=30) of each coloration were placed individually into a clear 3"x3"x10" holding chamber in the center.

of the tank. After a five minute acclimation period, the holding chamber was removed and the female allowed to interact with both males. Courting behaviors were recorded for a 10 minute period, after which the female was removed into an isolation chamber for 24 hours and the experiment repeated using a different combination of males. Initial male selection, time to initial selection, and overall time spent courting each male was recorded. Early results analyzed with Student's t-test ($p < 0.05$) strongly indicate that female platyfish utilize a negative assortative mating strategy, preferentially selecting for alternatively colored males. Based on these findings, coloration may play an important role in maintaining diversity along with other previously studied morphological factors (eg fin size, body size, etc).

Female Mate Choice in the Guppy (Poster Session)

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

Heterogeneity within a population enhances its long-term survival. A fundamental aspect of maintaining such population heterogeneity is the retention of rare or uncommon phenotypes by selective mating strategies. Utilizing a negative frequency-dependent mating strategy, females would be expected to exhibit an affinity towards a population of males comprised of multiple phenotypes, as compared to those showing no phenotypic diversity. Employing three color variants (yellow, red, and blue) of the guppy (*Poecilia reticulata*, Poeciliidae), this study was designed to investigate whether *P. reticulata* females would preferentially seek out heterogeneous populations of males exhibiting multiple color morphs. Adult female guppies were individually exposed to two groups of males ($n=10$), one comprised of a single color morph and the other of two of the three color morphs. For the latter group, the ratio of males exhibiting the two colorations was changed incrementally over multiple trials, beginning and ending with homogeneous populations (5:0, 4:1, 3:2, 2:3, 1:4, 0:5). Experiments were conducted employing a long configuration 76 liter aquarium, partitioned at both ends with clear Plexiglas to serve as the male population compartments (11cm x 20cm x 30cm). Individual females were placed into an 11cm x 11cm x 50cm holding column located in the center compartment (39cm x 20cm x 30cm) of the experimental tank. Subsequent to a five-minute acclimation period in the holding column, each female was released and behaviors recorded. Courting behaviors and population affinities (ie female location relative to the male compartments) were recorded every 5 seconds over a 5 minute observation period. Results showed that females did not distinguish between homogeneously colored groups of males and those exhibiting either the 4:1 or 1:4 color ratios. However, females clearly showed affinities for the male groupings of 3:2 and 2:3 ($p < 0.05$).

Mercury Bioaccumulation in Reef Fishes from the South Atlantic Bight: Preliminary Findings (Poster Session)

Barbara Corley, University of South Carolina Aiken, Virginia Shervette, University of South Carolina Aiken, Byron White, South Carolina Department of Natural Resources, John Dean, University of South Carolina, Angela H Lindell, University of Georgia and Gary Mills, University of Georgia*

Fishes are an integral part of diets around the world, with approximately one billion people relying on fishes for their main source of protein. Eating fish provides an array of nutritional benefits; however the emerging concern of mercury exposure from the consumption of fish has led to much controversy concerning risks versus benefits. For this reason, studies measuring the mercury concentrations in commonly caught and consumed fish are an important part in relaying useful information to the public.

But, care must be taken when issuing region- and nation-wide advisories for fish species or groups in which Hg data are only documented from one area for a wide-ranging species or from a small sample of individuals within a species. For example, in the mid-2000s, South Carolina fishers expressed confusion and concern about the FDA, EPA and SCDHEC “DO NOT EAT” advisory for “tilefish” (as an aggregate group) that was based on data from 1971 of 60 golden tilefish (*Lopholatilus chamaeleonticeps*) samples from Gulf of Mexico (GOM). The fishers pointed out that more than one tilefish species are caught commercially and populations from the Atlantic coast may not have the same levels of Hg as fish from the GOM. When golden tilefish samples from offshore of SC were examined in 2011 much lower Hg concentrations were found compared to the older GOM data. The main goal of this study is to quantify mercury concentrations in edible muscle tissue from South Atlantic Bight populations of four species of grouper (gag grouper, red grouper, speckled hind, and scamp), red snapper, and gray triggerfish all of which are recreationally and commercially important in South Carolina and throughout the Southeastern region of the US. Specifically, for each species we are: 1 Examining the relationship between Hg concentration and fish size, age, and gender; and 2 Comparing our findings from Atlantic waters to those reported from the GOM and current federal and state guideline consumption advisory threshold levels.

Queen Triggerfish: Initial Findings on Aspects of Life History for a Data-Poor Species in US Caribbean Waters (Poster Session)

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Little to no peer-reviewed published research exists on basic life history parameters of queen triggerfish that occur in US Caribbean or other waters of the US. The 2013 SEDAR Stock Assessment for Queen Triggerfish indicated that the lack of current species-specific life history information greatly hindered the assessment and given the data limitations, projections for future status of the stock could not be constructed. However, queen triggerfish are considered to be important food fish for local communities in Puerto Rico and the US Virgin Islands so managing the stocks in such a way that people can continue to utilize this species for food and economic stability is important. In order to address this dearth in our understanding of such an important resource we purchased 54 queen triggerfish in late Jul/Aug 2013 from Puerto Rican fishers. Here we present our findings concerning size-at-age and aspects of reproduction from PR samples combined with data from ongoing collections of queen triggerfish from waters off of South Carolina since January 2013. The size and estimated age of PR fish ranged from 229-351 mm FL and 3-7 years, respectively. Fish from SC ranged in size from 475-516 mm FL and estimated age from 14-20 years. Our preliminary data indicate that according to otoliths, queen triggerfish can live up to 20 years and the mean size-at-age calculated from our small dataset indicate that PR fish are smaller for their age compared to the only previously published study that included samples from PR collected in the early 1980s. No information exists concerning reproductive ecology of queen triggerfish from US waters in the peer-reviewed literature. Our data indicate that PR fish were not actively spawning in late Jul-early Aug. SC queen triggerfish caught in May and June exhibited signs of recent spawning activities.

Age and Growth of Gray Triggerfish from South Carolina Commercial and Recreational Fisheries (Poster Session)

Nichole Clark, University of South Carolina Aiken, Virginia Shervette, University of South Carolina Aiken, Brittany Jowers, University of South Carolina Aiken, Courtney Adams, University of South Carolina Aiken, Alexis Harvin, University of South Carolina Aiken, Barbara Corley, University of South Carolina Aiken, Chevy Augustine, University of South Carolina Aiken, Amanda Kelly, College of Charleston/SCDNR and John Dean, University of South Carolina*

Gray triggerfish has become a popular foodfish in many local fish markets throughout the southeastern United States. South Carolina commercial fishers and federal fisheries managers alike have expressed interest in sustainable harvesting of this species to ensure a productive and long-term future. Towards this end and in collaboration with commercial and recreational fishers, we have obtained and processed gray triggerfish carcasses over the past 20 months for catch-specific size, age, and sex data. Here we present our preliminary findings concerning this work.

Assessing reef fish aggregations in the Florida Keys (Poster Session)

Danielle Morley, Florida Fish and Wildlife Commission, Todd Kellison, National Marine Fisheries Service, Christopher Taylor, SEFSC, Beaufort, Alejandro Acosta, Florida Fish and Wildlife Commission and Benjamin Binder, Florida Fish and Wildlife Commission*

Fish spawning aggregations (FSAs) are a vital part of the life cycle of many commercially and recreationally important reef fish species. A dearth of knowledge regarding the location of FSA sites prevents their protection and effective management. In the Florida Keys, a multi-agency cooperative effort has been underway for 5 years to assess reef fish aggregations using different technologies and survey methods. This multi-tiered approach is used to determine both the reef fish utilization patterns of these sites as well as any geomorphological characteristics present. This study is focused on providing managers with data that will allow them to make informed decisions to ensure the successful continuation of reef fish aggregations in the Florida Keys.

Freshwater Fish Management and Conservation

Bar Grading of Pellet-Reared Alligator Gar in Tanks and Raceways (Freshwater Fish Management and Conservation)

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Grading reduces losses of young Alligator Gar to cannibalism during culture. Mechanical grading is an alternative to visual grading. Our objective was to determine the influence of bar grading on production of Alligator Gar in tanks and raceways. In study 1, 21-dph Alligator Gar were stocked in 75-L acrylic tanks at a density of 32 fish/L. Alligator gar were offered formulated feed at 10% of body weight/d for 35 d. Fish were graded twice each week into three size groups. Production data were compared to data from ungraded tanks of Alligator Gar, which served as controls. In study 2, 19-g fish were stocked in concrete raceways at a density of 003 fish/L. Fish were offered Golden Shiner at a rate of 10% of body weight/d and formulated feed ad libitum up to 10% of body weight/d for 36 d. Fish in raceways were also graded twice each week into three size groups. Again, production data were compared to ungraded control groups of Alligator Gar. At the end of study 1, Alligator Gar averaged (SD) 119 (24) mm TL and weighed 9 (7) g.

Growth was significantly higher, but survival and yield were significantly lower in the control group than in the graded treatment. At the end of study 2, Alligator Gar averaged 236 (26) mm TL and weighed 66 (24) g. Growth in length was significantly greater in the control groups than in the graded treatment. However, yield, survival, and growth in weight were not significantly different between the control group and the graded treatment. The general lack of grading influence on production in study 2 is contrary to study 1 and to previous research. Unlike our previous research on mechanical grading in raceways, we began study 2 with Alligator Gar trained onto formulated feed. These results suggest that grading is important for hatchery production when gar are less than 19 g, but might not be important if sufficient formulated feed and live forage are offered to Alligator Gar greater than 19 g.

Monitoring Paddlefish (*polyodon spathula*) Movement with Ultrasonic Telemetry in the Grand (Neosho) River System (Freshwater Fish Management and Conservation)

Brad Johnston, Oklahoma Department of Wildlife Conservation and Jason Schooley, Oklahoma Department of Wildlife Conservation*

Since the opening of the Oklahoma Department of Wildlife Conservation (ODWC) Paddlefish Research Center (PRC) on Grand Lake in 2008, more than 20,000 adult paddlefish have contributed to studies on morphology, physiology, population demographics, and angler use, among other investigations. Though the PRC data are valuable in many respects, there are unanswered questions concerning the ecological requirements of the species. The objectives of this study are identifying paddlefish swimming depths and determining movements and successive year spawning of adult females. In January 2011, 30 sexually mature (gravid) female paddlefish were captured with gill nets and surgically implanted with ultrasonic transmitters. The transmitters consist of two varieties: 15 depth and 15 temperature with extended battery life (~48 months). Twenty submersible underwater receivers (SUR) were installed and equally distributed at fixed locations in the Grand Lake main pool to maximize coverage. The 4 lower most SUR's are relocated up into the rivers from January thru May. To-date there has been over 260,000 total detections. However, due to transmitter malfunction and the harvest of study fish, detection rates have drastically fallen over the last two seasons. In 2011 all functional transmitters were detected in the rivers during spring migration, as well as being recorded moving back down into the lake. In 2012 half of the study fish were detected in rivers, while the other half was detected no higher than Gray's Ranch (Mid-Lake). In 2013 all functional transmitters were detected in the rivers. Ninety-five percent of the depth detections were within 10 meters of the surface, regardless of total depth.

Catch-and-Release Mortality of Paddlefish on Grand Lake (Freshwater Fish Management and Conservation)

Eric Brennan, Oklahoma Department of Wildlife Conservation and Brent Gordon, Oklahoma Department of Wildlife Conservation*

Snagging is the most common method of paddlefish take in Oklahoma. Paddlefish regulations in Oklahoma have tightened over the past 30 years, ranging from a daily creel of five to the currently proposed yearly creel of two. Over this period, catch and release has been allowed (1981-1991, 2003-Present), prohibited (1992-2002), and is currently mandatory on Monday and Friday. Very little is known about catch-and-release mortality of snagged paddlefish as well as the effect of catch-and-release on the continuation of the spawning run. During March and early April 2013 19 paddlefish (8 female, 11 male)

had ultrasonic telemetry transmitters attached. Fish were snagged by anglers in upper Grand Lake and the lower Neosho River in and donated to ODWC for use in this project. When a fish was snagged the amount of time the angler spent fighting the fish and handling the fish were recorded. Once the fish was turned over to ODWC length and weight were recorded as well as notes and pictures of the snagging wound and any abnormalities with the fish. Once all data was taken an ultrasonic transmitter was attached to the dorsal fin. After being released fish movement was then monitored through Grand Lake and its tributaries for the life of the transmitter using active and passive tracking.

Snag Angler Use and Paddlefish Harvest in Northeast Oklahoma (Freshwater Fish Management and Conservation)

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The popularity of snag angling for North American paddlefish (*Polyodon spathula*) in Oklahoma has increased since free fish cleaning services were made available at the Paddlefish Research Center (PRC) in 2008 on Grand Lake O' the Cherokees. Simultaneous with the opening of the PRC, Oklahoma Department of Wildlife Conservation instituted a system where a free paddlefish permit was mandatory for paddlefish angling. Though many permits issued were unused or unwanted, harvest data collected at the PRC were linked to permit data to investigate trends in individual harvest across the years 2009-2013. Largely due to the position of the angling opportunities in the corner of the state, nonresident anglers harvesting paddlefish outnumbered resident anglers more than two to one. Finer scale investigation on angler origins via zip code revealed a fishery dominated by a relatively small regional area within the corners of four neighboring states, yet attracting many anglers from great distances. Angler avidity was classified as experimental, intermediate, or traditional based on the number of harvest years within the study period. Regardless of residence, the fishery was dominated by experimental anglers indicating high turnover and recruitment. Angler retention was higher for nonresident anglers while this segment maintained steadily increasing numbers during 2009-2013. As expected, traditional anglers were responsible for higher individual harvest and a higher proportion of nonresident anglers were classified as traditional. Data analyses identified high-harvest anglers within the demographic structure of the fishery. New harvest regulations enacted in January 2014 including an individual annual harvest limit of two fish and mandatory harvest reporting aim to limit only high-harvest individuals while preserving opportunity for all anglers.

Status of the Arkansas River Shiner, *Notropis girardi*, in Oklahoma (Freshwater Fish Management and Conservation)

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Over the last 30 years, the Arkansas River Shiner, *Notropis girardi*, has disappeared from over 80 percent of its historic range. The current range is restricted to approximately 820 kilometers of the South Canadian River within portions of Oklahoma, Texas, and New Mexico. Based on some previous collections from the early 1990s, it was thought that a small population might still occur within portions of the Cimarron River within western Oklahoma and Kansas. Surveys were conducted starting in 1992 to 2011 within the extent of the South Canadian and Cimarron Rivers in Oklahoma to document and monitor the current extent of *N. girardi*. Collections were made in both the Cimarron and Canadian Rivers using standardized seine hauls and all fish were collected and preserved for sorting and analysis. Of the 90

collections, *N girardi* were identified in 38, all of which were from the South Canadian River. Data suggest that throughout the Canadian River system, *N girardi* is a widespread and moderately abundant species but are absent from the Cimarron River system.

Conservation Genetics and Population Status of the Flame Chub, *Hemitremia flammea* (Freshwater Fish Management and Conservation)

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The southeastern United States has a rich geologic history that contributed to the evolution of an extremely diverse aquatic fauna throughout the region. Biodiversity offers the opportunity to uncover phylogenetic relationships within and among species groups to better understand evolutionary and geologic history. The Flame Chub, *Hemitremia flammea*, is a brightly colored minnow species native to the Cumberland, Tennessee, and Coosa river drainages in Kentucky, Tennessee, Georgia, and Alabama. This monotypic species has been described as a spring endemic and was believed to be experiencing long-term population isolation across its range. In this study, the cytochrome-b gene region was analyzed for 230 individuals from 29 populations across the three drainages, including two new populations. Results from maximum parsimony and Bayesian analyses recovered very shallow divergence between the 31 haplotypes. AMOVA analyses indicated that most genetic variation was distributed within and between populations, not between drainages. Based on these results as well as field observations, this species may not be restricted to spring habitats as was originally presumed. *H. flammea* can move within river systems and likely even between drainages similar to *Fundulus julisia* and the *Catnotus* darters. Preliminary screening of microsatellite primers identified four primers that work for this species: Lco5, seat406, seat409, seat412. Further analyses using microsatellite techniques and further field sampling using geospatial modeling would refine these results. Species like *H. flammea* are indicators of the health and persistence of groundwater resources that are under increasing pressure due to a growing human population.

Hickory Shad Angler Preferences on the Roanoke River, North Carolina (Freshwater Fish Management and Conservation)

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Hickory Shad *Alosa mediocris* are anadromous fish sought during their early spring migration by recreational anglers. Targeted Hickory Shad angling trips are often intercepted during the early weeks of a creel survey conducted annually from March to May on the Roanoke River to monitor the renowned Striped Bass *Morone saxatilis* fishery. From 2007 to 2013, North Carolina Wildlife Resources Commission staff conducted 567 completed trip interviews of 1,268 boat anglers targeting Hickory Shad at public access areas on the Roanoke River. Along with angler effort and catch, we summarized catch disposition, angler origin and tackle preferences. Most anglers targeting Hickory Shad on the Roanoke River released their catch with 57% of anglers reporting catch and release only, followed by 28% of Hickory Shad anglers that reported a combination of both harvest and release during their angling trip. The remaining percentage (15%) preferred to harvest their catch; a breakdown of preferences within the daily creel limit of 10 Hickory Shad will be discussed. The majority of Hickory Shad anglers interviewed were

from North Carolina, although non-resident anglers also targeted Hickory Shad on the Roanoke River. Hickory Shad anglers preferred using artificial lures, although observations of specific lures, flies or combinations were not quantified. Commission staff will continue the annual spring creel survey to gain insight on angler preferences for Hickory Shad angling on the Roanoke River to sustain this popular recreational fishery.

Impacts of Gear Selectivity on Black Crappie Growth Rate Estimates and Harvest Management Decisions (Freshwater Fish Management and Conservation)

*Jason Dotson**, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute and *Cheree Steward*, Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute

Harvest restrictions are a common management technique intended to reduce fishing mortality and increase harvest yield of black crappie *Pomoxis nigromaculatus* populations. The effectiveness of harvest restrictions depends on the population growth and mortality rates, thus the ability to effectively determine growth rates is critical for making informed management decisions. The current standardized protocol utilized by Florida Fish and Wildlife (FWC) for sampling black crappie is trawling, but this gear type selects for small slow growing fish, which may bias growth rate estimates and impact harvest management decisions. Thus, it is critical to explore other gear types for estimating growth rates of black crappie. The objectives of this study were to 1) compare estimates of growth rates, age composition, size structure, and total annual mortality of black crappie collected from trawls and recreationally harvested carcasses, and 2) to determine the impacts of growth rates estimated from the two gears on size limit evaluations with an age-structured yield-per-recruit model. We collected black crappie at Lake Dora, Florida from 2005 – 2009 with a trawl (N = 6,058) ranging from 68 – 358 mm TL and from recreationally harvested carcasses (N = 1,834) ranging from 184 – 361 mm TL. The trawl primarily captured juvenile fish, while anglers primarily captured adult fish. The growth models and size structures estimated for black crappie captured in trawls and recreationally harvested carcasses were significantly different. Estimates of total annual mortality (A) were 0.61 for ages 0 – 5 with the trawl and 0.58 for ages 3 – 7 with recreationally harvested carcasses. Estimates of growth rates from the two gear types resulted in drastically different model output of yield-per-recruit and spawning potential ratio, which could ultimately influence management decisions. Recreationally harvested carcasses may provide an alternate sampling technique for black crappie. However, it is important for managers to consider the influence of gear selectivity on growth rate estimates when evaluating minimum length limits.

Marine Fisheries Management and Ecology

Assessing the Effect of Variable Recruitment on the Growth Dynamics of Young-of-the-Year Summer Flounder in Chesapeake Bay (Marine Fisheries Management and Ecology)

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During the last quarter-century, management of Summer Flounder along the Atlantic coast resulted in significant increases in abundance such that rebuilding targets were recently achieved. Although spawning stock biomass is high, recruitment of young-of-the-year (YOY) Summer Flounder remains variable. Chesapeake Bay is one of the principal nursery areas for this species, but processes such as growth and survival that affect abundance of YOY Summer Flounder have not been explored. Our preliminary observations indicate that in years of low recruitment, mean size of YOY Summer Flounder in the late fall is generally greater than that observed in years of high recruitment, suggesting density-dependent growth. In this study, we investigated the relationship between growth and abundance of recruits from the 1988 to 2012 year classes of Summer Flounder from Chesapeake Bay. We also considered the effects of environmental factors on growth because local conditions in the bay may contribute to variable growth within a year class. To estimate year-class specific growth, we used monthly length data from YOY fish captured by bottom trawl from the lower Chesapeake Bay and the high salinity areas of the three major Virginia tributaries (James, York, Rappahannock rivers). For each year-class, growth was estimated by modeling changes in the mean and variance of the monthly length data as a function of exogenous factors; both linear and non-linear changes in these parameters were considered. This approach for describing growth was similar to that used to model growth of invertebrates, but to our knowledge this is the first application of this method to fish.

A Preliminary Analysis of Age and Growth of Scamp, *Mycteroperca Phenax*, from the Southeastern U S (Marine Fisheries Management and Ecology)

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We analyzed otoliths of scamp, *Mycteroperca phenax* (Jordan and Swain 1884) (n = 1200), collected between 2006-2008 from the commercial snapper grouper fishery off North Carolina and South Carolina. Biological data were analyzed to determine age-growth characteristics. Scamp is a moderate sized grouper inhabiting subtropical reefs, rocky ledges and high relief bottom throughout the U S Atlantic and Gulf of Mexico. The species is valuable to both the commercial and recreational fisheries of the southeast U S, with estimated annual landings from headboats sampled by the Southeast Region Headboat Survey (SRHS) averaging 27,238 kg between 1986 and 2011, equating to an average ranking of 12 out of the 73 species managed under the South Atlantic Fishery Management Council's (SAFMC) Snapper-Grouper Fishery Management Plan (FMP). Private recreational sector landings averaged 25,967 kg annually from 1981-2011. Commercial landings will be analyzed and presented. Sectioned otoliths were moderately easy to read, with average percent error (APE), a common metric of between reader agreement, averaging 72.8% for a subset of 200 otoliths read by three readers. Annulus formation on otoliths occurred between the months of March and July, with peak formation occurring in May. Sampled fish ranged from ages 3-20 and from 430-870 mm FL. Mean observed sizes at age were 491, 516, 644, 703 and 775 mm FL for ages 3, 5, 10, 15 and 20 respectively. The von Bertalanffy equation describing theoretical growth was $L_t = 833 * (1 - e^{-(0.10 * (t+42.5))})$. Results from this study will be compared with previous life history analyses from the southeast U S and the Gulf of Mexico. Scamp is a potential candidate for a federal stock assessment in the Southeast Data, Assessment and Review (SEDAR) process in 2015. While the species has not been assessed, analysis of several data sources suggest declining trends: (1) combined recreational landings have been declining since 2006, from 108,000 kg to 22,500 kg in 2011, and (2) mean weight of headboat-caught fish has declined from an average of 455 kg in 1972 to an average of 187 kg in 2003 (analyses of headboat data from 2004 to present are underway).

Testing a Novel Mesh Shape to Reduce Bycatch in the North Carolina Large Mesh Gillnet Fishery (Marine Fisheries Management and Ecology)

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We tested the effectiveness of experimental gillnets with a novel rectangular mesh at reducing rates of bycatch of red drum and other fish species while maintaining catch rates of target southern flounders *Paralichthys lethostigma* compared to control nets with conventional square mesh. Three different mesh sizes of experimental vs control net (55, 575, and 6 inch stretch) were fished side-by-side in a shallow water (~2 m deep) North Carolina estuary. Zero-inflated poisson generalized linear models (GLMs) were fit to catch data for legal southern flounder, red drum, and all other fish species, respectively. Mesh type was a factor in each GLM that best fit the catch data for the three fish groups. On average across all three mesh sizes, square mesh caught 19 times the number of legal southern flounder but also 28 times and 25 times the average number of red drum and other fish species, respectively, than rectangular mesh. While the target catch was reduced, future refinements to rectangular mesh construction may lead to improvements in flounder catch while continuing to reduce bycatch. The mechanism by which the experimental net reduced flounder catch rates and bycatch rates could be due to the shape of the mesh or the reduced height of the net in the water column.

Influence of Oceanographic Conditions on the Vertical Habitat of Four Tropical Tuna Species in the Central Pacific (Marine Fisheries Management and Ecology)

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Climate change has resulted in the expansion of oxygen minimum zones (OMZs) but the impact on the vertical distribution of commercially important species, such as tunas, is not well understood. Although La Niña events are characterized by increased upwelling along the equator, the increased productivity and subsequent sinking of organic matter also induces the expansion of OMZs. The strongest La Niña since 1979 was experienced in 2008, which was characterized by strong equatorial upwelling and an extremely shallow thermocline. From February to June, dissolved oxygen restricted the potential comfort and physiological vertical habitat of four commercially important tuna species (yellowfin tuna, *Thunnus albacares* B; bigeye tuna, *T. obesus* L; *T. alalunga* B; and skipjack tuna, *Katsuwonus pelamis* L) more than temperature. Although zooplankton biomass, density and myctophid counts peaked between 0°N and 5°N from February to June, the amplitude of the ADCP backscatter declined rapidly in the upper 200 m, which corresponded to a region with an extremely shallow thermocline. Between February and March, the thermal minimum of all four tuna species was reached by 200 m. However, as the strength of the La Niña event declined, the thermocline deepened and the habitat restriction in regards to temperature was reduced. Between 5°N and 10°N the OMZ reached the epipelagic zone, severely restricting both the physiological and comfort vertical tuna habitat in all three transects.

Planktivory and Cannibalism in Early Post Larval Atlantic White Marlin (*Kajikia albida*) (Marine Fisheries Management and Ecology)

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As much as 2000 metric tons of Atlantic white marlin, *Kajikia albida*, are harvested commercially each year. Despite the economic value of this long-lived predator, very little is known about the ecology of their early life history stages. Due to this deficiency, we describe the gastrointestinal (GI) contents of early post larval Atlantic white marlin, which were collected in plankton and neuston trawls approximately 150km west of Boca Grande Pass, Florida. GI contents were identified to the lowest feasible taxon and qualitatively assigned digestive and GI fullness index scores. The GI contents suggested these fish primarily fed on planktonic copepods and other microinvertebrates, switching to more piscivorous, and occasionally cannibalistic diets between 8 and 20mm standard length. While cannibalism in other billfishes has been reported previously, this is the first documented case in Atlantic white marlin. Further study and larger sample sizes are needed to fully understand the feeding ecology of young Atlantic white marlin; however, this study provides an important first step toward this lofty goal.

Potential Impacts of Extreme Salinity and Surface Temperature Events on Population Dynamics of Black Drum, *Pogonias cromis*, in a Hypersaline Lagoon (Marine Fisheries Management and Ecology)

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Black drum, *Pogonias cromis*, are four to six times more abundant in the hypersaline upper Laguna Madre (ULM), Texas than observed on the rest of the Texas coast. Prior to the early 1990s, population levels in the ULM were smaller and similar to the rest of the Texas coast. The increase in the ULM adult black drum populations seems to be the result of an exceptional recruitment event which occurred in 1990. Recruitment in this system occurs on a much larger scale than observed elsewhere on the coast. Variability in recruitment within the ULM seems to be positively related to high salinity events and low winter temperatures within the system. Such harsh conditions may reduce predation on and interspecific competition with larval/juvenile black drum since it appears they are able to withstand these environmental extremes. The high abundances and larger recruitment events may be related to early reproductive maturation hypothesized to be an adaptation to deal with hypersalinity in this system, and previously noted for black drum in this region.

Monitoring of Reef Fish Communities in the Edisto Marine Protected Area off South Carolina (USA) (Marine Fisheries Management and Ecology)

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The Edisto Marine Protected Area (MPA) was designated by the South Atlantic Fisheries Management Council in 2009 as part of a series of deep-water reefs off the Southeast United States to reduce fishing of reef-associated fish species. The Edisto MPA is located 45 nautical miles southeast of Charleston, SC, making it highly susceptible to fishing pressure from both commercial and recreational vessels. The purpose of the current work is to utilize monitoring efforts from a regional fishery-independent survey to assess any impacts that the establishment of the Edisto MPA has had on reef fish communities. In particular, we describe the community structure of reef-associated fish species found in the Edisto MPA.

and surrounding areas and determine if any changes in this structure have occurred with the designation of the MPA Chevron traps have been used by the Southeast Reef Fish Survey to monitor reef-associated fish in the area since 1990 Trap catches were assigned to several time periods, including before and after the establishment of the MPA Trap catches also were assigned to three areas: within the MPA, adjacent to the MPA, and distant from the MPA Historically, abundance and biomass of several exploited species in traps were high within the MPA and low distant from the MPA Current trap catch rates are similar in all areas and low relative to historic numbers In general, communities have not changed drastically over time The effects of bottom habitat on community composition also were investigated for 2009 and 2010 Bottom habitat data were derived from camera deployments conducted in conjunction with chevron trap deployments in these two years Ultimately, this project will be used to assess if the MPA designation has resulted in any recovery of exploited species

Trophic Dynamics of Large Pelagic Fish Predators in the US South Atlantic (Marine Fisheries Management and Ecology)

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Sustainable management of marine fishery resources requires an understanding of the ecological drivers that contribute most to community structure and population dynamics In pelagic ecosystems, the functional role played by large pelagic predators is poorly understood, yet this knowledge is essential to model ecosystem-level responses to changes in their abundance and distribution To assess the trophic structure of the pelagic community in the US South Atlantic, stomachs and muscle tissue samples were collected from blue marlin (*Makaira nigricans*), wahoo (*Acanthocybium solandri*), dolphinfish (*Coryphaena hippurus*), yellowfin (*Thunnus albacares*) and blackfin tuna (*T. atlanticus*) through participation in organized fishing tournaments and cooperation with charter fishing fleets operating in the offshore waters of North and South Carolina from spring 2010 through fall 2013 All prey items recovered from predator stomachs were identified to the lowest possible taxon, while both muscle and liver tissue samples were analyzed for carbon and nitrogen isotope ratios Stomach contents revealed fishes as the most important prey by mass for all predators, except blackfin tuna Fishes were also numerically dominant in the diets of wahoo, dolphinfish, and blue marlin, while invertebrates, primarily crustaceans, were the most numerous prey consumed by yellowfin and blackfin tuna Dietary overlap was evident among predators and size classes, but the extent of overlap varied considerably between species and seasons Wahoo was the only predator that showed evidence of diet specialization and also had the highest amount of overlap with blue marlin Yellowfin tuna and dolphinfish demonstrated more varied diets, including prey species that are associated with sargassum mats typical of the epipelagic zone, and displayed a moderate level of dietary overlap However, yellowfin tuna also preyed on fishes and invertebrates associated with mesopelagic waters that dolphinfish did not Stable isotopic analysis indicated seasonal shifts in primary prey use and trophic position by dolphinfish, yellowfin and blackfin tuna A trophic hierarchy, in which larger predators occupied the highest trophic positions, was observed throughout the spring and summer but not during the rest of the year Among predators, blackfin tuna were the smallest in our study and displayed the most unique diet while maintaining a similar trophic position Results to date suggest that all predator species evaluated in our study forage in similar habitats and rely on a few dominant prey items

Reproduction of the Bonnethead Shark (*Sphyrna tiburo*) from the Southeastern US Atlantic Coast (Marine Fisheries Management and Ecology)

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Thoroughly understanding the life history of marine wildlife can be essential for the regulation of both commercial and recreational fisheries. Bonnethead sharks (*Sphyrna tiburo*) make up part of the small coastal shark (SCS) fishery complex along with the Atlantic sharpnose shark (*Rhizoprionodon terranovae*), blacknose shark (*Carcharhinus acronotus*), and finetooth shark (*Carcharhinus isodon*). In the last decade, stock assessments of this fishery have shown that some Atlantic components are being and/or have been overfished (NMFS, 2007). Reports show that the bonnethead shark is caught regularly in targeted fisheries and makes up a large portion of shark bycatch in gillnets and trawls. This places them at significant risk of overexploitation, therefore it is important to take a proactive approach to managing these populations. The species reproductive biology has been well-characterized for populations from the Gulf of Mexico, however, little is known about bonnetheads that reside on the US Atlantic coast. The lack of data from the Atlantic prompts the need for refining biological productivity estimates of this species. **The goal of this study is to improve fisheries management of US Atlantic bonnethead sharks (*S tiburo*) by obtaining much-needed information on the life history of these populations.**

To accomplish this, the objective of the study is to characterize the poorly-studied reproductive biology of US Atlantic *S tiburo* and compare it to that of well-studied Gulf populations of this species. Male and female bonnetheads are collected monthly over a year's time from South Carolina to Florida waters. Reproductive stage is being assessed using morphological, histological, and endocrinological analyses. Size of reproductive organs such as the testis and epididymis in males, and ovaries and reproductive tract components in females are measured to identify important stages of reproduction such as gametogenesis. Histological analyses of reproductive tract components are used to confirm these stages as well as identify other important stages in the reproductive cycle, such as sperm storage in females. Plasma sex steroid hormone concentrations will be determined as well to further corroborate these reproductive patterns. The data obtained in this study will be compared to reproductive information previously characterized for bonnethead shark populations from the Gulf of Mexico. Last, data will be provided to fishery managers to provide critical information about population growth in US Atlantic *S tiburo*.

Winter Flounder Habitat Use in New York/New Jersey Harbor and the Influence of Spring Temperatures on Subsequent Year Class Strength (Marine Fisheries Management and Ecology)

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Winter flounder (*Pseudopleuronectes americanus*), a commercially and recreationally important flatfish, use portions of New York/New Jersey Harbor as spawning, nursery, and foraging habitat. Dredging to maintain and deepen shipping channels within the harbor may affect winter flounder, which is experiencing a dramatic inshore fishery decline. Because mortality rates associated with early life history stages may strongly influence fish recruitment processes, protecting winter flounder eggs and larvae from dredging impacts is important to local population recovery. Knowledge of local habitat use is needed for

management practices, such as seasonal dredging restrictions, to be effective. We examined winter flounder habitat use in New York / New Jersey Harbor through long-term (2002-2010) bottom trawl and ichthyoplankton sampling programs. Interannual variability in catch-per-unit-effort (CPUE) primarily was attributable to fluctuations in Year-1 juvenile CPUE, which was positively correlated with total annual egg abundances from the previous year. Adult male CPUE during the spawning season was positively correlated with total egg abundances of the same year, whereas adult female CPUE was unrelated to annual egg abundances in the harbor. Annual variation in adult male densities in the harbor during the spawning season reflects the intensity of estuarine spawning activity, whereas adult female densities may include non-reproductive, foraging individuals. Seasonal fluctuations in condition indices reflected energy use during the spawning season, with relatively high condition in January, reduced levels in March and April, and elevated condition again in May. Adult CPUE peaked in April, coincident with the critical feeding period that follows spawning. Mean April water temperatures were positively correlated with egg abundances the following year and Year-1 juvenile CPUE two years later. A similar correlation between April temperatures and Year-1 juvenile abundances two years later was demonstrated using published data for winter flounder collected in Niantic Bay, CT. Higher April water temperatures may enhance benthic secondary production during the critical feeding period, and thus increase prey availability for foraging adults that need to restore energy reserves in order to reproduce the following year.

Population Size Structure, Age Structure, and Growth of the Invasive Lionfish (*Pterois volitans*) in the Coastal Waters of Eastern Florida (Marine Fisheries Management and Ecology)

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The Indo-Pacific lionfish (*Pterois volitans*) is an established predatory marine invader in the western Atlantic, Gulf of Mexico, and Caribbean Sea. There is a growing database suggesting lionfish are having substantial negative impacts on native ecosystem structure (Albins and Hixon 2008, Green et al 2012); however, scientific investigations on the impacts of lionfish have been focused predominantly in tropical ecosystems, and research focused between south Florida and North Carolina is largely absent. Generally, fish life history parameters, especially growth rates, vary with a suite of environmental (ie, temperature), biological and ecological (ie, prey availability) factors; as a result, the population dynamics of lionfish will vary regionally and among ecosystems. To achieve baseline population data on lionfish in a new biogeographical region, approximately 1,500 lionfish have been caught off the coasts of northeast and southeast Florida. Seasonal von Bertalanffy growth curves were fitted to length frequency data of the northeastern fish, which were caught in April and August of 2013, revealing both higher growth rates than previously reported in other regions and a distinct bimodal population representative of seasonal reproduction, which is previously unreported for this species. Growth curves will be fitted to southeastern fish caught in September of 2013, as a comparison of growth in the two different ecosystems. Analysis of sagittal otoliths of fish from both regions is ongoing and will be used to validate age and in growth modeling, and make comparisons between fish from different biogeographical regions. This project will provide localized population structure, growth, and reproduction information necessary to managers attempting to mitigate their ecological impacts in this region.

Potential Impacts of a Non-Native Piscivore, the Pike Killifish, on Juvenile Common Snook (Marine Fisheries Management and Ecology)

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Pike killifish is an established non-native fish species in Florida that is found in both fresh and estuarine waters. It was first established in south Florida in 1957 with a secondary establishment occurring in the Tampa Bay area in 1994. Negative ecological impacts, related to decreases in small-bodied fish abundances, have been linked to pike killifish in both of these regions. Recent increases in the range and abundance of pike killifish in Tampa Bay and overlap in habitat usage has led to concerns about potential competition with, and predation on, early-juvenile common snook (<150 mm SL), which is the focus of this study. Potential competition is being investigated by comparing growth, condition, and diet of early-juvenile snook from invaded and un-invaded waters; by investigating the overlap in diet of the two species; by comparing the relative abundance of prey items from waters with and without pike killifish present; by comparing the growth of early-juvenile snook in enclosures with and without pike killifish co-occurring; and by video-recording space utilization and interactions of early-juvenile snook and pike killifish in mesocosms. Stomach contents of pike killifish will be examined for snook remains as evidence of predation, and predation trials will examine what size snook are vulnerable to predation by pike killifish. This study should indicate whether pike killifish have an ecological impact on early-juvenile snook, which could result in reduced population sizes or delayed recovery of snook stocks and may need to be incorporated into future snook stock assessments. Research is ongoing, but some preliminary evidence suggests that pike killifish may only exert minimal negative impacts on early-juvenile snook. The mean growth of snook in experimental enclosures with pike killifish present (6 snook/6 pike killifish) did not differ significantly from their growth in enclosures without pike killifish present, and although the difference was not significant their mean growth in enclosures with an increased density of snook (12 snook) was less than both the pike killifish and the control (6 snook) treatments, indicating that intraspecific interactions between snook may be greater than interspecific interactions with pike killifish. Preliminary analysis of pike killifish stomach contents and predation trials suggest that large adult (≥ 90 mm SL) pike killifish are capable of consuming snook up to approximately (50 mm SL) in lab conditions, but in the wild they may rarely consume snook (1 snook found in 128 pike killifish stomachs examined to date).

Establishing Field-Based Evidence for the Effects of Hypoxia on the Reproductive Capacity of Chesapeake Bay Fishes (Marine Fisheries Management and Ecology)

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The spatial and temporal extent of summer hypoxia (dissolved oxygen < 2 mg L⁻¹) in Chesapeake Bay and its tributaries is increasing, and the effects on aquatic resources vary depending on timing and duration of hypoxic events. Hypoxia has been shown to affect fish distribution by shifting biomass to normoxic regions, which may result in increased competition for resources or reduced energetic intake due to lower prey quality in newly inhabited areas. Additionally, laboratory studies indicate that hypoxia directly affects reproductive capacity of fishes by altering endocrine function, and reducing gonadal development. Atlantic Croaker (*Micropogonias undulatus*), which use estuarine habitats in Chesapeake Bay during summer to grow and prepare for spawning, may be vulnerable to reduction in feeding habitats and may also suffer from exposure to hypoxia and subsequent endocrine disruption. In this study, we examined the effects of hypoxia on fish energy content to assess impacts on lipid accumulation and

storage in different tissues by comparing the response of fish from three Chesapeake Bay tributaries with unique dissolved oxygen dynamics during summer Atlantic Croaker were collected by bottom trawl from three tidal tributaries in Virginia characterized by different levels of summertime hypoxia: no hypoxia (James River), periodic hypoxia (York River), and chronic hypoxia (Rappahannock River) We compared the proximate composition of somatic and gonadal tissues of females collected in spring (before hypoxia) and summer (during hypoxia) to evaluate the effects of hypoxia on lipid storage and reproductive potential Not surprisingly, we observed a shift in fish distribution above and below the region of hypoxia; as we hypothesized, the ability of Atlantic Croaker to accumulate lipids in tissues varied depending on presumed hypoxia exposure The lipid content of fish tissue was related to the severity of hypoxia such that lipid content of somatic and gonadal tissues increased under normoxic to periodic-hypoxic conditions Under chronic levels of hypoxia, somatic and gonadal tissues accumulated fewer lipids, likely reducing reproductive output that year This field-based approach can be applied to other fishes that use estuarine habitats during summer to assess the sublethal effects of hypoxia on reproductive potential

Reproduction of Pelagic Fishes in the Northern Gulf of Mexico (Marine Fisheries Management and Ecology)

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Large pelagic fishes, such as species in the families Scombridae, Istiophoridae, Rachycentridae, Coryphaenidae, and Carangidae, support important commercial and/or recreational fisheries in the northern Gulf of Mexico (nGOM) Most of these species are highly migratory, and little is known regarding the biology of many of these fishes in the nGOM, although data may be available for other regions In particular, information on the reproductive biology of large pelagic fishes in the nGOM is lacking This presentation will review available data on the reproduction of seven commonly occurring nGOM large pelagic species: Bluefin Tuna (*Thunnus thynnus*), Yellowfin Tuna (*Thunnus albacares*), Wahoo (*Acanthocybium solandri*), King Mackerel (*Scomberomorus cavalla*), Cobia (*Rachycentron canadum*), Blue Marlin (*Makaira nigricans*) and Greater Amberjack (*Seriola dumerili*); no data are available for other large pelagics in the region All exhibit asynchronous, indeterminate oocyte development and are batch spawners The spawning season occurs in spring-summer for all species, and ranges from 2 months (Blue Marlin, July-August) to 6 months (Cobia, April-September) Bluefin Tuna (April-June), King Mackerel (May-July) and Greater Amberjack (April-June) all have a 3 month spawning season, Wahoo has a 4 month season (May-August) and Yellowfin Tuna spawn for 5 months (May-September) However, it has been suggested that individuals of some large pelagic species do not spawn annually in the nGOM For those species with a known spawning frequency, the majority spawn every 4-5 days (Wahoo, King Mackerel, Cobia, Greater Amberjack), but Yellowfin Tuna spawns every 116 days, although there is no evidence of daily spawning Relative batch fecundity is only known for three species (577 eggs/g for Wahoo, 140 eggs/g for King Mackerel and 53 eggs/g for Cobia) Size at 50% maturity has not been reported for any of these species, although King Mackerel and Greater Amberjack are thought to reach 50% maturity at age 3 Available data suggest similar reproductive life history strategies for nGOM large pelagics, but more information is necessary to understand the reproductive contribution of these species and to develop better fishery management plans

Fecundity Pattern of Gray Triggerfish, *Balistes Capriscus* (Marine Fisheries Management and Ecology)

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It is difficult to discern the spawning strategy of gray triggerfish (*Balistes capriscus*) in terms of energy allocation and pattern of oocyte development. Of 4 studies including over 2000 histology samples, only 2 spawning females were detected. From our laboratory archive of 560 ovarian histology samples only 31 exhibited postovulatory follicles. Therefore, the traditional fecundity method for indeterminate spawners cannot be applied to this species. In addition, nesting and parental care by triggerfish suggests that fecundity pattern may be determinate in line with other species displaying these behaviors. To test fecundity pattern, ovaries from multiple years were analyzed for oocyte diameter, development type and growth rate. These measures were obtained through image analysis of ovarian histology and tissue whole mounts. According to pertinent literature, determinacy can be proven by three criteria: a hiatus in development between primary and secondary oocytes, a decreasing number of secondary oocytes, and an increase in secondary oocyte diameter as the season progresses. Gray triggerfish fulfilled only one of these requirements, developing a distinct size hiatus between primary and secondary oocytes typical of a group synchronous pattern. No pattern was discerned from the number ($R^2 = 0.0756$, $p < 0.05$) or diameter ($R^2 = 0.0514$, $p > 0.05$) of vitellogenic oocytes through the spawning season, suggesting that fecundity is indeterminate. In addition, females were noted to carry secondary oocytes from May to August; a duration of time that indicates individual females are likely to spawn multiple times. Analysis of oocyte growth rate, interspawning interval and potential fecundity is being completed for comparison with other species.

Design and Maintenance Considerations for an Offshore Acoustic Array Deployed off Cape Hatteras, North Carolina (Marine Fisheries Management and Ecology)

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The use of acoustic arrays to study the migration patterns of marine fish moving through open ocean habitats has become more practical with the development of regional and international data-sharing networks; however there are special design considerations that must be taken into account when deploying these systems in open-ocean environments. Long-term deployment and retrieval of acoustic receivers can provide a significant logistical challenge, especially in deeper waters of the continental shelf. Starting in 2009, East Carolina University has maintained an acoustic array in the Hatteras Bight of coastal North Carolina, which extends ten miles seaward of Hatteras, North Carolina. We tested, developed, and modified a successful offshore acoustic array system that has provided valuable behavioral data on elasmobranchs (*ie*, spiny dogfish, sand tiger shark, sandbar shark, white shark, cownose rays and spiny butterfly rays) and finfish (Atlantic sturgeon, hickory shad, and American shad). We provide recommendations on array design and maintenance that are durable enough to withstand nor'easters, hurricanes, extreme rates of sediment deposition, strong current flow, and heavy vessel traffic.

Assessing Cobia (*Rachycentron canadum*) Population Structure Using Tag-Recapture and Genetic Data (Marine Fisheries Management and Ecology)

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Cobia is a recreationally-important species that has been documented to undertake long distance seasonal migrations between annual spawning and overwintering grounds. Cobia has traditionally been managed as South Atlantic and Gulf of Mexico stocks, with the division occurring at the Monroe/Dade County line in South Florida. Cobia movement, distribution, and stock boundaries in the South Atlantic and the Gulf of Mexico were evaluated using conventional tag-recapture information and genetic analysis. Five datasets from tagging studies conducted throughout the South Atlantic and Gulf of Mexico were pooled to provide recapture information (n=1,406) on cobia seasonal migrations and site fidelity. Recapture data were partitioned by region of original tagging with special emphasis placed on the Atlantic Coast of Florida and Florida Keys, where the Atlantic/Gulf stock boundary was theorized to occur. Cobia from each dataset were tagged over similar time periods with methodologies that were not appreciably different between programs. Of the recaptures, only 15% (n=4) tagged north of Florida occurred in the Gulf of Mexico and only 05% (n=5) tagged in the Gulf occurred north of Florida. Recaptures of fish tagged off Brevard County (Cape Canaveral) occurred throughout the South Atlantic and Gulf from New Jersey to Texas. Although the Florida Keys have been theorized to serve as a mixing zone between Atlantic and Gulf populations, no fish tagged in the Florida Keys were recaptured north of Florida and no fish tagged north of Florida were recaptured in the Florida Keys. Fish tagged during the spawning season in the South Atlantic exhibited strong annual site fidelity. Additionally, genetic samples collected during the spawning season from Chesapeake Bay to Port Aransas, TX (n=1,461) were genotyped at 10 microsatellite loci to evaluate population structure throughout that range. Samples collected in Southeast Florida (Port St Lucie) and the Florida Keys were genetically homogeneous with samples collected throughout the Gulf. Samples collected offshore of North and South Carolina differed from those collected throughout Southeast Florida and the Gulf of Mexico, indicating population structure between the two regions. Samples collected in inshore South Carolina and the Chesapeake Bay were genetically different from each other and all other locations, suggesting localized discrete population segments. Both the tagging and genetics data suggest a stock break that occurs somewhere around Brevard County, FL as opposed to the traditional management boundary of the Florida Keys.

Determining the Trophic Structure and Underlying Nutrient Source Dynamics of an Estuarine Predator, *Cynoscion nebulosus*, in a River Dominated Estuary (Marine Fisheries Management and Ecology)

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Apalachicola Bay, located in the panhandle of northwest Florida, is one of the most productive estuaries in the northern hemisphere. The Bay has an extensive network of seagrass beds, brackish water sub-aquatic vegetation, oyster reefs, and saltmarshes which are thought to provide food resources and predation refuge for several ecologically and economically important marine species. While prior studies have investigated the spatial and trophic dynamics of estuarine fish communities in Apalachicola Bay and other estuaries, few have included piscivores that occupy the highest trophic levels in the system. By combining $\delta^{13}\text{C}$, ^{15}N and ^{34}S stable isotope analysis and gut content analysis we aim to: (1) determine the

relative importance of different sources of organic carbon (seagrass, saltmarsh vegetation, terrestrial detritus, phytoplankton) underlying the productivity of seatrout in Apalachicola Bay, and (2) investigate how diet and trophic level of seatrout varies spatially in relation to habitat type and seasonally in relation to variation in river flow Preliminary $\delta^{13}\text{C}$ and ^{34}S isotopic data suggest that seatrout inhabiting the freshwater dominated regions of the bay are supported via a plankton based food web while seatrout occupying the more saline lower regions of the bay rely more heavily on benthically derived carbon sources such as seagrass and macroalgae While the relative importance of differing carbon sources varied spatially, these observed patterns appeared unaffected by seasonal changes in river flow, potentially due to unusually low flow rates during the study Throughout all regions of the bay, $\delta^{15}\text{N}$ isotope and diet data suggest seatrout undergo an ontogenetic shift in diet of mostly decapod crustaceans as juveniles to a diet of mostly finfish as adults This study marks the first attempt to delineate the sources of primary productivity supporting an apex predator within Apalachicola Bay across spatial, temporal and ontogenetic time scales

Population Dynamics in Fishes

Contribution of Stocked Sauger to the Broodstock Population in RS Kerr Reservoir on the Arkansas River Navigation System; A Final Report and Management Implications (Population Dynamics in Fishes)

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Abstract- Over the last few decades, the relative importance of sauger *Stizostedion canadense* has increased in Oklahoma This is due to the popularity of the Oklahoma Department of Wildlife Conservation's (ODWC) saugeye *Stizostedion vitreum* x *Stizostedion canadense* stocking program and more anglers discovering that sauger make excellent table fare Sauger are native to Oklahoma, found in the Poteau, Illinois, Red, Neosho, and Arkansas Rivers Although populations appear stable, several threats to successful recruitment exist Construction of the McClellan-Kerr Arkansas River Navigation System in the 1970's destroyed the sauger's natural spawning habitat ODWC stocked sauger fingerlings in the Arkansas River from 2000 to 2002 to augment population size, but these stockings were never formally evaluated In 2010, 280,000 sauger fry and 88,000 fingerlings were marked with oxytetracycline (OTC) and stocked into RS Kerr Reservoir The process was repeated in 2012 with 172,000 fry and 27,000 fingerlings Post-stocking electrofishing, and rod and reel sampling was performed in RS Kerr Reservoir Otoliths were removed from 135 age-1 sauger in 2011, 57 age-2 sauger in 2012, and 3 age-1 sauger in 2013 Otoliths were checked for OTC marks by the Oklahoma Fisheries Research Lab Results from this study will indicate to what degree fingerling stocking impacts the sauger population and whether continued stocking is justified

Reducing Menhaden? a Data Review Investigating Population Changes off of Georgia's Coast (Population Dynamics in Fishes)

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The Atlantic menhaden, *Brevoortia tyrannus*, is migratory, schooling fish with a range that extends south to the tip of Florida and north into the Gulf of Maine. They are an ecologically important link between primary producers and larger consumers. Additionally, because of the high oil content of their flesh, they are of particular interest as the basis for the East Coast's reduction fishery, which is located in Virginia. Over the last few decades, concerns have been raised that the reduction fishery is overharvesting, leading to a myriad of ecological perturbations. There is a wealth of data and published literature from the areas surrounding the reduction fishery, particularly the Mid-Atlantic States. These data indicate declines in the population and in recruitment. However, due to the lack of published data investigating these declines in the southern reaches of their home range, it is not clear whether these changes are consistent throughout *B. tyrannus*'s home range. The purpose of this project is to review existing local data sets to identify changes in the menhaden population off of Georgia's coast. The data sets used for this review are from Georgia Regents University, St. Catherine's Island Ichthyofaunal Studies from 1996-2012, and Coastal Resources Division of Georgia Department of Natural Resources, Ecological Monitoring Trawl Surveys from 1996-1998 and 2003-2012. Taken together, these data encompass the entire Georgia coast with sampling occurring at a variety of habitats, such as beaches, river, creeks, and sounds. Preliminary review of our data set suggests there are declines in adult populations. Further analysis is needed to be certain of the extent of decline and to address other changes in these populations.

Time Series Analysis of Indicator Species in the Cumberland River System (Population Dynamics in Fishes)

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Monitoring programs are frequently relied upon to support decisions on how to best manage for species sustainability. Quantifying the population dynamics of rare and elusive species (eg, threatened or endangered species), however, is a challenging process for both methodological and statistical reasons. Rare and elusive species, such as the federally threatened blackside dace (*Chrosomus Cumberlandensis*), often occur in low numbers and may also be behaviorally cryptic. As a result, surveys conducted to monitor abundance often produce data sets dominated by zero counts but containing some observations of high numbers. Applying traditional statistical approaches to zero-inflated data often requires data manipulation (eg, making zero observations positive), and violations of statistical assumptions can still occur. Here, we discuss some advantages and implications of modeling zero inflation, such as by using hurdle models or the zero-inflated Poisson model, without assumptions of normality. Overall, modeling abundance data is often of interest in relation to anthropogenic landscape transformation occurring over time (eg, surface coal mining, changing agricultural practices, and land development). We expect that zero-inflated mixed-models can provide advantages for modeling count data while also incorporating landscape-level predictor variables of interest. Currently, these approaches are being used to model abundance of blackside dace in relation to surface coal mining events in the Cumberland River system in Tennessee and Kentucky.

Genetic Population Structure of Black Drum (*Pogonias cromis*) in US Waters (Population Dynamics in Fishes)

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Black drum (*Pogonias cromis*) is an estuarine-dependent fish that supports important recreational and commercial fisheries throughout its range along US Atlantic and Gulf of Mexico coasts. A previous study examining genetic population structure of black drum, using mitochondrial DNA, reported distinct Gulf of Mexico and Atlantic stocks, although Atlantic samples were limited and collected from only one location (Chesapeake Bay). The current study is using nuclear microsatellite markers and fin clip samples collected from multiple locations along the Gulf of Mexico and western Atlantic to re-evaluate the stock structure of black drum and examine small scale spatial genetic population structure along the US Atlantic coast. As no microsatellite primers have been developed for black drum, spotted seatrout and red drum primers were screened, selected, and optimized for use with black drum. Six polymorphic loci were identified and used to genotype samples. Preliminary results suggest significant genetic differentiation between Gulf of Mexico and Atlantic samples, with possible fine-scale structure along the Atlantic coast. Additional samples will be processed from both regions that will further clarify emerging patterns. Data from the present study will prove useful for management and conservation of black drum, including accurate definition of geographic stock boundaries to determine appropriate management units. Increased knowledge of genetic population structure along the Atlantic coast may help determine how states should work together on implementing common management regulations, which currently vary from state to state.

Spatial and Seasonal Patterns of the Nearshore Fish Assemblage from Florida to New York, USA (Population Dynamics in Fishes)

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Understanding fish stock and community patterns across broad ecological gradients and between management zones requires a comparative approach integrating data from multiple sources. We utilized species and abundance data from two fishery-independent bottom trawl surveys, the Southeast Area Monitoring and Assessment Program – US South Atlantic (SEAMAP-SA) and the Northeast Area Monitoring and Assessment Program (NEAMAP), to characterize spatial and seasonal patterns of the nearshore US East Coast fish assemblage from Cape Canaveral, FL to Montauk, NY. Trawl data were limited to 2008–2012, spring and fall, and 4–12 m water depth. We used two multivariate statistical approaches, clustering (hierarchical agglomerative) and ordination (nonmetric multidimensional scaling), to characterize community composition patterns in space and time. Clustering allowed us to detect ecological breakpoints, while ordination allowed us to depict ecological gradients. Preliminary results indicate seasonally-dependent connectivity between management regions (South Atlantic and Mid-Atlantic). Notable inter-annual variability in spatial patterns reflects fluctuations in the relative biomasses and migration timing of abundant species. Relative contributions of individual species to cluster separations will be presented, as well as species correlations to ordination dimensions. Results highlight the dynamic nature of spatial and temporal patterns in nearshore fish community composition and will guide future species- and community-level modeling efforts aimed at determining environmental drivers that act to structure this diverse assemblage.

Molecular Hypothesis of Some Gulf of Mexico Myctophids (Population Dynamics in Fishes)

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Myctophidae (lanternfishes) represents one of the most abundant and diverse fish families in the world. Until recently, little molecular analysis on the family had been conducted, and none to date have incorporated any species from the Gulf of Mexico (GOM). Most myctophids undergo diel vertical migrations (DVM) although members of the Diaphini tribe (genera *Diaphus* and *Lobianchia*) occupy a group that has several species with DVM truncation. We use stomach contents and trophically transferred parasites to detect fishes that undergo DVM truncation. We also use two mitochondrial DNA regions to look for a phylogenetic component to the truncation. Myctophids were collected by bottom trawl from 2011-2012 by the NOAA R/V *Pisces*, examined for parasites, stomach contents identified, and sequenced the barcode region, cytochrome oxidase I (COI), and 12S ribosomal DNA (12S) of select fishes. Bayesian inference (BI) analysis was used to build phylogenetic trees of 5 species of *Diaphus* and *Symbolophorus rufinus* from the GOM, 14 and 7 previously accepted species belonging to the Diaphini tribe for COI and 12S, respectively, and 4 other myctophid species belonging to other tribes. BI analysis of the 12S was able to recover a monophyletic Diaphini tribe while the COI did not. *Symbolophorus rufinus* was sister to the other *Symbolophorus* used. Parasite and stomach content analyses suggested that larger specimens of *Diaphus dumerilii* and *Diaphus cf. rafinesquii* both exhibited DVM truncation. In both BI analyses, *D. dumerilii* was resolved as the outgroup to the other species of *Diaphus*. Bayesian inference analysis also suggests that most GOM species are closer to each other than to the other species of *Diaphus*. The ability to resolve any phylogenetic link of DVM truncation requires additional species to be analyzed and the use of additional gene regions.

Distribution and Abundance of the Bluntnose Flyingfish (*Prognichthys Occidentalis*) in the Northern Gulf of Mexico (Population Dynamics in Fishes)

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The aim of the present study is to characterize the distribution and abundance of larval *P. occidentalis* (family Exocoetidae) in the northern Gulf of Mexico. Here, we report on summer ichthyoplankton cruises conducted in the northern Gulf of Mexico (NGoM) from 2009 to 2011. Samples were collected using neuston nets towed through the upper meter of the water column in the outer shelf and slope waters of the NGoM. Over the three year sampling period, a total of 9,533 bluntnose flyingfish larvae were collected representing 77% of the total flyingfish catch collected. Interannual variation was detected with densities of *P. occidentalis* larvae higher in 2009 and 2010 (113 and 79 larvae 1000m⁻², respectively) than 2011 (19 larvae 1000m⁻²). *P. occidentalis* larvae were present in each month and year sampled, and percent frequency of occurrence ranged from 40% in July 2011 to 100% in June 2010, suggesting that bluntnose flyingfish represent a common and important component of the ichthyoplankton assemblage in the NGoM. Generalized additive models were used to evaluate the influence of oceanographic conditions on the density of *P. occidentalis*. Several environmental variables (longitude, sea surface height anomaly, distance to Loop Current, current velocity, and salinity) were found to significantly influence *P. occidentalis* distribution and retained in the final GAM model. Abundance of *P. occidentalis* larvae increased in waters associated with higher salinities and negative sea surface height, corresponding to frontal boundaries and cyclonic features in the NGoM. These areas typically have higher productivity because of upwelling, which may provide the larvae with more feeding opportunities.

Differential Growth within a Stock: A Case Study of Blueline Tilefish (Population Dynamics in Fishes)

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Environmental conditions and differential fishing pressures can cause variability in individual growth patterns across time and space. This variability could be attributable to factors such as different environmental conditions, food availability, habitat availability, and fishing pressures. Variation in growth can affect management practices as well as the productivity of a stock that is undergoing exploitation.

Blueline tilefish (*Caulolatilus microps*) are an offshore, demersal species that shows different growth patterns across temporal and spatial scales. They have been commercially and recreationally harvested since at least 1975 off the South Atlantic coast of the United States. Previous studies have shown changes in growth patterns over time within this region (Ross and Huntsman 1982, Harris et al 2004). However, in the early 2000s states in the Mid-Atlantic and New England also began catching blueline tilefish. Since then, increasing proportions of total commercial catches have come from Mid-Atlantic and New England states. We sampled blueline tilefish from the Mid-Atlantic and found that these fish exhibit larger sizes at age than fish from the South Atlantic.

Several mechanisms including differential fishing pressures and climate change effects could have impacts on this countergradient variation in growth. We investigated these mechanisms to determine how their impacts can be assessed and the likelihood of their influences on blueline tilefish. Different regional fishing regulations, fishery compositions, and historical harvests suggest that differential fishing pressures could be a main contributor to the observed spatial structure. Shifts in catch locations could also suggest northward range expansion. This behavior in other demersal species has been correlated with rising ocean temperatures associated with global climate change (Dulvy et al 2008).

Angler Exploitation of Stocked Rainbow Trout in Three Kentucky Urban Waters (Population Dynamics in Fishes)

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The Kentucky Department of Fish and Wildlife Resources recently conducted an exploitation study for a seasonal put-and-take rainbow trout fishery at three Fishing in Neighborhoods (FINs) lakes. These small impoundments are three of 39 lakes enrolled in the urban fishing program. Lakes enrolled in the FINs program are stocked with catchable size rainbow trout in November, January and March. Angler catch, exploitation and temporal patterns were determined with a tag reward exploitation study. Press releases were sent out to local newspapers and signs posted around the lakes to notify anglers of the tagging study. All anglers who returned a tag received a rainbow trout pewter pin and were entered into monthly cash drawing for prizes ranging from \$10 to \$100. Two-hundred rainbow trout were tagged in November, February and March for each lake with Floy anchor t-bar tags. Nearly 25% of the trout were double tagged to account for tag loss. The tag would be assumed to be lost if an angler returned only one tag from a double tagged fish. Tag loss ranged from 5% to 7% at the three lakes. A concurrent creel survey was used to estimate non-reporting by having a creel clerk surreptitiously record the tag number of caught tagged fish while recording the angler's catch. If the observed tag was not returned it was accounted for in a non-reporting estimate. Non-reporting of tagged fish ranged from 0% to 8% at the three lakes. Tagging mortality was assumed to be 0% as trout were held for the mandatory 21-d holding period at the hatchery after sedation with MS222. The median number of days at large after stocking ranged from 16 to 23 days for tagged trout at the three lakes. Corrected exploitation rates were highly variable among the three lakes.

ranging from 28% to 75% Corrected catch rates at all three lakes exceeded 80% of stocked trout (82% to 88%) Stocked trout appear to be highly susceptible to angling and utilized by anglers at these FINs lakes The size of stocked trout was similar all three months and at all three lakes No differences were observed in harvest rates based on fish size However, judging from data from a concurrent creel survey the harvest rate was likely higher than the exploitation study indicates The tag was removed the first time the fish was caught, but many fish are likely caught multiple times before ultimately being harvested

Stargazing Darter, *Percina Uranidea* (Jordan and Gilbert): The Search for a Species in Decline (Population Dynamics in Fishes)

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The Stargazing Darter, *Percina uranidea* (Jordan and Gilbert), has experienced habitat loss and population declines throughout its range The species has been extirpated from the Wabash River system of Illinois and Indiana, and is considered rare in Missouri The species persists as two geographically separated subpopulations, one in the Ouachita River basin of south Arkansas and another in the White River basin of northern Arkansas and southern Missouri The southern population has been documented in the Saline and Ouachita rivers, and the lower sections of the Little Missouri River and Moro Creek Recent sampling revealed low catch rates in the Ouachita River, but no individuals were collected from the Saline River since 2001, despite extensive efforts In this study we sought to update the species' status in Arkansas and examine the apparent decline of the Saline River population Samples were conducted using a mini Missouri trawl or a mini beam trawl in an effort to more effectively sample deep gravel and cobble runs Sixteen sites were sampled in the Saline River, and comparison sites were sampled in the Ouachita (9 sites), Current (3 sites), Black (1 site), and Eleven Point (2 sites) rivers *P. uranidea* were collected from the Current (n=53), Black (n=4), Ouachita (n=1), and Saline (n=3) rivers While this confirms that the species persists in the Saline River, catch rates were very low across the southern subpopulation's range We recommend continued efforts to understand the decline of this subpopulation, which was historically much more abundant, and to protect and restore habitat in these rivers

Movement and Habitat Use of Alligator Gar in Escambia River Florida (Population Dynamics in Fishes)

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The population status of alligator gar *Atractosteus spatula* in Florida is currently unknown, but is thought to be declining throughout its historical range Harvest of this species in Florida was prohibited in 2006; however abundance estimates are needed to assess this suspected decline in population size Therefore, a project was initiated to examine habitat use, movement, and home range of alligator gar in the Escambia River Twenty-two alligator gar (TL range: 93 to 190 cm) were captured in gill nets and tagged with external transmitters Long-term movement and habitat data were collected by active day-time tracking and passive tracking via fixed station receivers Arrays of fixed station receivers collected data continuously for 24 hours and were used to estimate short-term movement and habitat information

Preliminary findings indicate alligator gar tend to use main-stem river habitat during the daytime period in summer months Conversely, alligator gar use oxbow habitat at night during the summer months and spend most of their time in this habitat during winter months Movement appears to be related to surface water temperature and season Alligator gar move little during winter, but become highly mobile during late spring and summer Understanding movement patterns and habitat use could lead to increased catch; making an accurate estimate of abundance possible This information will be helpful in assessing the status of alligator gar in Florida and ultimately re-evaluating the current regulation

An Episodic Drought Drives Unpredictable and Persistent Changes to a Floodplain Prey Subsidy Consumed By Subtropical River Fishes (Population Dynamics in Fishes)

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In the tropics and subtropics, maintaining natural hydrologic connections between rivers and adjacent ephemeral floodplains is critical to conserving and sustaining high levels of fisheries production within these systems In these regions, periods of heavy rainfall cause rivers to swell, inundating more productive floodplains The inundation of these floodplains provide high allochthonous food availability, critical to the successful growth and reproduction of exploited river fishes

Extreme and episodic droughts may alter these floodplain and trophic connections by reducing the duration that floodplains are inundated, potentially resetting floodplain communities that subsidize river fishes The resetting floodplain communities may then have persistent impacts on the magnitude of these subsidies, while floodplain trophic structure returns to pre-disturbance conditions Yet, the role that extreme and episodic droughts play in dictating floodplain subsidy dynamics remains understudied

In 2011, an episodic drought impacted coastal rivers in the southern Everglades, substantially reducing inundation patterns in surrounding marsh floodplains This drought likely altered marsh fish communities that function as important seasonal prey subsidies to snook (*Centropomus undecimalis*) in adjacent coastal rivers Thus, our research objectives were to test 1) whether or not the episodic drought altered marsh floodplain subsidies to snook and 2) document the legacy of the drought and thus recovery trajectory of these prey subsidies From 2010 to 2013, we sampled monthly abundances and diets of fishes within the Everglades floodplain-river interface We predicted that immediately after the drought, subsidies would be reduced as floodplain communities were heavily impacted by the disturbance The following year, we predicted that due to the slower recovery of floodplain top predators, smaller prey, most notably centrarchids, that function as the subsidy would experience a predation release, increasing the magnitude of the subsidy to riverine snook Our results show that one year after the drought in 2012, floodplain sunfish subsidies were largely absent, and subsequently very little sunfish biomass was consumed Two years after the drought, the biomass of sunfishes entering the coastal river tripled relative to pre-drought conditions, but sunfish biomass was differently packaged, such that the average body size of sunfish prey doubled Despite the increased magnitude of sunfish biomass, the consumption of this floodplain subsidy did not differ from pre-disturbance conditions With increases in the frequency of climate extremes, we may expect floodplain subsidies to become less predictable, which will likely alter their role in provisioning important riverine fisheries

Fish Physiology and Ecosystems

Behavior and Temperature Tolerance of Invasive Rio Grande Cichlids (*Herichthys cyanoguttatus*) and Native Bluegill (*Lepomis macrochirus*) in a Simulated Outdoor Canal Mesocosm (Fish Physiology and Ecosystems)

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The Rio Grande cichlid (*Herichthys cyanoguttatus*) is an invasive species in Louisiana that was introduced to the Greater New Orleans Metropolitan Area (GNOMA) some 20-30 years ago and has spread to both natural and artificial bodies of water. In recent years, a decrease in *H. cyanoguttatus* populations has been observed during particularly frigid winters in GNOMA, while bluegill (*Lepomis macrochirus*) populations appear stable. We designed a study to focus on the behavior and level of activity of both species in an artificial system during periods of extreme cold. We built an outdoor pond (4m by 16 m by 06 m), with one third of its area sheltered by a simulated culvert, to simulate a canal within the GNOMA. A two-antenna PIT tag array was placed between the culvert and the open areas of the pond, with PIT tags inserted into 10 bluegill and 11 cichlids. Level of activity was measured by recording the average number of tag readings for each fish each day. Preliminary analysis shows that cichlids survived and were active at temperatures as low as 7 C. Both cichlids and bluegill were equally active at all temperatures, even below 10 C, and both species increased in activity with higher temperatures ($p < 0001$), although bluegill did not increase their activity levels from 13 to 16 C. Results of this study will provide important information on the growing range of temperature tolerance and wintertime activity in the invasive Rio Grande cichlids of GNOMA.

Food Habits of Blue Catfish (*Ictalurus furcatus*) Introduced into Lake Oconee, Georgia (Fish Physiology and Ecosystems)

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Blue Catfish (*Ictalurus furcatus*) are an important commercial and recreational species and are used widely for predator-control purposes within the United States; as a result, it has been introduced widely throughout the country. Because of its widespread introduction, there is a potential for this species to have negative effects on native aquatic communities. Blue Catfish are native to the Coosa river drainage in northwest Georgia, but recently have been discovered outside of this range. Blue Catfish were first discovered in Lake Oconee in 1997. In Lake Oconee, their abundance and growth rates have increased dramatically, but their food habits are unknown. Therefore, food habits of Blue Catfish were determined by examining the stomachs of 808 specimens from Lake Oconee's upper and lower regions during all seasons beginning in summer 2012. Stomach contents were analyzed using the Index of Relative Importance, which was calculated by determining the frequency of occurrence, percent composition by weight, and percent composition by number of each prey item. The dominant prey item during the summer was Asian Clams (*Corbicula fluminea*; 98%). Dominant prey items for the fall season shifted to a more diverse array of prey items including Asian Clams (46%), Mayflies (Ephemeroptera; 23%), Flies

(Diptera; 16%), and Threadfin Shad (*Dorsoma petenense*; 15%) Winter dominant prey items shifted to Mayflies (45%), Threadfin Shad (35%), and Asian Clams (16%) Mayflies (84%) dominated the spring prey diet The upper region fish relied heavily on Asian Clams (48%) and lower region fish relied on Mayflies (36%) The results show that the diet of introduced Blue Catfish in Lake Oconee, Georgia, is omnivorous More importantly, the results also show that they are not preying intensely on native bivalves and fish species They actually feed intensively on the invasive Asian Clam during the summer and fall seasons This finding is important because it demonstrated that introduced Blue Catfish are helping to control another non-native invasive species However, the competitive interaction between Blue Catfish and other native species is unknown For example, Blue Catfish may be out-competing other species such as the White Catfish (*Ictalurus catus*) and the Channel Catfish (*Ictalurus punctatus*), whose populations have plummeted with the introduction of Blue Catfish Future research focusing on the competitive interactions between Blue Catfish and White Catfish and Channel Catfish will be helpful in understanding the trophic dynamics among these native and introduced ictalurids

Assessing Stocking Efficacy of Sauger Using Genetic Markers and Evaluating Their Movement and Mortality in the Cumberland River in Tennessee (Fish Physiology and Ecosystems)

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Sauger *Sander canadense* in the tailwaters of several Tennessee impoundments represent the largest percid fisheries in the southeast USA However, declining Sauger populations have been evident since historical spawning migrations were blocked by dams The Tennessee Wildlife Resources Agency annually stocks Sauger to augment recruitment, but little is known about the success of the stocking program or the spawning movements of adults in the Cumberland River Because Saugers are seasonally very vulnerable to anglers in tailwaters, it is important to evaluate the population-level effects of catch-and-release (CR) mortality The objectives of this research are to (1) assess the efficacy of the Sauger stocking program, (2) describe the spawning migration of Saugers in the Cumberland River, and (3) estimate the instantaneous rate of CR and harvest mortality Fin clips were collected from all Sauger broodstock during the 2012 and 2013 spawning seasons and their progeny were stocked into Old Hickory Lake Age-1 Sauger were captured December-March using experimental gillnets and fin clips were collected from all young-of-year fish for genetic analysis of microsatellite loci to identify their natal origin (ie, hatchery or wild) To assess spawning movements, Saugers have been implanted with radio transmitters in early winter and tracked weekly throughout the spawning season To estimate the instantaneous mortality rate associated with CR fishing, Saugers implanted with radio transmitters are also tagged with an external high-reward (\$100) tag Tag-return data on telemetered individuals will allow the estimation of catch rates, release rates, and CR mortality for released fish

Hypo-Osmotic Tolerance of Juvenile Gulf Killifish (Fish Physiology and Ecosystems)

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Gulf killifish *Fundulus grandis* are a euryhaline fish species native to coastal estuaries of the Gulf of Mexico This species is a popular baitfish and could help diversify aquaculture production in the southeastern US In order to make inland culture feasible, this research has focused on the challenges posed by low salinity on killifish culture and the physiological changes that affect killifish performance in

hypo-osmotic conditions In an initial experiment, embryo and larval performance criteria were measured for air incubated eggs and larvae up to 2 weeks post-hatch in either 0ppt, 7ppt, or a sequential combination of these salinities Survival and growth of both the embryos and larvae were better in 7ppt conditions than freshwater conditions, leading to the hypothesis that Gulf killifish hypo-osmotic tolerance may improve at a later age In the second experiment, killifish were challenged with low salinity treatments of 0, 25, 5, and 75 ppt at 2, 7, and 12 weeks post-hatch for four weeks to determine growth, survival, gill Na⁺, K⁺-ATPase activity, and whole body ion content Samples were taken after 2, 14, and 28 days post-transfer for each age group Preliminary results indicate Gulf killifish at two weeks post-hatch grew and survived as well at 25 ppt as at higher salinities but growth was reduced in freshwater At 7 weeks post-hatch, freshwater survival and growth rates were comparable to other salinity treatments These results suggest low salinity levels are feasible for killifish culture, and stocking of freshwater ponds may be most successful at 7 weeks post-hatch

The Effects of Pre-Release Anthropogenic Stressors and Subsequent Stress Response on Post-Release Success of Hatchery Reared Spotted Seatrout (Fish Physiology and Ecosystems)

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Alteration of habitat associated with coastal development and increased demand for food and recreation can result in the depletion of fisheries resources such as the spotted seatrout (*Cynoscion nebulosus*), the Gulf of Mexico's most popular recreational fish Stock enhancement, or the release of cultured fish to supplement wild populations, is one potential tool for managing important fisheries resources Although large efforts have been put into the enhancement of some marine species, the effectiveness of stocking is not well understood and techniques for ensuring success have not been well developed Studies have shown that hatchery environments can affect many fundamentally learned behaviors; however the role that stress associated with handling, transport, and release processes may play in the success or failure of spotted seatrout stock enhancement is unknown My research is focused on the impacts of physiological anthropogenic stressors and the subsequent stress response to growth and survival upon release for stock supplementation

Gene Expression Accurately Reflects Fertility in Striped Bass (Fish Physiology and Ecosystems)

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In 2009, we modeled profiles of maternal ovary gene expression and their relationship to egg quality, evaluated as production of viable mid-blastula stage embryos, in domestic striped bass (*Morone saxatilis*) using artificial neural networks and supervised machine learning Collective changes in expression of a limited suite of genes (233) representing <2% of the queried ovary transcriptome explained >90% of the eventual variance in embryo survival Egg quality related to minor changes in gene expression (<02-fold), with most individual transcripts making a negligible contribution (<1%) to the overall prediction of egg quality In 2012 we repeated this survey using domestic and wild striped bass finding that the previous results could be replicated and extended to the fertility of wild stocks with remarkable precision (ca 95%) Correlation analyses of this suite of candidate genes indicated that collective dysfunction of the ubiquitin-26S proteasome, COP9 signalosome, and subsequent control of the cell cycle engenders embryonic developmental incompetence in striped bass Our results show that the

transcriptomic fingerprint evidencing this dysfunction is highly predictive of, and therefore likely to determine, egg quality, a biologically complex trait crucial to reproductive fitness. The ability to extend the results from domesticated fish to wild stocks has important implications for fishery management as they indicate clear differences in the fertility of individuals whose eggs are morphologically indistinguishable.

Initial Infection of Young of Year (glass eels) American Eel (*Anguilla rostrata*) By the Invasive Swimbladder Parasite, *Anguillicoloides Crassus* (Fish Physiology and Ecosystems)

Jennifer L Hein*, South Carolina Department of Natural Resources, Isaure de Buron, College of Charleston, Bill C Post, South Carolina Department of Natural Resources, William A Roumillat, South Carolina Department of Natural Resources and Stephen A Arnott, South Carolina Department of Natural Resources

This study was designed to investigate the infection of American eel (*Anguilla rostrata*) elvers and glass eels (young of year) by an invasive nematode parasite, *Anguillicoloides crassus*. The primary objective of the study was to determine when young eels, migrating to freshwaters, first showed parasites in their swimbladder. Elvers (71-156 mm) and glass eels (34-78mm) were sampled monthly from March to September 2013 (n = 379) from the Goose Creek Reservoir dam, South Carolina. Prevalence of infection was 68% for elvers (n = 136) and 7% for glass eels (n = 243). Prevalence by eel pigmentation stage was analyzed and showed a positive correlation between prevalence and pigmentation stage, and no apparent infection occurred until eels developed at least halfway through the pigmentation stages. No monthly variation in infection occurred in elvers. However, *A. crassus* prevalence in glass eels was very low (average = 2%; n = 190) during spring months (March, April, May) but escalated to 21 % (n = 61) in the summer months (June, July, August). The increase in prevalence over the summer may be indicative of a combination of various factors likely acting in synergy including a potential diet shift in glass eels, a faster feeding rate, an increase in intermediate host availability, as well as the possible formation of an 'infection hot spot' due to the aggregation of parasitized eels below the dam.

Density of Resident Fishes Among Variably-Altered North Carolina Saltmarsh Creeks (Fish Physiology and Ecosystems)

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Anthropogenic alterations to saltmarsh watersheds along the US south Atlantic coast can impact the production of common resident taxa. We deployed a 1 m² throw trap monthly in summers 2012 and 2013 in the vegetated portions of five variably-altered saltmarsh creeks in coastal North Carolina to compare the density of resident macrofauna: mummichog *Fundulus heteroclitus*, mosquitofish *Gambusia holbrooki*, sheepshead minnow *Cyprinodon variegatus*, and grass shrimp *Palaemonetes* spp. For each species, the relationship between density and a combination of biotic and abiotic variables was examined using Poisson-distributed generalized linear models (GLMs). Model parsimony was evaluated using Akaike Information Criteria (AIC). The GLM that best fit the data (lowest AIC score) for each species included creek as an explanatory variable. Salinity, depth, and percent coverage of *Spartina alterniflora*

were additional factors that explained patterns of faunal density. Percent imperviousness also explained patterns of density, but the direction of the effect was dependent on species. Results of this study emphasize the importance of imperviousness and vegetative cover in affecting the density of resident fish and invertebrate species inhabiting saltmarsh creeks along the US south Atlantic coastline.

"Lunar Influences on Recruitment Phenology of Caribbean Amphidromous Fishes" (Fish Physiology and Ecosystems)

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Amphidromous fishes are a major component of tropical coastal and island lotic fish assemblages. Amphidromy is especially dominant in fishes that inhabit streams on volcanic islands where watersheds are typically short and steep, drain directly to the ocean, and local hydrology is flashy. In the amphidromous life-history, adults live and spawn in freshwater, their eggs or larvae are transported downstream, larvae grow in the marine environment, and post-larvae recruit to the river mouth and undergo metamorphosis to the juvenile phase during ingress to the river. This life history is crucial for population success in geologically young, ephemeral, and frequently disturbed habitats such as those of oceanic volcanic islands. Dispersal during the marine larval phase and subsequent recruitment by post-larvae allows for population colonization, re-colonization, and replenishment. In addition to being essential for population maintenance, the post-larval recruitment phase is important for the ecosystem services provided by freshwater amphidromous fishes. Artisanal and subsistence fisheries of post-larvae occur in all regions where amphidromous fishes are important components of stream fish assemblages and can have high economic and cultural value. In these fisheries post-larvae are captured at river mouths during mass recruitment episodes. Recruitment peaks are known to be seasonal and periodic by fishers with periodicity often linked to lunar phase. However, recruitment seasons and peaks with respect to moon phase vary by location and are not quantified for most locations. Amphidromous fish recruitment is also thought to be an important subsidy of resources for riverine consumers as a predictable, large influx of biomass from the marine environment.

Despite the importance of amphidromous post-larval recruitment for Caribbean freshwater fisheries and ecosystems, their ecology and management have received relatively little research attention. Our study is the first attempt to develop a quantitative sampling method and study the post-larval recruitment phenology of amphidromous fishes on the island of Puerto Rico. During the summers of 2012 and 2013, we compared sampling efficiency among methods that targeted amphidromous post-larvae during river ingress and determined the relationship of post-larval recruitment to moon phase. A 1-m × 1-m, 1mm mesh, kick net was the most effective sampling method, and catch rates revealed consistent peak upstream migration during the last lunar quarter moon phase. Our results provide a repeatable and efficient, standard method for sampling and monitoring post-larval recruitment and identify specific timing that is crucial for the ecology and management of Caribbean amphidromous fishes.

Does Swimming Performance Explain Differences in the Salinity Preference Between Two Killifish Species? (Fish Physiology and Ecosystems)

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Fundulus heteroclitus and *Fundulus majalis* are estuarine fishes physiologically adapted to tolerate wide ranges of salinity. In southeastern Atlantic marshes they are commonly used as bait and sustain a commercial bait fishery. *Fundulus majalis* has been reported to inhabit high salinity areas of estuaries, while *F. heteroclitus* has been reported in a wide variety of salinity ranges. Swimming performance for both species was measured in a swim tunnel under different salinity treatments to investigate whether there are physiological limitations on swimming performance that prevent *F. majalis* from inhabiting low salinity areas. Our initial hypothesis was that *F. heteroclitus* would have a higher swimming performance in low salinity, making *F. majalis* a poor competitor in low salinity environments. The fishes were tested in high salinity (30), low salinity (15), plus also adapted to high salinity and quickly tested in low salinity to stimulate a sudden influx of fresh water (rainstorm). Prolonged swimming speed and burst speed trials were used to assess differences between aerobic and anaerobic swimming capacity. For prolonged swimming trials, *F. majalis* swam significantly better than *F. heteroclitus* in high and low salinity, while no differences were detected between the swimming performance of the two species under the sudden change treatment. For burst swimming trials, *F. majalis* swam significantly better than *F. heteroclitus* in the high salinity and the sudden change salinity trials, while there was no difference between the swimming performance of the two species in low salinity. For both species, swimming performance did not change significantly with changing salinity. Our results show how the swimming performance of *F. majalis* are not significantly affected by changes in salinity, and its higher swimming performance would in fact make it a better competitor compared to *F. heteroclitus*. One possible explanation is different habitat preference, with *F. majalis* preferring open sandy substrate beach habitats and *F. heteroclitus* more complex marsh habitats.

Ontogenetic Diet Shifts in Early Life History Stage Estuarine Fishes (Family Sciaenidae) from the Chesapeake Bay (Fish Physiology and Ecosystems)

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Early life history stage fishes are much more susceptible to starvation than adults. Therefore, successful feeding in the early life history stages is critical. Members of the family Sciaenidae, the drums, are an excellent model group to investigate ontogenetic diet shifts because as adults they occupy a broad spectrum of feeding niches. Stomachs have been excised from over 400 specimens comprising 11 species of sciaenids representing two foraging guilds (benthic sciaenids vs pelagic sciaenids) collected from the Chesapeake Bay. Stomach contents were identified to the lowest possible taxonomic level and then pooled into the prey's primary habitat (ie, pelagic shrimp, benthic shrimp). To examine ontogenetic shifts in sciaenids, mean percent number of each prey category was calculated to reduce the bias associated with small sample sizes. Dietary shifts were observed in larval sciaenids by 28 mm standard length (SL). Before 28 mm SL, both benthic and pelagic foraging sciaenids were foraging on pelagic crustaceans, mostly copepods, in the earliest life history stages. By 28 mm SL, 1/3 of the benthic foraging sciaenid diet consisted of benthic crustaceans whereas pelagic sciaenids were consuming mostly pelagic crustaceans (47%). Many of the examined sciaenid species have overlapping spawning and ingress periods, therefore, the ability to partition foraging habitats in early life history stages may be a mechanism to reduce competition and induce niche partitioning.

The Reproductive Biology of the Finetooth Shark, *Carcharhinus Isodon*, in the Northwest Atlantic (Fish Physiology and Ecosystems)

*Amanda Brown**, University of North Florida, *Jim Gelsleichter*, University of North Florida and *Bryan Frazier*, South Carolina Department of Natural Resources

The finetooth shark is a small coastal shark species found in Atlantic waters from South Carolina to Florida and the northern Gulf of Mexico. This species has recently come under increased fishing pressure and has been designated as “overfished” according to past stock assessments. New life history and reproductive biological data is needed on this species so that these populations can be properly managed and sustained. However, the most recent published study on the Atlantic population of *C. isodon* was conducted over 20 years ago and other studies have found variations regarding the reproductive periodicity of *C. isodon*. To address this issue, this study examined the reproductive biology of Atlantic finetooth sharks, focusing on samples obtained from South Carolina to southeast Florida. Morphological measurements of reproductive organs were obtained from these animals throughout the year to determine reproductive timing. Histological analysis was conducted on the testis and ovaries of mature animals to determine reproductive stage. Last, plasma serum concentrations of the sex steroids testosterone in males and 17 β -estradiol in females were also measured as these hormones have been shown to fluctuate in the reproductive cycle and are therefore good indicators of reproductive condition. Preliminary data indicates that for males, testis width increases starting in September and peaks in late April/early May, followed by a rapid decline in mid to late May. Morphological measurements of head epididymis width follow the same pattern of growth and regression. Histological analysis of the testis confirms this pattern, demonstrating the presence of mature spermatozoa in Spring samples directly prior to copulation, indicating this is the period of spermatogenesis. Last, plasma testosterone concentrations in males also peaked in Spring followed by a rapid decline in May, corroborating morphological and histological data. In females, maximum follicle diameter was greatest from winter-early Spring, indicating that this is the period of vitellogenesis. Follicular diameter decreased after late Spring, suggesting that this is the period of ovulation and fertilization. Embryos were presented in only non-vitellogenic females during winter and spring, suggesting that reproduction is biennial and vitellogenesis and gestation are non-concurrent. Females typically had litter sizes of 3-6 pups/litter every other year, with non-viable pups occurring in 18% of litters to date. Plasma estradiol levels appear to agree with morphological data as vitellogenic, non-gravid females showed the highest 17 β -estradiol levels and pregnant non-vitellogenic females had comparatively lower levels.

Hermaphroditism and Other Aspects of Reproduction in the Endangered Smalltooth Sawfish, *Pristis Pectinata* (Fish Physiology and Ecosystems)

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Because of its status as the only domestic US marine fish currently listed as endangered under the US Endangered Species Act (ESA), it is rare to have opportunities to necropsy specimens of the smalltooth sawfish (*Pristis pectinata*), a factor that complicates efforts to obtain much-needed information on the reproductive biology of this poorly studied species. Due to this, researchers have primarily focused on the use of non-lethal indicators of reproduction (eg, sex hormone profiles) to describe sawfish breeding, along with opportunistic, post-mortem examination of specimens that have died unintentionally as a result of various natural or unnatural causes (eg, cold stress, capture as bycatch in fisheries). Recently, in the course of such examinations, a total of 3 sawfish considered to be male based on external morphology

were found to possess both male and female gonadal tissue, suggesting that hermaphroditism may be more common in males of this species than it is generally considered to occur in most elasmobranchs. This presentation provides a summary of the morphological and, when possible, histological structure of the reproductive tract of these individuals along with brief reviews of hermaphroditism in elasmobranchs and what is known regarding reproduction in *P. pectinata*.

Habitat Use By Bull Sharks (*Carcharhinus leucas*) in Lake Pontchartrain; Implications for Seasonal Movements, Osmoregulation, and Trophic Impacts (Fish Physiology and Ecosystems)

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Lake Pontchartrain is a productive estuarine ecosystem in Louisiana which provides food and protective habitat for coastal marine species including Bull Sharks (*Carcharhinus leucas*). I am assessing movement and distribution of *C. leucas* using an acoustic receiver monitoring array and by actively tracking sharks throughout Lake Pontchartrain and surrounding habitats. These data provide information about habitat preferences (including water quality) and seasonal distributions. With this information, I will determine where juvenile *C. leucas* are distributed during the cooler winter months as well as the size and age at which they leave the estuary. In addition to tracking movements, I am collecting blood samples and fin clips from each shark to measure the osmoregulatory parameters and perform stable isotope analysis to gain insight into their trophic impact as potential apex predators. Preliminary data suggest that juvenile *C. leucas* are moving along a 30 km stretch of Lake Pontchartrain's northern shoreline on a daily basis.

Characterizing a Scalloped Hammerhead Nursery in NE Florida (Fish Physiology and Ecosystems)

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Scalloped hammerheads (*Sphyrna lewini*) are a large shark common in the coastal waters of the eastern US. It is well documented that juvenile scalloped hammerheads utilize shallow nearshore waters as nursery habitat; however, few studies have identified potential nursery habitat in Florida. With the National Marine Fisheries Service recently listing the scalloped hammerhead as overfished, and Florida Fish and Wildlife's decision to prohibit commercial and recreational harvest of scalloped hammerheads, identifying scalloped hammerhead nursery habitat in Florida waters is critical to helping protect this species. This study identifies a nursery for young-of-the-year scalloped hammerheads in the Tolomato River, FL. Sampling occurred from May – October from 2010-2013. Scalloped hammerheads had a mean length of 490cm TL (range = 395 – 59cm TL), and all had well healed umbilical scars. Mean CPUE was greatest in July (35 sharks/50 hooks * hr). There was a significant difference in the observed sex ratio of males to females (156:1, $\chi^2 = 53$, $p = 0.017$). Only 3 tagged sharks were recaptured, two of which were recaptured less than 1km from where they were tagged. Annual mean CPUE was significantly greater in the Tolomato River (24 sharks/50 hooks *hr) compared to surrounding areas in Cumberland (0.08 sharks/50 hooks *hr) and Nassau (0.04 sharks/50 hooks *hrs). These findings suggest this area functions as nursery habitat for this species, and is only the second documented account of a scalloped hammerhead nursery on the east coast of Florida.

Using Passive Acoustics to Better Understand Reproduction of Spotted Seatrout and Red Drum (Fish Physiology and Ecosystems)

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Sciaenids (eg, spotted seatrout, red drum) produce acoustic signals to defend their territories and during spawning. Sound production in these fishes is typically performed by males and involves rapid movement of the sonic muscle against the swimbladder. This courtship behavior could serve to aggregate reproductive groups leading to synchronization of male and female gametes. Thus, passive acoustics (ie, the act of listening to underwater sounds) could be used as a way to better understand where, when, and how often Sciaenids reproduce and how man-made stressors such as climate change, stormwater runoff, chemical contaminants, and noise pollution (eg, associated with pile driving, dredging, boat and shipping traffic, or wind energy) may impact this behavior.

Our lab is using new technology that allows recording of underwater sound at a temporal scale not previously possible to investigate sound production and courtship behavior of Sciaenids in captivity and in the wild. Using DSG-Ocean loggers, the underwater ‘soundscape’ can continuously be recorded during long-term deployments. Our objective was to investigate the relationships between sound production, temperature, and egg release in captive red drum (*Sciaenops ocellatus*) and spotted seatrout (*Cynoscion nebulosus*). Spotted seatrout and red drum were kept in separate fiberglass tanks. DSG-Ocean recorders were deployed in each tank and were scheduled to record sound as a ‘wav file’ for two minute duration every twenty minutes from April to December, 2012. On a daily basis, released eggs were counted and the percentage of fertile eggs was determined.

Spotted seatrout produced three types of calls: staccatos, grunts and drums. Sound and egg production were more prevalent in tanks that contained more males. Sound production predominantly occurred between 20:00 and 01:00, exhibiting nightly patterns of calling. Water temperature was a significant factor in courtship behavior, with more drums, grunts, and staccatos occurring when the water was warmer. Most importantly, more calling by males led to significantly more eggs released by females. Red drum produced one type of call but the number of pulses in each call varied. Sound production predominantly occurred between 16:00 and 00:00, exhibiting early evening and nightly patterns of calling. Most importantly, more calling by males led to significantly more eggs released by females. Thus, by monitoring underwater sound using our DSG-Ocean recorders, we can identify spawning aggregations of spotted seatrout and red drum in the wild and determine how natural and manmade factors may impact reproduction at small temporal scales over extended time periods.

B1a – a New Tool for Evaluating Condition in Fishes (Fish Physiology and Ecosystems)

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Operating in a similar manner to “Fat Meters” at gyms, BIA (bioelectrical impedance analysis) meters can tell us a great deal about the condition of fish and health of their populations. BIA uses a weak electrical current to determine electrical properties of fish that can be related to body compositional measures like fat or lipid levels, protein levels and water content. Once a model is developed these measures can be taken without the need to sacrifice fish. Because lipid levels in fish are known to be positively related to attributes such as survival, egg quality, and growth, BIA presents an important new development for

application to fish management BIA models have been developed for a number of salmonid species, as well as cobia, bluefish and striped bass Application to key management species like black basses, sunfishes, catfishes and others is the next logical step In this talk we describe how to develop and apply BIA models to fish, show how it compares to other popular condition metrics, and suggest standard methodology to help ensure positive results Data from existing models is used to define sample size and fish condition ranges needed for model development

Feeding Ecology of Invasive Lionfish in Biscayne National Park, Florida, Using Morphological Stomach Content Analysis Supplemented with DNA Barcoding (Fish Physiology and Ecosystems)

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The Indo-Pacific lionfishes (*Pterois volitans* and *P miles*) are invasive marine fishes that have become established in the Caribbean Sea, Gulf of Mexico, and western North Atlantic Ocean Lionfish have venomous spines in their dorsal, pelvic, and anal fins that effectively defend them against potential predators in the invaded range Additionally, lionfish are generalist, opportunistic predators that consume a variety of invertebrates and small reef fishes such that the presence of lionfish can significantly reduce fish abundance, diversity, and recruitment on invaded reefs

The present study is focused on the feeding ecology of lionfish in Biscayne National Park Located in southeast Florida, the Park extends from Miami to the northern Florida Keys and consists of multiple diverse ecosystems, including mangrove swamps, seagrass beds, coral limestone keys, and the northern portion of the third-largest coral reef in the world These habitats are highly valuable not only ecologically, but also economically as they support multi-million dollar fishing and tourism industries, all of which are at risk of the damaging predatory impacts of lionfish within the Park boundaries

The National Park Service has been removing lionfish from Biscayne National Park since June 2010 Park staff have collected lionfish year-round from a wide variety of habitats including shallow patch reefs, deep shelf ledges, shipwreck sites, and other anthropogenic structures (eg pilings) This is the first invasive lionfish study specifically targeting Biscayne National Park and characterizes lionfish diet by lionfish size, season, and park location by identifying stomach contents using morphology supplemented with DNA barcoding for prey item identification and validation A total of 513 stomachs, containing more than 2600 different prey items, were examined from lionfish ranging in total length from 41 to 372 mm Consistent with previous studies, results indicate that lionfish feed predominantly on small cryptobenthic reef fishes (eg gobies) and small crustaceans (eg grass shrimp), showing a shift from a primarily crustacean diet to a primarily teleost diet with increasing lionfish body size No significant difference in diet was detected between seasons or park location among mature lionfish (> 180 mm total length) This study provides a better understanding of the impact of lionfish on the food web and ecology of Biscayne National Park and data to develop resource management strategies

Policy, Education, and Communications

An Angler Attitude Survey of a Reclaimed Strip-Mine Wma in Western Kentucky (Policy, Education, and Communications)

Jeremy Shiflet, Kentucky Department of Fish and Wildlife Resources, JeremyShiflet@kygov*

Peabody Wildlife Management Area (PWMA) encompasses 45,732 acres of reclaimed coal strip-mine land in western Kentucky. An annual user permit is required to access the area which is open to hunting, fishing, and general outdoor recreational activities. Fishery resources include 293 bodies of water ranging in size from 0.3 to 183 acres. Fishery related improvements have been restricted due to budget constraints and limited knowledge of angler preferences. In 2012, 7,479 persons purchased a PWMA user permit in addition to a fishing license. A sample of 1,800 of these individuals was surveyed to determine angler attitudes regarding the fishery resources and user needs on the WMA. A multiple contact methodology was used to maximize responses. A total of 797 usable questionnaires were received for an adjusted return rate of 48%. Sixty percent of the respondents indicated Fishing was the primary reason they purchased a Peabody user permit in 2012. Anglers averaged 256 days fishing on Peabody WMA in 2012 (range = 1-200 days) with 578% of the anglers indicating they have fished Peabody WMA for more than ten years. Respondents indicated they had fished in 141 of the 293 lakes on the WMA. Largemouth bass was the most sought after species by 90.2% of anglers, followed by bluegill/redear sunfish (78.7%), crappie spp (65.8%), and catfish (38.2%). The three primary angler concerns were insufficient boat (37.0%) and bank (36.9%) access, and too much vegetation in lakes (32.0%). Of the anglers surveyed, 40.5% fished from a boat 100% of the time, while 27.1% fished from the bank greater than 50% of the time. Part of the information obtained was expected, while anglers revealed other issues that had not been previously considered. Results of this survey will help guide future fishery resource enhancements.

The Fisheries Blog: Communicating Fisheries Science to an Internet Audience (Policy, Education, and Communications)

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Increasingly, scientific communication is using popular social media outlets such as Facebook and Twitter. The weblog (hereafter 'blog') has also been a diverse information-sharing medium well-established in fields such as politics, news, and culture. Fisheries science is still grounded in the academic journal model as a basis from which peer-reviewed information can disseminate. However, in addition to the journal mode of communication, fisheries professionals are beginning to see the value in short, free, internet-based information to convey the vast amounts of pertinent fisheries information in reports or often-inaccessible professional journals. With this need in mind, *The Fisheries Blog* was introduced in January 2012 to make available topical fisheries themes accessible to anyone with internet access. Each Monday, *The Fisheries Blog* features a popular-style article, with content ranging from reviews of primary literature, synopses of ongoing research projects, and information on topical fisheries themes. The blog is not intended to be exhaustive of fisheries material, but rather an easily accessible forum to disseminate information and generate discussion through comments and guest bloggers. Our goal is for

articles to be useful to a wide audience: from seasoned fisheries professionals, to undergraduate fisheries students new to the discipline, and to curious fisheries-minded citizens

Addressing Invasive Species Spread through Commercial Bait Sales in Kansas: A Case History (Policy, Education, and Communications)

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The risk of invasive species spread from commercially sold bait has been well documented across North America, but has never been comprehensively reviewed in Kansas. A 2007 survey of the angling public revealed 71% of Kansas anglers who used live fish as bait, purchased their baitfish from a commercial bait dealer indicating a large potential for invasive species spread if commercial bait dealers are not providing an uncontaminated product. To minimize the risk of invasive species spread with commercially sold bait, the Kansas Department of Wildlife, Parks and Tourism enacted regulations in 2012 to restrict the species of fish and crayfish legal for sale, require disease certification for imports, utilize a closed water source, require dealers to report fish origin, and to provide a receipt with each sale of bait fish. To assist transition to the new rules, an informational booklet was developed to summarize regulations and provide an identification guide for legal species. Bait shops were visited twice throughout the fishing season and inspected for regulatory adherence and often, fish were purchased for disease testing. Visits provided data on the species and bait origin, locations of unknown regulated invasive species, and allowed Agency personnel to communicate directly with influential members of the fishing community. Bait dealers were largely in compliance with the regulations, requiring limited corrective action. In 2013 a follow-up survey was sent to commercial bait dealers to determine their overall level of support for Agency action and to provide data to improve program implementation. Seventy seven percent of commercial bait dealers were moderately to extremely satisfied with the program and provided useful data for future Agency action. Bait dealers, if provided with appropriate information and routinely inspected for regulatory compliance, are in a key position to help prevent the spread of invasive species and disease.

Student, Faculty and Employer Perceptions of Graduates' Preparation to Succeed As Fisheries Professionals (Policy, Education, and Communications)

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

We conducted a survey of AFS members to assess perceptions of the importance of knowledge in areas defined by the AFS certification program and how well students, university faculty members and employers felt graduates at the BS, MS and PhD levels were prepared in those areas of knowledge and other job-related skills to succeed as entry-level professionals in fisheries. We received responses from 1,490 AFS members. All student and employer groups rated critical thinking, written communication and oral communication skills as most important in contributing to success of entry-level professionals. The ability to communicate effectively with nontechnical audiences and to work effectively in teams also tended to rate higher in importance than nearly all academic subject areas. Students had much greater confidence in the adequacy of their preparation to succeed as fisheries professionals than employers did in most areas of knowledge and skill. Faculty members expressed slightly greater skepticism than students about graduates' preparation to succeed, but faculty ratings of preparation generally exceeded those of

employers significantly. The greatest disparities in perceptions of the adequacy of preparation of graduates occurred in written communication and critical thinking skills. Employers who hired entry-level fisheries professionals primarily at post-graduate levels (MS or PhD degrees) generally assessed their new employees as better prepared to succeed as professionals than those employers who hired primarily at the bachelor's degree level. However, a significant gap in perceptions or preparedness by students, faculty and employers persisted at all education levels. We believe that universities and employers should collaborate to assess effective means to address perceived deficiencies in knowledge and skills of graduates, including what roles universities and employers should play in life-long learning for fisheries professionals. The American Fisheries Society can play an important role in this process by updating and refining its certification process.

Impact of Epa's New 316 (b) Regulations on Aquatic Resources and Fishery Professionals (Policy, Education, and Communications)

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EPA has promulgated new 316(b) regulations in an effort to reduce the impact of once through cooling water on aquatic resources. Fishery professionals now will be drawn into discussions of whether or not certain engineering controls are sufficient to meet regulatory requirements for reducing impingement and entrainment mortality, as well as the impact on threatened and endangered species. Understanding how implementation of the new 316(b) rules will affect aquatic resources will become part of the fisheries management biologist job responsibilities. Here we attempt to explain how fishery managers may be involved in this process.

Regulatory Review of CWA 316(b) Regulations (Policy, Education, and Communications)

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Section 316(b) of the Clean Water Act (CWA) requires that point source dischargers use the Best Technology Available (BTA) for minimizing the impact of water withdrawals through their Cooling Water Intake Structures (CWIS). Typically the greatest impacts of water withdrawals are the impingement and/or entrainment of aquatic resources such as fish, fish larvae, fish eggs, and/or shellfish. There is a long convoluted history of 316(b) regulations that dates back to shortly after the CWA was enacted. Recently EPA has promulgated new 316(b) regulations. As these new regulations are enacted they will impact fishery resources throughout the USA.

Pollution and Toxicology

Analysis of the Extent and Temporal Changes of Shoreline Oiling from the Deepwater Horizon Oil Spill, Gulf of Mexico, USA (Pollution and Toxicology)

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Based on comprehensive and repetitive surveys by shoreline assessment teams, the oil from the 2010 *Deepwater Horizon* spill in the Gulf of Mexico was documented as stranding on 1,773 km of shoreline. Of the shorelines oiled, beaches comprised 508%, marshes 449%, and other shoreline types 43%. One year after the spill began, oil remained on 847 km; two years later, oil remained on 687 km and three years later, oil remained on 634 km, with 73% of the shoreline classified as trace (<1%) oiling degree. Shoreline cleanup activities were authorized on 660 km, or 733% of oiled beaches. Because the oil stranded over a three-month period and when the beaches were in a relatively eroded condition, the oil became deeply buried and posed many challenges to its removal. The continued remobilization of oil buried in both intertidal and nearshore sand resulted in the chronic re-oiling of sand beaches at trace levels for over three years, thus the slow rate of decline in the shoreline oiled lengths. Early treatment of sand beaches focused on use of beach cleaners and sifting to minimize clean sediment removal; later treatments were mostly manual. Both manual and mechanical treatment was authorized on 71 km, or 89% of oiled marshes and associated habitats, though actual treatment was conducted in smaller zones within these segments. With detailed guidance and careful oversight, intensive treatment of salt marshes resulted in faster recovery, compared to oiled and untreated marshes.

Effects of Antimycin, a Piscicide, on Benthic Macroinvertebrates in a Great Smoky Mountains National Park Watershed (Pollution and Toxicology)

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This study assessed the effects of antimycin (Fintrol®) on benthic macroinvertebrates during the largest brook trout restoration in the southeastern United States. Control and treatment sites were established in 1st-4th order streams throughout the watershed and below the fish passage barrier where a neutralizing agent, potassium permanganate (KMnO₄), was administered. Benthic and drift samples were collected before, during, and after application. Community parameters were analyzed using RMANOVA to determine differences among control, treatment, and neutralization sites over time. Overall, negative effects of antimycin were minimal and undetectable two months post-treatment, indicating rapid recovery of the benthic community following application. Effects were generally greater in downstream sites compared to headwater sites. Several variables were significantly different among control, concentrated, and dilute KMnO₄ neutralization sites; however, differences were undetectable six months post-treatment. Although no taxa were eradicated, an immediate downstream shift in select taxa was observed. Many taxa were substantially more abundant several months post-treatment, indicating a thriving macroinvertebrate community throughout the watershed in the absence of predation. These results demonstrate the ability to commence native fish stocking efforts immediately after chemical degradation.

Mississippi Coastal Fish Assemblage Structure and Dynamics before and after the Deepwater Horizon Oil-Spill (Pollution and Toxicology)

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Anthropogenic disturbances have been shown to have a variety of effects on ecosystem processes and function. As a result of the April 2010 Deepwater Horizon (DWH) incident, oil and oil dispersants were introduced into northern Gulf of Mexico ecosystems. Rigorous empirical data are required to assess the

potential impact of the DWH to coastal ecosystems To assess potential impacts to fish assemblages, we utilized a previously published dataset (1992-1994) and our own collections (2011-2013) to assess patterns of current and pre-DWH fish assemblage structure and dynamics Sampling included a total of 254 pre-DWH and 180 post-DWH trawl samples covering estuary and subestuary habitat across the Mississippi coast The final dataset contains over 40,000 individuals representing over 100 species

Polycyclic Aromatic Hydrocarbon Biomarkers in Gulf of Mexico Sharks and Fishes in the Years Following the Deepwater Horizon Oil Spill (Pollution and Toxicology)

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The Deepwater Horizon Oil Spill released large quantities of liquid petroleum into the Gulf of Mexico This was the largest oil spill in US history and the depth that it occurred at creates a unique yet challenging research opportunity It is vital to determine the effects on Gulf wildlife from oil-related pollutants, particularly the polycyclic aromatic hydrocarbons (PAHs), which are the most toxic components of oil A variety of PAH biomarkers have been used to evaluate health impacts from the oil spill Due to the rapid metabolism of these compounds, detoxification enzymes activity such as, cytochrome P450 1a and glutathione-S-transferase were measured to assess PAH exposure Additionally PAH metabolites from these processes were measured in bile Thus far results suggest continued exposure with several species indicating significant increases in GST activity and FAC concentration from 2011 to 2012 This increase likely represents the redistribution of PAHs settle in sediment Samples from 2013 are currently being analyzed

Mercury Toxicity in the Longnose Gar (*Lepisosteus osseus*): A Model for Examining Potential Negative Health Effects of Hg Among Fishes (Pollution and Toxicology)

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Though mercury (Hg) occurs naturally, anthropogenic emissions have increased atmospheric Hg levels by an estimated factor of three since the Industrial Revolution This has caused corresponding increases in Hg levels in terrestrial and aquatic ecosystems Wetlands contribute to the transformation of elemental mercury into its most toxic form, methylmercury (MeHg), by anaerobic sulfur-reducing bacteria and serve as a pathway for Hg from freshwater to the marine environment Methylmercury is the most bioaccumulative form of mercury and the only trace metal which permeates all trophic levels Mercury is acknowledged as one of the most threatening environmental toxicants to humans because of its potential for neurological, behavioral, and reproductive impairment As a result, forty states have fish consumption advisories in place based on Hg risk and the US Food and Drug Administration has suggested limiting exposure to Hg through food consumption to no more than 02 mg/week of MeHg Despite this knowledge, the effects of Hg on lower trophic level biota are largely unknown The present study examines potential negative health effects of Hg in two coastal longnose gar (*Lepisosteus osseus*) populations by measuring a suite of organosomatic indices, exploring variation in reproductive output and timing of maturity, and evaluating any correlation between Hg concentration and body condition factor In addition, the potential for reproductive offloading of Hg is explored Preliminary results show that

temporal trends of several organosomatic indices are correlated with Hg concentration with a lag time of two months Understanding the effects of Hg on fishes will inform fisheries management decisions as well as fish consumption recommendations for humans

Sources and Effects of Estrogens in the Upper Conasauga River (Pollution and Toxicology)

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Populations of rare and endangered fish have been declining in the Upper Conasauga River (UCR) Concurrently, agricultural activities have increased in the watershed, and in a preliminary contaminant survey we measured high concentrations of estrogens in sediments throughout the UCR watershed The goals of this study were to determine the effects of estrogens on fish in the UCR and identify UCR tributaries with the highest estrogen input Specific objectives were to: 1) determine the presence and bioavailability of estrogens in UCR tributaries by assessing vitellogenin (Vtg) induction in caged male fish, 2) assess the estrogenic potency of UCR sediments by measuring Vtg induction in sediment-exposed male fish, 3) determine sediment toxicity to larval fish, 4) determine incidence of intersex in a survey of multiple species of fish in the UCR, and 5) determine if exposure to estrogens altered the sexual development of male western mosquitofish (*Gambusia affinis*) in the UCR Study sites included five UCR tributaries with similar land use characteristics Results from this study showed estrogens are present in UCR water, with estrogenic equivalencies (EEq) ranging from 157 ng E2/L (± 08 , standard deviation) in Spring Creek to 1636 ng/L (± 82) in Mill Creek Estrogen concentrations were higher in sediment samples from the creeks, with EEq ranging from 726 $\mu\text{g E2/kg}$ in Sugar Creek to 1647 $\mu\text{g E2/kg}$ in Mill Creek However, male fish produced higher concentrations of Vtg when exposed to UCR water than when exposed to UCR sediments, suggesting estrogens in the water column were more bioavailable than those in the sediment Sediment toxicity tests revealed significant growth differences in larval fathead minnows (*Pimephales promelas*; $p = 00022$) and tricolor shiners (*Cyprinella trichroistia*; $p = 00016$) exposed to Mill Creek and Sugar Creek sediments compared to controls Of the 174 male fish (27 species) collected for the intersex survey, 13 (75%) were intersex Sugar Creek had the highest rate of intersex at 136% (3 of 22 males) Gonopodia of western mosquitofish collected from a farm drainage ditch were significantly ($p = <00001$) shorter compared to western mosquitofish from the lower Conasauga River Results indicate environmentally relevant estrogenic compounds are present in UCR surface water and sediment, and these compounds may be linked to declines in fish populations Additionally, this approach has facilitated identification of tributaries with the highest estrogen loads, where best management practices should be targeted for greatest impact

Dams and Reservoirs: Fishery Challenges

Southeast Aquatic Connectivity Assessment Project (Dams and Reservoirs: Fishery Challenges)

John Kauffman, Southeast Aquatics Resource Partnership*

Fragmentation of river habitats by dams and other aquatic barriers is one of the primary threats to aquatic species in the United States These barriers limit the ability of sea-run fish species to reach preferred

freshwater spawning habitats and prevent resident fish populations from moving among habitats critical to their life requirements

To help address this problem, The Nature Conservancy (TNC) and the Southeast Aquatic Resources Partnership (SARP) are undertaking an assessment of dams in the southeast US that will be completed in late 2014. The project with funding from the South Atlantic Landscape Conservation Cooperative (SALCC) seeks to help support planners and managers in their efforts to target fish passage and other aquatic connectivity projects where they can have the most benefit.

The Southeast Aquatic Connectivity Project (SEACAP) will identify opportunities to improve aquatic connectivity by prioritizing dams based on their potential ecological benefits if removed or bypassed within watersheds that interest the SALCC area. The project area is approximately 250,000 square miles with over 350,000 miles of mapped streams. Building off other connectivity projects in adjacent regions (eg Chesapeake Fish Passage Prioritization and the Northeast Aquatic Connectivity) dams are evaluated on a suite of metrics in a Geographic Information System. Metrics include the number of river miles that would be opened upstream of a dam, the number of downstream dams, presence of diadromous fish species and metrics which assess watershed conditions and the ecological condition of the stream on which the dam is located. Metrics are combined to produce a relative prioritization and displayed in an interactive web map with a custom analysis tool for running user-defined scenarios.

The project team is composed of three from TNC and four from SARP as well as a volunteer workgroup that provides guidance on connectivity metrics important in the Southeast and review of the GIS layers. Over 50 people from state, federal and NGO's are on the workgroup and have participated in three virtual meetings (project introduction, status of dam mapping and identification of target taxa, and development of metrics that are important to ecological value). From two databases and contacts with area states, approximately 14,000 dams were snapped to streams in the GIS. About 3500 additional dams are expected to be added to the above total. Biological metrics will be developed from the Multistate Aquatic Resource Information System (MARIS) and Nature Serve as well as state stream health assessments.

Reconnecting American Eels to the Upper Roanoke Basin (Dams and Reservoirs: Fishery Challenges)

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One indication of watershed health is diversity of aquatic fauna. American eels spawn in the Atlantic Ocean, and their offspring use rivers from maritime Canada to northern South America as nursery areas. They were historically largely eliminated from the upper Roanoke River Basin due to flood control and hydropower dam construction, consequently reducing upstream native fish diversity as well as eel production. As part of the Federal Energy Regulatory Commission relicensing process with Dominion/North Carolina Power, the National Marine Fisheries Service issued a Section 18 fishway prescription requiring safe, timely and effective passage be provided for eels reaching the Dominion dams.

We sampled eels in the river's bypassed reach and in the tailrace below Roanoke Rapids Dam from 2005 – 2008 to assess the abundance and distribution of eels below the dam. Large collections in conventional elver traps within the bypassed reach documented seasonal and horizontal distribution patterns and led to construction of high-capacity eelways at the north and south ends of the bypassed reach in 2009-2010. Over a million eels have been passed upstream during 2010-2012. We will discuss observed patterns of eel abundance and upstream migration, eelway design considerations, and other factors involved in eel restoration.

Characteristics of Two Self-Sustaining Populations of Paddlefish in Northeast Oklahoma (Dams and Reservoirs: Fishery Challenges)

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Oklahoma has several self-sustaining populations of paddlefish (*Polyodon spathula*) that support sport fisheries. The most important of these is in Grand Lake O' The Cherokees (Grand Lake). The Oklahoma Department of Wildlife Conservation (ODWC) established the Paddlefish Research Center (PRC) on Grand Lake in 2008. This installation increased communication with paddlefish anglers who complained of decreased fish size on Grand Lake. Simultaneously, population monitoring on Keystone Reservoir (Keystone) showed that paddlefish there tended to be larger than from Grand Lake. Our objectives for this study were to: 1) estimate and compare characteristics of these two paddlefish populations, and 2) determine differences in fishing pressure between reservoirs. Paddlefish gillnetting data from winter 2010 and 2011 showed no significant difference in relative abundance between the populations however, differences in length frequencies, relative weights, growth and reproductive condition were observed. Mean length-at-age, relative weights and gonadal fat indices for both male and female fish from Keystone were significantly greater than those from Grand Lake, while gonadosomatic index values were significantly greater for Grand Lake for female fish.

The Use of Fish Attractors in Reservoirs: A Survey of North American Resource Management Agencies (Dams and Reservoirs: Fishery Challenges)

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Many resource management agencies use fish attractors (brush piles, artificial reefs, rock piles, PVC structures, etc) to concentrate fish for anglers to locate and catch. These structures are also thought to provide additional fish habitat benefits in ageing reservoirs. The Oklahoma Department of Wildlife Conservation, the Southern Division AFS Reservoir Technical Committee, and the Reservoir Fisheries Habitat Partnership all had an interest in surveying resource management agencies about their use of fish attractors in reservoirs. We wanted to determine what types of structures are commonly used for fish attractors, how the structures are built, what factors affect the use and placement of these structures, and how this information is shared with anglers. The survey was sent via e-mail to fish habitat coordinators or fish chiefs in all 50 states in March 2013. We received 55 responses from 41 states and one private contractor. The majority of fish attractor use (56%) is on small reservoirs (less than 2,500 acres) and targets largemouth bass and crappie. Thermocline and water level fluctuation were the top two

environmental variables considered when placing fish attractors. A summary of results is being prepared by the SDAFS Reservoir Committee and will be shared via its website. A survey of angler opinion and usage of fish attractors within the SDAFS footprint is also being considered.

Beaver and Mill Dams Alter Freshwater Mussel Habitat, Growth, and Survival in North Carolina Piedmont Streams (Dams and Reservoirs: Fishery Challenges)

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Anthropogenic and beaver (*Castor spp*) dam-building activities alter aquatic habitats and have profound effects on the availability, quality, and connectivity of resources. Freshwater mussels are imperiled indicator species, perform key ecosystem services and serve as basal resources in stream foodwebs. Understanding the effects of increasing beaver populations and dam removals is imperative to the conservation of freshwater mussels. We examined the effects of beaver and mill dams on freshwater mussel growth and food resource availability and quality. We complemented stream survey data with a common garden experiment conducted in the upper Tar River Basin of North Carolina, USA. We found that mill impoundments improved mussel food quality and significantly ($p < 0.05$) increased growth of freshwater mussels in mill dam tailraces. In contrast, sites with beaver impoundments did not experience enriched food resources or growth. Caged mussel mortality was twofold higher across all beaver reaches (399%) compared to mill reaches (200%). Patterns in mussel growth and survival were positively correlated with increased total suspended solid (TSS, $< 250 \mu\text{m}$) mass and % nitrogen, measures of mussel food quantity and quality. Our research suggests that discontinuities in the flow continuum alter stream energetic pathways with dramatic consequences for the growth and survivorship of freshwater mussels. Increased water retention times resulting from impoundments may decrease nutrient spiraling lengths and increase small particle retention and nitrogen thereby increasing mussel food quality. While dam removals may increase physical habitat connectivity, impoundments also serve as important nutrient sinks especially in nutrient-rich Piedmont streams. Quantifying costs and benefits of restored connectivity to taxa across multiple trophic levels as well as addressing effects on key small stream and wetland ecosystem services should be considered when prioritizing restoration projects.

A Photographic Counter for Monitoring American Eels at an Eel Ladder (Dams and Reservoirs: Fishery Challenges)

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Fish passage, a frequent focus of fishery management in riverine systems, often involves manual or automated monitoring methods. During 2003–2013, we monitored passage of over 20,000 yellow-phase American eels at an eel ladder on Millville Dam of the lower Shenandoah River, a Potomac River tributary. To reduce travel and personnel costs of manually monitoring the eel ladder, a photographic counter was designed and tested as a method of estimating lengths and counting American eels. The photographic counter (patent pending) is comprised of a 35 mm SLR camera with an infrared motion sensor, and a transparent thermoplastic box spliced into PVC pipe at the top of the eel ladder. The camera recorded a digital photograph of each eel that passed through the ladder. Counts and estimated length

measurements based on data from the photographic counter were consistent with those using manual methods. In addition to reduced monitoring costs, another benefit was the time stamp of digital images from the photographic counter, which provided the exact time of eel passage.

Continuous Telemetry of Fishes Near a Heated Effluent from a Power Plant on the Cumberland River, Tennessee (Dams and Reservoirs: Fishery Challenges)

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Laboratory-derived thermal preferences of fishes frequently dictate power plant discharge protocols. To better understand thermal tolerances and develop more accurate criteria, especially during the summer months, 56 fish were tagged with temperature-sensing ultrasonic transmitters and monitored with continuous telemetry to record thermoregulatory behavior in and around the heated discharge at the Tennessee Valley Authority's Cumberland Steam Plant on the Cumberland River. An array of submersible ultrasonic receivers (SURs) during the summers of 2012 and 2013 in the vicinity of the discharge logged thousands of observations on the temperatures used by several species, including Blue Catfish *Ictalurus furcatus*, Channel Catfish *Ictalurus punctatus*, Smallmouth Buffalo *Ictiobus bubalus*, and Largemouth Bass *Micropterus salmoides*. Tagged fish spent at least some time in the thermal plume, though each species used the heated discharge differently. Largemouth Bass were frequently detected in the SUR array but rarely in the plume. Smallmouth Buffalo were frequently in the array and regularly used the plume. Channel Catfish were rarely observed in the array, but used the plume almost exclusively when in the array. Catfish *spp* and Smallmouth Buffalo were observed in temperatures as high as 37°C.

Comparison of Methods and Bait-Type to Minimize By-Catch When Sampling for Channel Catfish in Reservoirs (Dams and Reservoirs: Fishery Challenges)

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Hoop nets are often used to sample channel catfish (*Ictalurus punctatus*) populations in reservoirs as they produce relatively unbiased estimates of relative abundance compared to other traditional methods, such as gill nets. However, bycatch of other species, especially aquatic turtle species, can be considerable, especially when nets are set to fish for multiple nights. Trotlines baited with soap have been shown to minimize turtle bycatch when compared to other baits used on trotlines, but soap-baited trotlines have not been compared to other methods nor has soap as bait been used in hoop nets. To determine the effectiveness of soap as an alternative bait type as a means to assess channel catfish populations while minimizing bycatch, we conducted a study at Lake McMurry in central Oklahoma that paired hoop nets (3-night set) with trotlines (1-night set), each with two bait types (trotlines with shad and soap, and hoop nets with cheese and soap) during May and June of 2013. We assessed differences in mean catch-rates (number of fish per set night) and mean lengths of channel catfish with repeated-measures ANOVA and differences in length-frequencies with paired Kolmogorov-Smirnov (K-S) tests. We also conducted a sample size analysis through resampling to determine effort needed to reach various measures of sampling precision among methods. We found no significant differences in mean catch-rates among the gear-bait type combinations ($P = 0.37$), which varied from 83 to 199, but trotlines caught larger channel catfish than

hoop nets on a mean-length and length-frequency basis ($P < 001$ ANOVA and K-S) Resampling analyses resulted in lower required sample sizes at all measures of precision when trotlines baited with soap was the method, sometimes more than half as the next best method Soap as bait resulted in less turtle bycatch than other bait and was zero when used with trotlines Additionally, trotlines had lower overall bycatch, catching from one to three non-target species compared to hoop nets that caught from five to six other species Our results indicate that trotlines baited with soap may be an alternative gear for efficiently and robustly sampling channel catfish populations without turtle bycatch

Evaluating Reservoir Fish Assemblages: How Much Sampling Is Enough? (Dams and Reservoirs: Fishery Challenges)

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We analyzed community metrics derived from approximately 20 years (1986 to 2008) of monthly gillnet sampling conducted in Richard B Russell and J Strom Thurmond reservoirs to assess spatial and temporal variability in the metrics Over the entire sampling period, we collected 45 species from each reservoir and the number of species captured was relatively constant across stations and ranged from 36 to 38 for Thurmond reservoir (4 stations) and 33-37 for Russell reservoir (5 stations) The average number of species collected in a calendar sampling year was also relatively constant among stations and ranged from 20 to 25 for Thurmond and 19 to 21 for Russell Though numbers of species were similar, there were identifiable temporal (across months and years) and spatial (across stations) patterns in catch with respect to the number of fish and the individual species collected Using the patterns in catch, we generated temporal subsets of the data (combinations of various months) and subsequently evaluated the similarity in inferences between the subsets and the full data set with respect to the species accumulation curves, species composition, and species rankings Within years, subsets of specific monthly samples typically greatly under-represented the assemblage derived from the complete annual sampling regime; however, community metrics derived from subsets of the data pooled across many years were very similar to those derived from the full dataset for the same time period For example, in Thurmond reservoir, pooling the data from May to June (25% of the overall effort) resulted in a similar assemblage as the full data set with nine of the top 10 species being the same and having very similar rankings The subset captured fewer species (28 of 38), as expected by sampling theory, but eight of the 10 species not sampled in the subset consisted of only 14 individuals, and six of the species were captured only once in 3,289 gillnets Our findings suggest there may be an opportunity for future monitoring programs that are interested in assessing changes in fish assemblages to spend less time on “routine monitoring” of the assemblage and more time on sampling to address specific issues or questions For example, decreasing community monitoring efforts to 3-6 months could make time and resources available to conduct age and growth or mark/recapture studies on key species of interest and gain a better understanding of factors driving changes in community structure

Impacts of Basin Fragmentation on Fish Community Restoration (Dams and Reservoirs: Fishery Challenges)

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Due to historical industrial and research impacts, the White Oak Creek watershed on the Oak Ridge Reservation in East Tennessee has reduced fish species richness compared to similar-sized reference streams. In recent years, many of these impacts have been mitigated through habitat enhancements and improvements in water quality and as a result, several species of fish not observed since historical collections have recently been observed in the lower reach of the watershed. However, numerous barriers such as road crossings and weirs throughout the stream are preventing upstream migration of fish. We selected six native fish species for an introduction effort aimed at investigating whether 1) missing species can survive throughout the watershed and 2) existing instream barriers are a significant factor in species distribution. Beginning in 2008 striped shiner, bluntnose minnow, northern hog sucker, rock bass, stripetail darter, and snubnose darter were collected from local streams and injected with latex paint or visible implant elastomer. Fish were introduced into six locations throughout the White Oak Creek watershed based on the presence of suitable habitat and the potential for dispersal. Natural reproduction was documented for five of the six species with striped shiner and snubnose darter exhibiting the most success. A range expansion was observed for several species including movements up to 850 m downstream by striped shiners to establish a new reproducing population. These results indicate that some portions of the stream are suitable for fish introduction efforts but species may still be limited to only downstream colonization due to instream barriers.

Life History Plasticity and Effects of Introduced Icefish on an Indigenous Zooplanktivorous Fish (Dams and Reservoirs: Fishery Challenges)

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Icefish *Neosalanx taihuensis* is a commercially important zooplanktivorous fish that has been introduced into Chinese freshwaters over a wide geographic range. Introduction of this species has induced decline and even extinction of native fish species in some waters. We examined effects of icefish introduction on growth and reproductive characteristics of an indigenous zooplanktivorous fish by comparing population traits of *Hemiculter leucisculus* in two reservoirs, one in which icefish has been introduced (Huangshi Reservoir: HSR) and one with no icefish introduction (Mengquan Reservoir: MQR). These reservoirs are geographically proximate and display similar nutrient regimes and native fish faunas. Standard length, body weight, and back-calculated SL-at-age of *H. leucisculus* in HSR were all significantly less than in MQR for both males and females. Females produce fewer and smaller eggs in HSR than in MQR for each age group. We suggest that reduced growth and reproductive investments by *H. leucisculus* in HSR are likely the result of icefish introduction. To investigate possible factors in the widespread success of introduced icefish, we evaluated life-history plasticity in introduced icefish among three waters at progressively lower latitudes in China: Xiashan Reservoir (XSR), Danjiang Reservoir (DJR) and Fuxian Lake (FXL). Icefish in XSR have a single spawning stock that spawns in spring; fish in DJR have spring and autumn spawning stocks; and fish in FXL spawn year-round. Mature females at higher latitude tend to be smaller in size, to produce smaller eggs, and to have higher relative fecundity compared to fish at lower latitudes. We hypothesize that life history plasticity contributes to icefish establishment success across a wide geographic range, and the lack of such plasticity may limit competitive success of indigenous zooplanktivores when icefish are introduced.

The Importance of the Benthos in the Food Web of Lake Marion, South Carolina (Dams and Reservoirs: Fishery Challenges)

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Lake Marion is a large (330 km²), rapidly flushed impoundment in the Coastal Plain of South Carolina. The benthos, sampled in spring and summer of 2009-2010, was dominated by invasive mollusks, mainly the Asiatic clam *Corbicula fluminea* and the olive mystery snail *Viviparus subpurpureus*, and insects, mainly the mayfly *Hexagenia limbata* and dipterans. Benthic biomass ranged from 82 g dry mass/m² in the upper region to 37 g/m² in the middle region and 12 g/m² in the lower region. *Corbicula* contributed 60-80% of benthic biomass; insects, <10%. For the upper region in spring and early summer, biomass of the benthos was three orders of magnitude greater than biomass of the zooplankton and two orders of magnitude greater than biomass of the phytoplankton. We speculate that the benthos, including *Corbicula*, depends on detrital material imported from the watershed. We are exploring how the trophic structure of Lake Marion is organized around the great mass of the benthos. Lake Marion's food web appears to differ substantially from food webs of Piedmont impoundments, such as Lake Norman, NC. The short hydrologic retention time and the large benthic component of the food web are major considerations for aquatic resource and fishery management in Lake Marion.

Influences of Dams on Downstream Larval Fish and Aquatic Macroinvertebrate Community Structure and Associated Physicochemical Variables (Dams and Reservoirs: Fishery Challenges)

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In the context of the serial discontinuity concept, we investigated influences dams have on structuring physicochemical variables and biotic communities along the stream continuum. Seven streams were sampled (one in each of MD, OH, and WV and four in PA) for larval fish and macroinvertebrates at predetermined distances below dammed sites. We tested the prediction that biotic richness and diversity (Shannon Index) would increase as distance from dams increased. Furthermore, we hypothesized that dams would influence water quality and habitat variables, which would aid in explaining the structure of biotic communities along the stream continuum. Temperature, pH, and conductivity showed significant relationships with distance from dams ($p < 0.05$; $r = 0.91, 0.62, \text{ and } 0.70$ respectively). Species richness and total number of individuals captured also increased with distance from dams ($r = 0.76$ and 0.82 respectively). Multivariate methods (PCA and NMDS) were used to summarize and interpret gradients in physicochemical and biotic data respectively. Using fourth-corner analysis we also investigated species trait and habitat associations as they relate to longitudinal changes in physicochemical variables. We suggest that dams may impact physicochemical variables and thus biota in a longitudinal fashion that is congruent with the serial discontinuity concept.

Fish Community Response to Dam Removal in Twelvemile Creek, Pickens County, South Carolina (Dams and Reservoirs: Fishery Challenges)

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A rare opportunity to study the ecological effects of dam removal in the Southeastern US presented itself with the removal of two mainstem dams on Twelvemile Creek, Pickens County, South Carolina. We sampled sites above and below the two dams before, during, and after dam removal to document changes in stream habitat and fish communities due to dam removal. We plotted fish metrics by site and year to and used a four factor ANOVA to test for differences among sites before and after dam removal, and used non-parametric multidimensional scaling (NMDS) to examine, visualize, and interpret changes in community composition across time. Prior to dam removal, habitat and fish community compositions in the small impoundments above both dams were distinct from their immediate downstream free-flowing reach counterparts. Impoundments were shallow with low velocities and were characterized by greater densities of lentic species such as sunfish and bass, whereas free-flowing sections were characterized by greater depth-diversity and velocity and had greater densities of lotic species such as darters, shiners, and madtoms. After dam removal, habitat conditions of the former impoundments changed rapidly, showing increased similarity to habitats found in immediate downstream free-flowing areas. However, fish communities of the two former impoundments showed initially different responses to dam removal. The fish community of the upper impoundment became more similar in composition to its immediate downstream free-flowing counterpart and an upstream free-flowing reference reach located above all dams. Species richness, darter density, and shiner density increased at the former upper impoundment, reflecting an expected community response to observed habitat changes. In contrast, the fish communities of the sample locations around the former lower dam (former impoundment and downstream free-flowing counterpart) have both become more similar in composition to an alluvial downstream reference reach located below all dams. This contrast in responses between dam removal locations may be partially due to cumulative downstream habitat disturbances resulting from the dam removal process (increased deposited sediment, increased turbidity, decreased depths and velocities). Prior to dam removal we routinely captured redeye bass at all sites; immediately following dam removal we began to capture non-native Alabama spotted bass. Alabama spotted bass continue to be captured in post-dam removal samples in all sample reaches except one located above a third dam that remains on the river. The continued presence of Alabama spotted bass in post-dam removal samples causes concern regarding potential hybridization with the drainage's native redeye bass population.

Stream and River Fishes: Assemblages and Movement

Fish Distribution Along an Elevational Gradient in Streams of the Honduran Interior Highlands

(Stream and River Fishes: Assemblages and Movement)

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Stream ecosystems in Mesoamerica are poorly studied, especially in Honduras. Even the few Honduran fish surveys have been limited to relatively low elevations. To date, little is known about the habitat correlates or limiting factors controlling Mesoamerican fishes. In this study, we examined patterns in water quality, physical habitat and fish assemblages along an approximately 1500-m gradient of elevation among 30 sites in six streams in the Honduran interior highlands. As elevation decreased, temperature, pH and conductivity increased while dissolved oxygen concentration decreased. Habitat volume increased with decreasing elevation, but substrate remained the same. Multiple logistic regression revealed that

among non-redundant independent variables, elevation was the only significant predictor of fish presence at a site. However, elevation likely operates as a surrogate for two different types of distributional limitations in these systems: physical barriers (eg waterfalls and dams) and physicochemical barriers. Presence of migratory fishes (eg, gobiids and mugilids) was clearly limited by physical dispersal barriers (ie, waterfalls); species richness increased dramatically downstream of a waterfall on one stream. Alternatively, *Heterandria bimaculata* exhibited self-sustaining populations (evidenced by substantial reproductive success at all sites) upstream of two dams and several waterfalls, but appeared to be limited by physicochemical conditions associated with elevation. Sites where *H bimaculata* was present showed little to no overlap in temperature with sites where *H bimaculata* was absent, despite sometimes close fluvial proximity (~1 km). This study demonstrates that local species richness can be controlled by multiple dispersal-limiting factors, and illustrates the need for more research in the streams of this region.

Conserving Data-Poor Stream Species: A Hierarchical Approach (Stream and River Fishes: Assemblages and Movement)

*Stephen R Midway**, Pennsylvania State University, srm30@psuedu, Tyler Wagner, US Geological Survey, Pennsylvania Cooperative Fish & Wildlife Research Unit and Bryn Tracy, NC Department of Environment & Natural Resources

The southeast United States is home to one of the richest freshwater fish assemblages in North America, as well as one of the most imperiled and threatened. Often, conservation efforts for many rare and threatened species are limited by a lack of data. Drawing on an extensive 20⁺-year data set, we modeled occurrence probabilities of 126 stream fish species throughout North Carolina. Specifically, we developed occurrence probabilities from hierarchical Bayesian multispecies models based on common land use and land cover covariates. We also used Index of Biotic Integrity (IBI) tolerance classifications as a second level in the model hierarchy, a level that is flexible for future model applications. Based on the partial-pooling property of the models we were able to generate occurrence probabilities for many imperiled and data-poor species, in addition to highlighting a considerable amount of occurrence heterogeneity that supports species-specific investigations whenever possible. Our results provide both critical species-level information for many threatened and imperiled species, as well as information that may assist with re-evaluation of existing management strategies such as surrogate species.

Evaluating Changes in Stream Fish Species Richness over a 50-Year Time Period within a Landscape Context (Stream and River Fishes: Assemblages and Movement)

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Worldwide, streams and rivers are facing a suite of pressures that change water quality and degrade physical habitat, both of which can lead to changes in the composition and richness of fish populations. These potential changes are of particular importance in the southeast USA, home to one of the richest stream fish assemblages in North America. Using data from 83 sites sampled in the 1960's and the previous 20 years, we used hierarchical Bayesian models to evaluate relationships between species richness and catchment land use and land cover (eg, agriculture and forest cover). In addition, we

examined how the rate of change in species richness over 50 years was related to catchment land use and land cover We found a negative and positive correlation between forest land cover and agricultural land use and average species richness, respectively After controlling for introduced species, a majority (66%) of stream sites showed an increase in native fish species richness, and the magnitude of the rate of increase was positively correlated to the amount of forested land cover in the catchment Site-specific trends in species richness were not positive, on average, until the percentage forest cover in the network catchment exceeded about 55% These results suggest that streams with catchments that have moderate to high (> 55%) levels of forested land in upstream network catchments may be better able to increase the number of native species at a faster rate compared to less-forested catchments

Reintroduction of Turquoise Darter (*Etheostoma inscriptum*) to Sixmile Creek, SC (Stream and River Fishes: Assemblages and Movement)

*Jeffrey Foltz**, Clemson University, *Jay DeLong*, Clemson University, *Kevin Kubach*, South Carolina Department of Natural Resources and *Stephan Irwin*, Tri-County Technical College

Imperilment of the fish fauna in the southeastern United States is well documented Furthermore, imperilment is high in the family Percidae due to losses of darters in the genera *Etheostoma* and *Percina* Local extirpations are almost always attributed to multiple human impacts Sixmile Creek in Pickens County, South Carolina is a creek impacted by multiple human activities in the past Large-scale and small-scale damming permanently isolated the creek and the watershed experienced poor agricultural practices in the early 1900's Land and forest management practices after the 1930's resulted in the return of water quality and stream habitat integrity in Sixmile Creek Any reasonable fisheries scientist would conclude that the turquoise darter (*Etheostoma inscriptum*) should be part of Sixmile Creek's fish fauna based upon present day distribution of this species in surrounding watersheds This paper summarizes the efforts of three Masters Degree students over a period of 25 years to 1) define the habitat requirements of the turquoise darter, 2) evaluate the habitat in Sixmile Creek as a candidate stream for reintroduction of turquoise darter, develop and implement a reintroduction program, and 3) assess the success of the reintroduction efforts and describe basic biological characteristics of the turquoise darter Turquoise darters have well defined habitat requirements described as water velocity of 60 cm/sec, cobble-boulder habitat (65 using modified Wentworth scale) and depth of < 20 cm Evaluation of Sixmile Creek's habitat in terms of proportion of riffles and characteristics of the riffles indicated that Sixmile Creek would provide suitable habitat Approximately 100 turquoise darters were introduced from Prater's Creek each year during February Darters were released on upstream riffles Each year darters were introduced on progressively more upstream riffles A total of 620 darters were introduced from 2003 to 2009 The restoration of turquoise darters was very successful Riffles in Sixmile Creek averaged 0.37 turquoise darters per square meter The sex ratio in the spring was 1.8 females per male Gonadosomatic indices (GSI) of females peaked on April 23rd at 13% Male's GSI peaked about three weeks earlier Fecundity ranged from 122-235 and there was evidence that *Etheostoma inscriptum* is a multiple spawner

Status of the Leopard Darter (*Percina pantherina*) in Southeast Oklahoma Streams (Stream and River Fishes: Assemblages and Movement)

*Curtis Tackett**, Oklahoma Department of Wildlife Conservation

The Little River system in southeastern Oklahoma and southwestern Arkansas supports all of the known populations of the federally threatened Leopard Darter (*Percina pantherina*) Throughout its range, the Leopard Darter has never been common, but its status has declined in recent decades as a result of habitat loss and habitat fragmentation due to the construction of reservoirs These reservoirs prevent the movement of Leopard Darters between the populations in each of the major tributaries of the Little River (eg Glover River and Mountain Fork River) and therefore isolate these populations and further endanger the species Critical Habitat is designated for this species in portions of the Little River, Glover Creek, and the Mountain Fork River within McCurtain and Pushmataha counties, OK, and in Polk County, AR Among the priority tasks identified in the Leopard Darter Recovery Plan are the identification of important Leopard Darter habitat and monitoring of the remaining populations The US Fish and Wildlife Service's Tulsa Field Office and the Oklahoma Department of Wildlife Conservation have monitored Leopard Darters for more than 20 years at traditional locations It is important to continue this effort and to conduct surveys at other sites that potentially support this species Future potential recovery options including introduction of this species in historic locations where they are not presently found are being considered

Fish Species Incidence Patterns in Naturally Fragmented Desert Streams: The Importance of Aquatic Refugia and Rescue Effects (Stream and River Fishes: Assemblages and Movement)

*Seiji Miyazono**, Texas Tech University and *Christopher Taylor*, Abernathy Fish Technology Center

Stream fragmentation via desiccation is a primal driver for desert fish assemblages We hypothesized that fragmentation of the stream continuum would intensify local species extinction by limiting dispersal and increasing the effects of local environmental factors on desert fish assemblages To test this hypothesis, we examined species-volume relationships, nested subset patterns, and distance-decay relationships for fish assemblages in 42 pools from three Rio Grande system stream reaches with different fragmentation levels in the Trans-Pecos region of Texas, USA Our results suggested that fish assemblages in our study sites were largely extinction-driven, and that large, deep pools were important aquatic refugia that could prevent the local extinction of certain fish taxa However, species-volume curves indicated that species richness for a given pool volume decreased with the degree of habitat fragmentation, suggesting that rescue effects might also be an important factor for decreasing the local species extinction In addition, we found a significant distance-decay relationship for fish assemblages in the most fragmented stream segment, suggesting that predation by nonnative species on native species in disconnected pool habitats could be intense due to dispersal limitation among pools These results suggested that fragmentation in the stream continuum might intensify local species extinction by decreasing habitat size and limiting rescue effects for fish assemblages in desert stream systems

Developing a Monitoring Protocol for the Pygmy Sculpin (*Cottus paulus*) (Stream and River Fishes: Assemblages and Movement)

*Christopher Matechik**, Auburn University and *Carol Johnston*, Auburn University

Long-term monitoring protocols require adequate levels of precision in order to detect temporal changes in abundance or density of a species However, the ability to detect changes can be reduced by sampling variation We used underwater visual observation, and evaluated two sources of sampling variation, habitat patch type and observer effects, to aid the development of a long term monitoring protocol for the

pygmy sculpin (*Cottus paulus*) The Pygmy Sculpin is endemic to Coldwater Spring and its associated run, near Calhoun County, AL. Rising concentrations of trichloroethylene (TCE) threaten the Pygmy Sculpin, thus there is a great need for a monitoring protocol. Our data indicate that pygmy sculpin utilize habitat patches disproportionately, which causes an increase in sampling variation if habitat patch type is not accounted for in the sampling scheme. A comparison between a simple random sampling scheme and a sampling scheme stratified by habitat type showed that the stratified sampling scheme had less variation for an equivalent amount of sampling efforts. Coefficients of variation were used to determine the optimal sample sizes for the strata. After developing a protocol, we compared multiple observers to determine if observer experience levels affected Pygmy Sculpin counts.

Ecological Benefits of Stream Mitigation in an Intensively Mined Region (Stream and River Fishes: Assemblages and Movement)

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Large scale surface mining in the Appalachians causes significant alteration of headwater catchments, and these impacts may be offset through stream restoration. There have been over 100 mining related stream mitigation projects in West Virginia in the last 10 years. Unfortunately, very little is known regarding the ecological benefits of mitigation projects. In this project we use a before-after-control-impact design to 1) quantify the ecological benefits of 21 stream restoration projects in the southern WV coalfields; 2) identify factors constraining benefits; and 3) model benefits of mitigation to assist in future site selection. Our results indicate that the benefits of the mitigation include: increased fish habitat and bed complexity, increased substrate diversity, increased macroinvertebrate biomass and diversity, and increased fish biomass and diversity. However, elevated TDS represents a critical factor limiting benefits of habitat restoration actions. Furthermore, mitigation benefits are minimal in streams that are highly isolated by poor regional conditions. Ultimately, our results can be used to guide stream mitigation actions that are more effective in restoring and maintaining ecological function of mined watersheds.

Hydrologic Structuring of Fish Life History Strategies Across the US: Implications of Losses in Flow Variation on Fish Assemblages (Stream and River Fishes: Assemblages and Movement)

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Lotic fish have developed life history strategies adapted to the natural variation in stream flow regimes. The natural timing, duration, and magnitude of flooding, as well as the hydrologic stability and predictability of lotic environments, contributes to the diversity, production, and composition of fish assemblages over time. Studies evaluating the role of hydrology in structuring fish assemblages have been more common at the local or regional scale with very few studies conducted at the continental scale. Furthermore, quantitative linkages between natural hydrologic patterns and fish assemblages are rarely used to make predictions of ecological consequences of hydrologic alterations. This study asks two questions: 1) What is the relative role of hydrology in structuring fish assemblages at large scales? and 2) Can predictive relationships between fish assemblages and natural hydrology be utilized to predict fish assemblage responses to hydrologic disturbance? We developed models to predict fish life history strategies using landscape predictors and hydrologic variables separately and then together. We then used models to predict the ecological consequences of altered hydrology due to dam regulation. We found that

hydrology does play a considerable role in structuring fish assemblages. However, the performance of models using only hydrologic variables was lower than that of models constructed using landscape variables. Isolating the relative importance of hydrology in structuring fish traits at the continental scale is difficult since hydrology is interrelated to many factors. By applying models to dam-regulated hydrologic data, we observed a few, but consistent predicted responses in fish life histories. In agreement with existing literature, equilibrium strategists are predicted to increase following dam regulation whereas opportunistic and periodic species are predicted to decrease.

Rapid Multi-Attribute Stream Surveys: A New Solution to Old Problems (Stream and River Fishes: Assemblages and Movement)

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As fisheries professionals, we develop models representing stream and water quality conditions as the basis for response to many management issues. However, most of these models are based on point samples or descriptions of short (several 100m) sections of stream or rivers. By using a new multi-attribute stream survey technique that integrates GPS, video, depth, water chemistry, and side-scan sensors, it is now feasible to survey many miles of stream (10 to 15 miles typically) in a single day with data collected approximately every meter. This new surveying approach can rapidly and cost-effectively transform the data-poor stream reaches into multi-attribute, high-resolution maps of the stream, stream channel, and water quality conditions. This output allows resource managers to move from statistical assumptions about the “average condition” of a stream based on a few small samples to a census of conditions with highly accurate, site-specific data available. All of the data collected is georeferenced and can be classified in GIS software to support multiple management objectives. As an example of the application potential of the multi-attribute stream survey technique, a number of recent studies in which we have been involved are highlighted. These projects address issues associated with classifying stream bank erosion susceptibility, monitoring the effects of dam removal, assessing impacts associated with mining, and determining habitat loss for endangered species. These case studies show the range of data collected and its utility in GIS mapping, hydrologic modeling, habitat identification, and overall stream health applications.

Incorporating a Trait-Based Approach into Effective Stream-Fish Management and Monitoring (Stream and River Fishes: Assemblages and Movement)

Robert Mollenhauer, Oklahoma State University*

Incorporating a Trait-Based Approach into Effective Stream-Fish Management and Monitoring

Robert Mollenhauer, Oklahoma State University, Oklahoma Cooperative Fish and Wildlife Research Unit, Stillwater, OK

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The alarming trends in the loss of fish species diversity require that stream researchers and managers act with a sense of urgency to devise sound conservation strategies. Aquatic organisms possess combinations

of morphological, behavioral, and physiological traits that have evolved together for adaptations that maximize fitness. Applying a trait-based approach to stream-fish conservation can increase the long-term success of management and monitoring programs. Understanding relationships between fish traits and the stream environment can assist in directing habitat protection and restoration efforts and allows stream managers to better assess the likelihood that individual fish species will persist with changing climate and land use. Linking stream fishes through common traits broadens the applicability of studies and provides insight into rare and poorly-studied species. Fishes that have similar combinations of behavioral and morphological traits will also likely have similar sampling-gear catchability. The objective of this study was to use hierarchical clustering to group stream fishes of the Ozark Highlands based on common ecomorphological (eg, relative size of fins, mouth, eye, etc) and life-history (eg, reproductive and feeding strategies) traits. Fish species were grouped into different numbers of clusters, but we simplified groups based on 24 traits hypothesized to be meaningful to issues threatening lotic ecosystems (eg, flow alteration). We demonstrate how these groups are useful for both standardizing stream-fish sampling methods and identifying potential future fish species of conservation concern.

Analysis of a Long-Term Brook Trout (*Salvelinus fontinalis*) Dataset: Comparisons Using 25 Appalachian Headwater Streams (Stream and River Fishes: Assemblages and Movement)

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Headwater streams provide pristine habitat for aquatic communities and are the predominant lotic ecosystem in the Appalachian Mountains. Changes in these habitats may therefore cause a proportional change in biotic populations greater than one would normally expect. We have used a long-term brook trout *Salvelinus fontinalis* dataset which includes both fish and habitat data to explore patterns and relationships over the last 10 years in 25 headwater streams in West Virginia, USA. Several patterns have emerged, such as a correlation in drought and juvenile trout recruitment. Also, we report density-dependence in brook trout populations across most streams with the potential for density-independent events to influence the patterns of brook trout distribution. We report impacts of “super storm” Sandy on these streams with respect to woody debris loadings before and after the disturbance event. These data may help forecast effects of future disturbance and impacts caused by anthropogenic pressures and/or climate change. We highlight the value of long-term datasets for their ability to show patterns and consistency useful for both research and management in variable ecosystems such as headwater streams.

Identifying Connectivity Differences Between Habitats of a Brook Trout Metapopulation Using Stable Isotope Analysis (Stream and River Fishes: Assemblages and Movement)

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Mobility is an important component of a species life history. This is especially true for a metapopulation, where movement among subpopulations allows for greater persistence within the landscape. The brook trout population of Shavers Fork West Virginia shows a unique spatial structure, where tributaries are sources of brook trout productivity and the mainstem provides important foraging habitat. We used stable isotopes of carbon and nitrogen to identify the relative connectivity of different tributaries to the mainstem of this watershed. We collected caudal fin tissue from 20 fish at 9 sites, 2 mainstem and 7

tributaries Mean position in $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ biplot space was used to reveal which tributary populations showed the greatest connectivity to the mainstem Classification of individual trout as mainstem (mobile) or tributary (resident) foragers was done by relating signatures of individuals in biplot space to the closest mean habitat signature We found that the mainstem and more mobile tributary subpopulations had a mean isotopic position more enriched in both $\delta^{15}\text{N}$ and $\delta^{13}\text{C}$, as expected for fish using the mainstem to forage This was also supported by the more mobile tributary populations containing a higher number of individuals with a mainstem signature Our results suggest that some tributaries within this watershed show greater connectivity to the mainstem than others Use of the mainstem within this watershed is extremely important for brook trout to supplement their growth, and this approach provides a means to identify which tributaries maintain the greatest connectivity to this important foraging habitat

South Carolina Stream Conservation Planning tool (Stream and River Fishes: Assemblages and Movement)

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Identifying and communicating the relationships between natural gradients, human activities, and aquatic habitat integrity is crucial to aquatic conservation The South Carolina Department of Natural Resources (SCDNR), in conjunction with Clemson University, has developed a novel web-based South Carolina Stream Conservation Planning Tool that enables a spatially explicit understanding of how human activities affect the biological condition of wadeable streams, intended to support decisions about aquatic conservation actions The web mapping application communicates findings from the South Carolina Stream Assessment (SCSA) to a broad audience, allowing users to visualize predicted biological conditions based on their status and severity across all South Carolina wadeable stream catchments Additionally, an interactive catchment management tool allows users to explore and forecast the impacts of customized land management scenarios on aquatic resource indicators at any user-specified location across South Carolina, and so engages users in the process of modeling and forecasting stream conditions

We selected stream condition metrics from over 200 measurements taken at approximately 700 streams locations sampled during the SCSA from 2006 to 2011 Metrics were related to spatial predictor data created under the National Fish Habitat Assessment We generated prediction models using the Random Forest machine-learning technique from the sample data, and applied the predictions to the entire population of wadeable stream reaches in the state The mapping application provides users with a browser-based interface to modify predictors at the catchment (local) scale A web service dynamically generates predictions based on these user inputs, and results are mapped at watershed (network) scales to display cumulative effects of the changes The dynamic execution of models broadens the utility of the application and opens the forecasting process to a non-technical audience By providing an accessible means of forecasting the effects of management decisions, the tool encourages a watershed perspective towards aquatic conservation The application is targeted to stakeholders at the policy making and conservation planning levels The approach described has been set up for South Carolina but is applicable to assessment programs at the regional and national levels

Age and Growth in Fishes

Movements of Striped Bass in North Carolina Waters Inferred from Otolith Chemistry (Age and Growth in Fishes (2))

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Striped bass, *Morone saxatilis*, is an important, highly migratory commercial and recreational species with significant fisheries along the eastern American seaboard. Their broad migration patterns complicate management strategies. With three independently managed stocks, North Carolina managers need to understand potential mixing of these different stocks. Striped bass from two major management areas in North Carolina -- the Albemarle and Roanoke River Management Area, and the Central/Southern Management Area -- were used to analyze migration patterns. Otolith microchemistry analyzed by LA-ICP-MS was used as a proxy for migration patterns as otoliths incorporate trace elemental signatures of the watersheds the fish inhabit. Preliminary results suggest a portion of the older Albemarle stock is anadromous, and many young fish enter ocean waters at a young age, then return to reside in Sound waters.

A Comparison of Ageing Methods in Red Snapper *Lutjanus Campechanus* (Age and Growth in Fishes (2))

*Danielle Horn**, Auburn University

Red Snapper (*Lutjanus campechanus*) is a highly exploited species of the northern Gulf of Mexico. Monitoring of the current stock and its directional trend relies on the determination of growth rate, mortality rate, and productivity. These values are generated in large part from accurate age data collected from annual opaque zone formation of otoliths. Presently, it is common practice to section Red Snapper otoliths prior to ageing. However, if a whole otolith could be accurately read than it would reduce processing time and cost. To test this hypothesis whole otolith opaque increments were compared to sectioned otolith increments. We collected and counted increments on 1504 un-sectioned otoliths. From these we randomly selected otoliths (total n=523) from each whole "age" up to age 6 (n=52 to 139 per age), and sectioned and counted increments for comparison to whole otolith counts. All otoliths with whole increment counts > 6 were sectioned due to lower sample sizes in older age groups. For all otoliths a linear regression of whole on sectioned otolith counts showed a slope = 0.84, $r^2 = 0.90$ (n= 591). For sectioned otoliths < age 7 a linear regression of whole on sectioned otolith counts showed a slope = 0.94, $r^2 = 0.94$ (n=523). As expected, these data showed that whole otolith counts for older Red Snapper (ages > 6) will underestimate the true age. However, the use of whole otoliths for ages 1 to 6 produced similar ages compared to sectioned otoliths. Although there is not complete agreement between whole and sectioned otoliths future studies might apply whole otolith aging methods considering the time and effort reduction.

Validation of Daily Ring Deposition in the Otoliths of Age-0 Alligator Gar (Age and Growth in Fishes (2))

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We developed and validated techniques for estimating the daily age of young-of-the-year alligator gar, *Atractosteus spatula*. These techniques allow fish ecologists to estimate hatch dates and early growth rates and to investigate other aspects of the early life histories of fishes. In addition, these tools allow us to assess how environmental factors may influence hatching success, the transition from endogenous to exogenous feeding, and early growth. Known-age alligator gar larvae were reared in the laboratory and were sampled from 3-d to 118-d post-hatch. Sagittal otoliths were extracted from each fish, and each otolith was embedded in a clear epoxy resin. Otoliths were sectioned, along a longitudinal plane, using a Buehler® high-precision sectioning saw and mounted with thermoplastic cement to microscope slides. Each otolith section was sanded with 600-grit sandpaper to reveal daily rings and then polished with ultra-fine, 1500-grit sandpaper. Otoliths were read three times each in random order without reference to known ages. The mean of the three counts for each otolith was used for analyses. Thus far, we have estimated the ages of eight fish. Mean daily ring count and known age were closely related ($r^2 = 0.94$, $P < 0.001$, regression slope = 0.968), indicating that daily ring deposition occurred in the otoliths of alligator gar. Daily increment counts were accurate through 76 d post-hatch, with mean deviance of estimated age within 2 d of the known age. Daily increments could be enumerated for older fish; however, accuracy decreased with age. Daily increments around the core (up to ≈ 15 d post-hatch) were difficult to read, but later increments were more discernable and deposited in a more regular pattern. We expect that a modification of our technique will enhance the readability of inner rings (ie, by hand-sectioning resin-embedded otoliths). We encourage researchers to utilize our aging technique to estimate hatch dates, the timing and frequency of hatching, and early growth rates of alligator gar in wild populations. Such early life-history information will be valuable in enhancing the management and conservation of gar populations. We expect to have over 75 YOY gar aged at the completion of this project.

Quantification of Life History Parameters in South Carolina Spot (*Leiostomus xanthurus*) (Age and Growth in Fishes (2))

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Spot (*Leiostomus xanthurus*) is targeted heavily by recreational anglers and it is also an important prey item for many marine piscivores, but no stock assessment has been performed, partly due to a lack of vital life history information. In response to research priorities identified by the Atlantic States Marine Fisheries Commission, the aims of this project were: (i) to validate the timing and frequency of annulus deposition in South Carolina spot otoliths, (ii) to determine age-at-length relationships for spot captured in South Carolina fishery-independent and fishery-dependent surveys, and (iii) to determine the sex ratio and size and age of maturity of spot in South Carolina. Annulus deposition in otoliths occurred once per year during April-June, with the first annulus being deposited at age 1. The majority of spot caught in both survey types were age 2 or younger. Age-at-length keys were similar between fishery independent and fishery dependent surveys, but they differed substantially between survey years due to variation in year class strength. The majority of males and females reached maturity at age 1. Females matured at a slightly greater length than males, and female size at maturity varied between survey years, possibly due to

density dependent effects Since age composition and reproductive parameters differed between years, it is recommended that these parameters should be monitored annually in order to provide data sufficient for stock assessments

Review of Techniques for Estimating the Daily Age of Young-of-the-Year Catfishes (Age and Growth in Fishes)

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I will provide a review of techniques that have been developed and validated for using otoliths to estimate the daily age of young-of-the-year (YOY) catfishes By aging YOY fishes, an ecologist can collect valuable information regarding the early life history of a species, including the estimation of hatch dates, hatch frequencies, and early growth rates (during yolk-sac and later stages, in some cases) Daily aging techniques also allow us to identify the critical environmental requirements of the early life history stages of fishes in freshwater and marine environments Therefore, this information is vital to the proper and enhanced management of a sport fish Early life history data collected for wild channel catfish populations in Alabama will also be presented

A Comparison of Age and Growth, and Size Structure of Blue Catfish in Oklahoma Between Tailwaters/Rivers and Reservoirs (Age and Growth in Fishes)

Chas Patterson, Oklahoma Department of Wildlife Conservation*

Blue catfish are found in reservoirs and river systems throughout Oklahoma Because of their broad distribution, blue catfish are popular among Oklahoma anglers throughout the state ranking as the fourth most preferred sport fish in Oklahoma since 2001 Most anglers target these fish in reservoirs, although approximately one-third of anglers target blue catfish in tailwaters and rivers Since 2003, the Oklahoma Department of Wildlife Conservation has collected abundance, age, size structure, and mortality data on 14 reservoirs throughout Oklahoma Results from those studies indicated that reservoir populations are dominated by blue catfish < 400mm total length In addition, growth of Oklahoma blue catfish is relatively slow, taking approximately 16 years to reach “preferred size” (762 mm, TL) In order to get a more complete representation of Oklahoma’s blue catfish fishery, five tailwater/river systems were electrofished for blue catfish and compared to previously collected reservoir data Size structure results indicated the proportion of blue catfish ≥ 762 mm (30 inches) was 15% in both the tailwaters/river and their respective reservoirs although blue catfish < 300 mm occurred less frequent mm in the tailwaters/river than in reservoirs In addition, growth was similar between tailwater/river and reservoir populations although growth in reservoirs was more variable These results continue to support the current statewide blue catfish regulation that has a daily creel of 15 fish of which only 1 fish can be ≥ 762 mm

Black Hole Or Gold Mine? Using Otolith Microchemistry To Answer Key Questions For Life History Strategies Could Be The New Glory Hole (Age and Growth in Fishes)

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The strategic habitat areas of striped bass (*Morone saxatilis*) continue to be a topic of interest to researchers, fisheries managers, recreational and commercial fishermen. This research will evaluate movement and site fidelity of the key species by assessing trace elements in otoliths and water chemistry in the Albemarle Sound/Roanoke River stock of North Carolina. Key elements have been identified to determine maternal contribution of resident versus anadromous mothers. Additionally, movement on small and large spatial scales has been analyzed to determine whether mature fish were resident versus migratory. Otolith microchemical analysis has also shown that hatchery fish were naturally tagged due to elemental deposition from aquifer water used during juvenile development. As a result, researchers have been able to discriminate hatchery fish from naturally spawned fish collected in the Albemarle Sound/Roanoke River. Major advances in otolith chemistry have provided answers to key questions in identifying movement and designing effective management strategies.

Use of Bomb Radiocarbon in Age Validation of North Atlantic Wreckfish, *Polyprion americanus*, Including New Estimates of Growth and Natural Mortality (Age and Growth in Fishes)

*Adam Lytton**, South Carolina Department of Natural Resources

Wreckfish, *Polyprion americanus*, is a commercially important long-lived demersal fish, occurring throughout the Atlantic. Wreckfish can be found in the eastern Atlantic from Norway to South Africa; including the Mediterranean, Canary Islands, Azores, Bermuda, and Madeira, and along the western north Atlantic from Grand Banks, Newfoundland to La Plata River, Argentina. Despite the wide geographic range, recent DNA evidence distinguishes a northern Atlantic and a southern Atlantic population. Commercial fishing for wreckfish takes place throughout its north Atlantic range, with the exception of Bermuda. Despite their importance to commercial fisheries, there is still uncertainty regarding several life history parameters, which in turn leads to greater uncertainty in stock status. For example, age estimates from the only previous age/growth study on north Atlantic wreckfish have not been validated and is thought to have under-aged wreckfish, possibly leading to inaccurate estimates of length at age, maximum age, and various related life history parameters. Many of these parameters are important for stock assessment and management. This study successfully used bomb radiocarbon to validate age estimates and annual increment formation in this long-lived species. The maximum observed age was 8 years, more than double the previous maximum age of 39 years. The updated length at age information (n= 554) was then fit to the von Bertalanffy growth model. The new growth parameter estimates were $L_{\infty}= 102$ cm, $k= 0.124$ yr⁻¹, $t_0= -496$ yrs. Subsequently, the growth parameter estimates and maximum age were used to estimate natural mortality rates, which ranged from $M= 0.009$ to $M= 0.275$. This new age/growth information is based on recently sampled specimens, collected during 2000 to 2011. Thus, this updated information should be used in future stock assessments and management of wreckfish.

Validation of Daily Growth Increments in Alligator Gar (*Atractosteus spatula*) (Age and Growth in Fishes)

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Daily ring formation has been validated for a variety of fish species, but there is little known information or data on ageing young of year alligator gar (*Atractosteus spatula*). Accurate age and growth information is essential in successful management of a fish population and for a complete understanding of early life history. In order to validate daily growth increments, acquiring known age fish is critical. Fortunately, as

the management of alligator gar has become increasingly important, particularly from stocking practices, artificial spawning and rearing has been conducted in many states creating a readily available source of known-age fish for which to validate daily ring formation. Therefore, alligator gar fry were received that have been artificially spawned with a known spawn date, hatch date, and swim-up date. These fry were stocked into two ponds at Tishomingo National Fish Hatchery and reared. Up to 10 individuals were sampled from the ponds every week, and their otoliths (sagitta, lapilli, and astericus) removed and daily age estimated. Results from this study will be presented and will help inform fisheries biologists which otolith is most accurate in reading daily growth increments. These analyses of the otoliths microstructure from known age fish will confirm when first growth increment is formed and deposited as well as if one growth increment was formed per day.

Age and Growth of the Invasive Asian Swamp Eel from South Florida Waters (Age and Growth in Fishes)

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The Asian swamp eel, *Monopterus albus*, is an invasive species in south Florida waters, where it is widely considered a potential threat to the ecosystem and native biota. Life history data detailing the age structure and growth of this species can prove useful in helping to control its further dispersal to other regions. Unfortunately, the use of otoliths to age fishes from tropical environments is often challenging, due to the lack of strong seasonal variation in environmental temperature. Our main goals were to 1) determine if otoliths could be used to effectively age invasive swamp eels in South Florida and 2) use otoliths to estimate the ages and growth rates of swamp eels. Twenty sagittal otoliths were processed from eels that ranged from 241 mm to 702 mm in total length. Transverse sections of otoliths were read independently by two experienced readers, and any disagreements in age assignments between readers were resolved through concert reads. Independent estimates of ages yielded 25% initial agreement. However, the average age discrepancy for samples disagreed upon was only 12 years, and readers agreed on ages up to 11 years. In addition, reader agreement for final age assessments was 100% after concert reads. Mean swamp eel age was 66 years, with ages ranging from 3 to 11 years. A strong, positive relationship was observed between the total length and $\log_{10}(\text{age})$ of eels ($r^2 = 0.656$, $P < 0.001$). As *Monopterus albus* is a protogynous hermaphrodite, the mean age of females, intermediates (transitional eels), and males was observed to coincide with this trait (females = 593 years, intermediates = 9 years, males = 95 years). These preliminary results, while not conclusive, are promising and additional samples will be processed to better detail the age and growth of this species.

Black Bass

A Meta-Analysis of Factors Potentially Influencing Contribution of Stocked Largemouth Bass to a Year-Class (Black Bass)

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We reviewed 116 stocking events from 18 published studies to characterize factors that may influence enhancement of Largemouth Bass populations with hatchery fish. Factors examined included system type and size, how hatchery fish were fed, size at stocking, stocking density, method of introduction, and marking and sampling methods. We used logistic regression to determine which factors resulted in a high contribution of hatchery fish to the year-class in the fall and spring following stocking. System size ranged 1–8484 ha. Stocking size ranged 23–315 mm. Stocking density ranged 1–645 fish/ha. Contribution of hatchery fish to a year-class ranged 0–100% and 0–90% in the fall and spring, respectively. Median stocking contributions were 15% and 14% for the fall and spring, respectively. Logistic regression indicated that stocking fish at a single location rather than throughout the littoral area resulted in higher fall and spring stocking contribution. Likewise, how fish were marked was significantly related to both fall and spring stocking contribution. Fall stocking contribution was more likely to be higher in natural systems, however this relationship disappeared by the following spring. Stocking density did not affect fall stocking contribution, however stocking density was positively related to spring stocking contribution. Systems with higher fall stocking contribution were more likely to have a high spring stocking contribution. How fish were fed, size at stocking, system surface area, and sampling method did not significantly affect fall or spring stocking contribution. Furthermore, mean fall stocking contribution did not differ between events deemed successful and unsuccessful by authors of the studies. Meta-analysis of stocking evaluations is hindered by poor reporting of program methodology in the published literature. However, careful consideration of hatchery rearing methods and stocking program goals may aid in realizing stocking program success.

The Stocking of Advanced-Size Fingerling Florida Largemouth Bass in Lake Talquin, FL... a Recipe for Enhancing a Trophy Bass Population (Black Bass)

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There has always been interest in the supplemental stocking of largemouth bass *Micropterus salmoides* in the Southeast. Many previous largemouth bass supplemental stockings used high numbers of small individuals or lower numbers of larger individuals reared on artificial (pellet) feed. Since 2000, Florida Fish and Wildlife biologists stocked variable numbers of advanced size fingerling (65-100 mm TL) Florida largemouth bass *Micropterus salmoides floridanus* reared on live prey (fairy shrimp and zooplankton) into Lake Talquin, a 3,561 hectare eutrophic reservoir in Northwest Florida. An attempt was made to stock all bass prior to May 15 each year. This stocking date was critical to ensure stocked bass could immediately consume YOY threadfin shad *Dorosoma petenense* as the primary forage and to prevent stress from high water temperatures (>26 °C). Numbers of stocked fish ranged from five to 60 fish/ha annually. In 2008, we reported that the highest stocking density (60 fish/ha) resulted in a 40% hatchery contribution to electrofishing samples at age 0 in the fall and a 37% contribution to electrofishing samples at age 3. In recent years, biologists have noticed an increase in the number of trophy bass (> 600 mm TL and 8 lbs) from Lake Talquin, despite significantly large year-classes naturally produced in 1984, 1991 and 1998 as a result of lake-wide drawdowns to improve nursery habitats. From 2010-2012, fifteen trophy-sized hatchery coded wire tag (CWT) bass weighing 8-125 lbs were recaptured during FWC long term monitoring samples or largemouth bass angler tournaments, even though approximately only 20% of early stockings (2000-2003) were tagged. Furthermore, 77 largemouth bass weighing 8-15 lbs were collected in 2013, of which only two were not identified as pure *Floridanus* based on genetic micro-satellite analysis of fin clips. Most of these are likely hatchery reared fish as prior to any

stocking, the percentage of pure *Floridanus* in Lake Talquin was reported at 12% During a statewide trophy bass (>8 lbs) tagging study in 2012 and 2013, six of the ten largest individuals in the state of Florida (by weight) were collected from the Lake Talquin system These long-term data suggest that the stocking of advanced fingerling Florida largemouth bass reared on live prey into a recruitment limited system with abundant, appropriate size forage improved trophy largemouth bass abundance and enhanced the quality of a trophy bass fishery

Year Class Response Of Largemouth Bass To Drawdown Management and Hydrilla Coverage At Rodman Reservoir, Florida (Black Bass)

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We examined the effects of reservoir drawdowns and hydrilla coverage on largemouth bass year class strength at Rodman Reservoir, Florida Average catch curve residuals that were obtained from multiple age samples illustrate that four of the seven cohorts produced during drawdown water levels were strong year classes, whereas the majority of cohorts produced during normal pool levels were generally average to weak year classes Linear regression of average catch curve residuals and the net change in percent area covered (PAC) of hydrilla were positively related ($R^2 = 0.60$) in cohorts produced during drawdown water levels, whereas no relationship was found between cohorts produced during normal water levels and hydrilla PAC The largemouth bass fishery at Rodman Reservoir could be managed for strong year classes in predictive intervals (3-4 years) by the current drawdown magnitude, timing, and duration if hydrilla PAC is managed accordingly

Decreasing Capture Vulnerability of Florida Bass *Micropterus Floridanus* with Exposure to Catch and Release Angling (Black Bass)

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The great regional economic benefits of recreational fisheries are tied to the level of satisfaction achieved by its anglers Angler satisfaction can be strongly influenced by catch rates of targeted sport fish A long standing perception in recreational fisheries is the proportionality between population densities and catch rates Attributable to this is the increasing practice of catch and release fishing, enforced through regulation and social norms A very limited amount of previous work has shown that this relationship may not hold true if caught and released fish modify their behavior with exposure to angling We wished to test this on a naïve population of Florida bass *Micropterus floridanus* in central Florida We structured the experimental design to identify how bass catch rates may change over time with cumulative angling effort Additionally, we wanted to see how the rate at which catch rates changed differed between lure types; active and finesse Previous mark-recapture studies using passive integrated transponder tags allowed us to begin with an estimated population size and continued marking allowed us to identify individual fish throughout the study The finesse lure expressed a linear decline in CPUE dropping from initial 177 fish per angler hour to 0.83 fish per angler hour at 144 cumulative hours The active lure showed an exponential decline in CPUE from 233 fish per angler hour to a final observed value at 144 cumulative angler hours of 0.25 fish per angler hour These results show that not only do caught and released fish

modify their behavior to avoid capture with cumulative angling hours but different lure types with different environmental cues induce this change at different rates This abrupt drop in CPUE means that normative practices like catch and release fishing may not increase CPUE proportionately to abundance This continuation of a limited pool of previous literature has great implication on how recreational fisheries should be managed in the future

History, Status and Management of Black Bass (*Micropterus*) Species in South Africa (Black Bass)

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South Africa has a long history of non-native sport fish introductions because native fish faunas contained few species that had sport fishing potential After the successful introduction of trout (*Oncorhynchus mykiss* and *Salmo trutta*) in the 1890s, four *Micropterus* species were introduced to create angling opportunities in warmer lowland rivers and impoundments Largemouth Bass *Micropterus salmoides* Spotted Bass *M punctulatus*, Smallmouth Bass *M dolomieu* and Florida Bass *M floridanus* were imported between 1928 and 1980 Establishment was very successful, and most river basins now contain at least one *Micropterus* species This resulted in the development of a vibrant sport fishery that, through associated expenditure, contributes significantly to the South African economy The South African recreational bass fishery is almost identical to that in the USA including formal ties between the South African Bass Angling Association and the Bass Anglers Sportsman Society in the USA Black bass are, however, a major threat to aquatic biodiversity in South Africa because their predation on and competition with native fishes and invertebrates has impacted negatively on aquatic community structure and has fragmented native fish populations Black bass are therefore specifically listed in the National Environmental Management: Biodiversity Act as requiring management Implementation measures include import and movement controls and eradication from conservation priority areas I provide an overview of *Micropterus* introductions, impacts and fisheries in South Africa with emphasis on existing and evolving legislation, conflicts, implementation strategies and the sometimes innovative approaches that have been used to prioritise conservation areas and manage Black bass populations Special reference is made to recent research collaborations between AFS members from South Africa and the USA

The Impacts of Catch and Release Angling on the Reproductive Success of Florida Bass, *Micropterus Floridanus* (Black Bass)

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Largemouth bass (*Micropterus* spp) are the most important, recreational freshwater game fish in North America and represent an interesting challenge for resource managers Although an estimated 60% of all captured black bass are caught and released, angler behaviors such as ‘bed fishing’ of nest guarding males have been shown to cause egg loss due to predation and increase the likelihood of individual nest failure This study evaluated catch-and-release angling as a potential mechanism for altering individual contribution rates to recruitment in Florida bass (*Micropterus floridanus*) We established nine replicate populations containing adult bass, forage fish, nest predators, and vertical structure to simulate natural area lakes A fishing treatment was applied to five lakes wherein nest guarding adult bass were targeted using conventional fishing tackle and individual nest fate was tracked via three times weekly snorkeling efforts Nine months after the establishment of experimental populations we drained all ponds and

collected fin clips from all adults and a subsample of juveniles for genetic analysis. We conducted parentage analysis using microsatellite markers to estimate the reproductive success of individual males and females and to test for differences in average contribution rates across fished and unfished populations. Preliminary findings will be discussed.

Evaluating the Efficiency of a Collection Device for Quantifying Densities of Early Life Stages of Smallmouth Bass in Streams (Black Bass)

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Abstract- Quantification of early life-history stages of fishes is an important component in understanding recruitment dynamics in streams. Counting eggs and larvae of fishes is difficult in a field setting because of the varying environmental conditions under which nest construction takes place. We designed a device for sampling early life stages using a 500 gph 12 v bilge pump attached to a 4" pvc collection chamber and 3/4" x 4' clear suction hose. A mesh bag serves as an inline filter and collects the eggs and fry. The objective of this study was to evaluate the efficiency of the sampler under varying velocity (moderate and low) and substrate conditions (sand, gravel, and cobble). We artificially constructed nests using the three different types of substrate, making them similar in appearance to nests constructed by centrarchids. We mixed a known quantity of gellan beads into each treatment (n=X of each substrate type and flow combination) and beads were sampled from each constructed nest using a standard approach. Results indicate the constructed device was at least 85 % efficient at collecting the beads under the different treatments. We also used the device in preliminary trials to collect fry and results indicate high efficiency. Additional testing to understand the bias associated with fry collection is warranted but the device appears to work well under relatively benign streamflow conditions.

Lessons Learned: Management of a Unique Trophy Largemouth Bass Fishery in Georgia (Black Bass)

*Timothy Bonvechio**, Wildlife Resources Division

The low density stocking of female-only largemouth bass *Micropterus salmoides* in combination with a catch-and-release regulation at Ocmulgee Public Fishing Area (PFA) met the objective of providing a unique trophy bass fishing destination. To describe the growth, size structure and mortality of the population, data from angling and electrofishing was compared. Both gears yielded similar numbers of trophy bass (> 36 kg) in the population. Of the total bass collected with both gears, 344 % exceeded the 36 kg mark and 88 % exceeded the 45 kg mark. Size-selective biases were apparent. Both gears consistently caught large individuals > 457 mm (TL), but only electrofishing collected a broader size range of bass including fish as small as 237 mm TL. The Kolmogorov-Smirnov two sample test indicated that the size structure of bass captured with the two types of gear differed significantly when all sizes of fish being captured were examined. For bass > 457 mm TL, angling and electrofishing size structure data did not differ significantly with the Kolmogorov-Smirnov two sample test. For electrofishing, the total annual mortality (A) estimate was 15%, and growth was described with the von Bertalanffy growth curve as $TL = 5642(1 - e^{-0.471[\text{age} + 0.409]})$. Due to a lack of age-classes collected with angling, growth curves and mortality estimates were not obtained. Biologist' should be cautious when using one gear to evaluate

trophy largemouth bass populations given that size selective biases do exist with angling and electrofishing that can influence growth, mortality and length-frequency assessments Volunteer angler data can be a viable method for supplementing electrofishing, especially where trophy sized bass can be difficult to collect

Factors Affecting Nesting Success in Florida Bass *Micropterus Salmoides Floridanus* (Black Bass)

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Male Florida Bass *Micropterus salmoides floridanus* provide parental care to their offspring, aggressively guarding their broods from predators This behavior increases their chances of raising a successful brood, but also makes them vulnerable to angling Factors such as timing of the spawn, brood size, and male total length have all been shown to influence nesting success for largemouth bass *Micropterus salmoides salmoides*, but have not been evaluated for Florida Bass To evaluate these factors, we conducted snorkel surveys during the spawning season and measured a variety of factors that could impact nest success Among lakes and years, apparent nest success varied from 59-100% Nest success did not vary between lakes, substrates, nest depths or nest sizes Presence of a guarding male bass was the strongest determinant of a successful nest This study will aid managers in manipulating habitat for improved recruitment and in stocking allocation of Florida Bass

Impacts of Angling for Nesting Florida Bass, *Micropterus Floridanus*, on Nest Success and Recruitment (Black Bass)

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Nesting black bass *Micropterus* spp exhibit parental care during the spring spawning season Anglers often intentionally target black bass that are guarding nests Previous studies of largemouth *M salmoides* and smallmouth bass *M dolomieu* have shown that catching fish off of nests will increase predation of eggs and larvae, which can reduce individual nest success Little work has been done to evaluate whether this indirect fishing-associated mortality could influence population level recruitment and no work has been done to look at impacts bed fishing has on Florida bass *M floridanus* During this study, nine replicate ponds were stocked with adult Florida bass, forage fish, and nest predators, and brush piles and vertical structure were placed into the ponds to simulate a natural system Ponds were snorkeled every other day throughout the spawning season to track nest success and abandonment In five of the ponds, every nest located was angled Angled fish were held in a cage within the pond for one hour before being released back into the pond No angling was conducted on the other four control ponds Nests were considered successful if swim up fry were observed Nest success rates were 52% for fished ponds and 45% for unfished ponds Of the fish caught off of nests, 50% returned to that nest and ended up with swim up fry Ponds were drained nine months after stocking in order to compare young-of-the-year recruitment between fished and unfished ponds

Understanding Variable Reproductive Effort in a Florida Bass Population (Black Bass)

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Florida Bass *Micropterus floridanus* reproductive effort (ie, the number of broods produced) has varied greatly both within and among a series of neighboring study lakes in north central Florida. The annual number of broods produced within each lake was not related to stock abundance. High proportions of non-spawning adults within populations have resulted in apparent missing year-classes. The objectives of this study were to 1) determine the proportion of spawning adult bass (≥ 250 cm) within each population; and 2) evaluate the period in the annual reproductive cycle when interruptions may be occurring. Mark-recapture population estimates were used to estimate the abundance of Florida Bass in each lake in each year. Snorkel surveys were used to quantify annual reproductive effort as the estimated number of broods produced. The proportion of spawning adult bass in each population in each year was quantified as the number of broods produced per spawner. Gonad histology and plasma samples for concentrations of steroids, estradiol and 11-ketotestosterone were used to evaluate the annual reproductive cycle of fish. Sex and reproductive stage as determined by steroid concentrations were validated using gonad histology from a subset of bass sacrificed in 2011 - 2012. Females were characterized as undeveloped, previtellogenic, early vitellogenic or late vitellogenic. Males were characterized as nonspermatogenic, low spermatogenic activity, moderate spermatogenic activity or high spermatogenic activity. We found evidence for both multiple spawning events per adult and skip spawning. The proportions of adults that did not spawn annually varied from moderate 70-75% to severe 95-98%. Histology and steroid concentrations showed evidence that some non-spawning adult females arrested their reproductive cycle prior to vitellogenesis (ie, resting). There was also evidence that non-spawning females progressed through more advanced stages of development but retained a high proportion of their eggs and were undergoing atresia (ie, reabsorbing, retaining). Individual differences in reproductive cycle cessation may indicate multiple influences determining whether a female is reproductively active in a given season. Understanding the mechanisms influencing annual reproductive cycles is important for evaluating recruitment dynamics in fish populations.

Black Bass (Genus *Micropterus*) Community Composition in the River-Reservoir Interface of Two Southeastern Rivers (Black Bass)

Andrew Taylor*, Oklahoma State University, Patrick O'Rourke, Georgia Department of Natural Resources and James M Long, US Geological Survey

Dams and impoundments are known to alter natural aquatic ecosystems and negatively affect many aquatic species. Similarly, the effects of reservoirs and reservoir-dwelling fishes on native fluvial species that reside in upstream tributaries of reservoirs may have management and conservation implications. The Shoal Bass (*M. cataractae*) and Chattahoochee Bass (*M. chattahoocheae*) are fluvial specialists and popular sport fish endemic to the Apalachicola-Chattahoochee-Flint Basin of the southeastern US. Both species are of conservation concern because of habitat alteration and negative effects of introgressive hybridization and interspecific competition from non-native congeners. Many non-native black bass species occur in reservoirs, creating a source of non-native species to migrate upstream into tributaries and interact with native species, although the degree to which this occurs is not well known. Thus, we sought to identify trends in how the community of native and non-native black basses (*Micropterus* spp) changed with increasing distance from a downstream reservoir. Our study was conducted in the Chattahoochee and Chestatee rivers upstream of Lake Lanier in northern Georgia where a popular sport fishery for native Largemouth Bass (*M. salmoides*) and introduced Alabama Bass (*M. henshalli*) exists. In

spring 2013, we sampled for black bass with boat electrofishing at four stations each in the Chattahoochee and Chestatee rivers beginning at the river-reservoir interface and progressed upstream into riverine habitats. We captured 127 individuals of four species, the majority of which were Alabama Bass and Shoal Bass. In both rivers, non-native Alabama Bass dominated the stations closest to the reservoir and declined in relative abundance upstream with a concomitant increase in Shoal Bass. However, non-native Alabama Bass still comprised 20-25% of the community at uppermost sites. Our results suggest that Alabama Bass can migrate upstream from their source populations in reservoirs, although the effects of their occurrence are still unknown. Future efforts that explore how differences in habitat (eg, discharge, water temperature, and water level) affect black bass species composition would be beneficial.

Development and Evaluation of the Florida TrophyCatch Program (Black Bass)

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TrophyCatch is a new fishery-dependent monitoring program for trophy-sized Largemouth Bass (>8 lbs) in Florida that offers unique incentives (eg, replica mounts) for anglers to document and report trophy catches that are voluntarily released. The objectives of the program are to reduce fishing mortality of trophy bass, increase state-wide catches of trophy fish, monitor long-term trends in trophy catches, and evaluate management actions and environmental conditions that produce trophy bass. Prior to the development of TrophyCatch, little verified information existed on catch and harvest rates of trophy-sized Largemouth Bass in Florida. To evaluate the efficacy of TrophyCatch to meet objectives, a multi-year, reward-based tagging study was initiated in 2011 (one year prior to TrophyCatch) to estimate mean annual state-wide catch and exploitation rates of trophy-sized largemouth bass before and during the operation of the program. To date, Florida biologists have tagged over 300 trophy-sized Largemouth Bass across 75 water bodies with varying trophic state, habitat characteristics, water quality, size, angling demographics, and fish communities to provide a realistic estimate of the state-wide average. Through two years of the tagging study, we estimated mean annual catch and exploitation rates of trophy-sized largemouth bass ranged from 0.24 (95% CI = 0.16 – 0.32) and 0.05 (95% CI = 0.01 – 0.09), respectively (Year-1), to 0.11 (95% CI 0.06 – 0.16) and 0.03 (95% CI 0.01 – 0.06), respectively (Year-2). These results suggest that trophy-sized Largemouth Bass experience similar catch and exploitation rates as smaller, legal-sized bass (>14 in TL). Through two years of the tagging study, 67% of harvested bass were taken for taxidermy, which suggests that TrophyCatch may influence fishing mortality by offering replica mounts as an incentive to release fish. During Year-2 of the tagging study (concurrent with TrophyCatch), 29% of anglers who caught a tagged bass were aware of the TrophyCatch program; however, of the anglers that were aware of the program and caught eligible bass, only 17% participated. These data suggest that increased marketing, product development, and angler accessibility to the program are needed to achieve program goals.

Evaluating Evidence for Density-Dependent Growth Responses in Largemouth Bass (Black Bass)

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Density-dependent growth in post-recruit life stages has been observed for many exploited fish populations. In small (< 40-ha) freshwater impoundments, strong density-dependent growth responses have been reported for largemouth bass and bluegill populations. However, few studies have evaluated density-dependent post-recruit growth in freshwater fish populations at larger spatial scales, such as large lakes and reservoirs. With increased management restrictions and adoption of voluntary release by anglers over the past 30 years, largemouth bass populations of North America have experienced declining mortality rates. If reduced mortality rates have resulted in increased abundance of largemouth bass, then these changes have the potential to influence growth dynamics via density-dependent growth responses. We used historical data from ten Alabama reservoirs and five Florida lakes and reservoirs to assess the relationship between largemouth bass growth and fish abundance indices through time. In general, mean length-at-age was not related to age-specific catch per effort (CPE) across lakes, although some positive relationships did exist. Temporal trends in CPE and mean length-at-age were also weak. As expected, CPE data were highly variable, which likely masked any relationships that may have existed.

Black Bass Population Dynamics in Lake Norman, North Carolina: A Decade after the Introduction of Spotted Bass (Black Bass)

Lawrence Dorsey, North Carolina Wildlife Resources Commission*

Since the late 1990's, Lake Norman, North Carolina has been plagued with introductions of non-native fish. Spotted Bass, White Perch, Alewives, Blueback Herring, and Striped Bass hybrids have been introduced without the consent of the North Carolina Wildlife Resources Commission. While these introductions have affected all of the fisheries in the reservoir, none has been more impacted than the black bass fishery. Spotted Bass were first collected in 2001 by Duke Energy biologists during annual spring electrofishing surveys. At that time, Largemouth Bass catch rates averaged 90 fish / 300 m but by 2010 catch rates had decreased to 25 fish / 300 mm. Spotted bass catch rates in 2010 were 220 fish / 300 m. These results suggest that Spotted Bass have become the dominant black bass in the Lake Norman fishery. However, recent data suggests that standardized sampling at historical sites may be misrepresenting the relative abundance of Largemouth Bass in Lake Norman. The standard sampling sites were established in 1993 to collect monitoring information for power plant effects and are located along main lake sections of the reservoir. In 2010 and 2013, additional sampling sites in cove and creek channel habitats were added. Largemouth Bass catch rates were equal to Spotted Bass catch rates in cove/creek habitats in 2010 but Largemouth Bass were three times more abundant than Spotted Bass in the same habitats in 2013. On main lake habitats, Spotted Bass were slightly more abundant than Largemouth Bass in 2010 but in 2013 Spotted Bass were three times more abundant than Largemouth Bass. These data suggest that Largemouth Bass are still thriving in Lake Norman but that they have been displaced from historically used habitats by Spotted Bass. Additional sites will be added in future surveys to further evaluate differences in species composition based on habitat use.

Nesting Success and Associated Habitat Characteristics of Shoal Bass in the Chipola River, FL (Black Bass)

Ted Alfermann, Florida Fish and Wildlife Conservation Commission, Andy Strickland, Florida Fish and Wildlife Conservation Commission, Christopher Middaugh, Florida Fish and Wildlife Conservation Commission and Ryan Butryn, Florida Fish and Wildlife Conservation Commission*

Over the past several years there has been a growing interest in the research of Shoal Bass *Micropterus cataractae*, a recently described black bass species endemic to the Apalachicola, Chattahoochee, and Flint River Systems in Florida, Alabama, and Georgia. The majority of this research has focused on movement, diet, co-occurrence with other black basses, and habitat use. As part of the Southeastern Native Black Bass Keystone Initiative, our study filled information gaps concerning reproduction and nest characteristics. We collected information on 67 shoal bass nests in April and May of 2012-2013 in the Chipola River, FL. Nests were located by visual observation and nest macrohabitat, nest depth, surface water velocity, mid-column water velocity, bottom water velocity, GPS location, adjacent habitat, and surface water temperature was recorded for each nest. Eggs or fry were counted on a subsample of nests using a grid system. We evaluated the use of the grid system by also taking empirical counts on a subsample of nests. Nest success was estimated from nests where we counted eggs and then fry upon hatching (n=13). Mean egg and fry counts were 1,042 (range: 152-2,406) and 290 (range: 8-1,293), respectively, which are the lowest documented counts among black bass species. Most nests (94%) were found on boulder and rocky fine substrates with few to none occurring on bedrock (6%) and sand/pea gravel (0%). Mean depth and surface temperature for nests was 100 cm and 23.0° C, respectively. Preliminary results suggest that spatial patterns exist regarding nest locations, with many nests clustered together and adjacent to shoal habitat.

The Influence of Streamflow on the Recruitment of Rock Bass in the New River (Black Bass)

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High levels of discharge during the spawning season of Smallmouth Bass, *Micropterus dolomieu*, have been shown to reduce recruitment in multiple streams in Virginia, including the New River. Few studies have been done on the effect of discharge on Rock Bass, *Ambloplites rupestris*, a similar and important recreational species, and no studies have been done in the United States. We investigated the effects of discharge on Rock Bass in the New River at two sites 5 and 55 miles downstream from Claytor Dam. We backcalculated a length at age 1 and 2 using otoliths collected from 80 Rock Bass from the New River. We determined an average length at age 1 and 2 and used this to filter out age 1 fish from 14 years of Fall electrofishing data on the New River. We determined a catch per unit effort (CPUE) of age 1 fish at each site and correlated it to spawning season discharge data from the previous year using a Spearman's Rank Correlation. The CPUE at the Upstream Site was negatively correlated with average and maximum discharge in July while the CPUE at the Downstream Site was negatively correlated with average and maximum discharge in August. Both August and July are after the reported spawning season of Rock Bass in Virginia. After examining the literature on Rock Bass spawning and nest building, we determined that high levels of discharge affecting juvenile Rock Bass that had recently left the nest was the most likely explanation for these results.

Effects of Aquatic Macrophytes on the Foraging Ability and Predation Risk of Juvenile Largemouth Bass (Black Bass)

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In recent years, state and federal agencies have invested resources introducing native aquatic vegetation to aging reservoirs. The goal of such plantings has often been to increase recruitment of sport fishes, particularly largemouth bass. Dense submersed macrophytes provide structural complexity that often reduces the foraging ability of piscivores, such as adult largemouth bass. However, little information exists on the effectiveness of emergent macrophytes to increase juvenile largemouth bass survival. Additionally, few studies have investigated the effects of aquatic macrophytes on the foraging ability of pre-piscivorous largemouth bass. Pre-piscivorous largemouth bass may be faced with a tradeoff if aquatic macrophytes reduce predation risk but also reduce foraging ability. Therefore, the objectives of this study were to 1) determine if aquatic macrophytes increase survival of juvenile largemouth bass when exposed to predation and 2) determine if aquatic macrophytes reduce the foraging ability of pre-piscivorous largemouth bass. To address the first objective, juvenile and adult largemouth bass were collected from lakes near Stillwater, Oklahoma and transported to the Oklahoma State University campus. American water willow was collected from nearby reservoirs and planted within a study tank at natural stem densities. A second tank, void of any structure, was used as a control. Behavioral trials were conducted with one adult largemouth bass and 10 juvenile largemouth bass in the same tank. Each adult largemouth bass was tested once in each treatment (vegetation present or absent), and analyzed using a repeated-measures ANOVA. American water willow significantly reduced the attack to capture ratio of adult largemouth bass, and decreased the number of follows and captures. To address the second objective, pre-piscivorous juvenile largemouth bass were obtained from the Holdenville State Fish Hatchery in Holdenville, OK. Four vegetation densities (0, 100, 250 and 500 stems/m²) were constructed using artificial macrophytes (green nylon twine) and placed within 5 gallon aquaria. Frozen bloodworms were used as prey; 30 bloodworms were thawed and placed haphazardly within each aquarium prior to the start of a 1-hour foraging bout. Each individual largemouth bass was tested in each vegetation density, and results were analyzed using a repeated measures ANOVA. Foraging return was greatest at the 100 stems/m² vegetation density and higher vegetation densities tested did not reduce foraging return compared to the vegetation-less control treatment. Overall, our results suggest aquatic macrophytes will reduce predation risk of juvenile largemouth bass with no negative effects on foraging return.