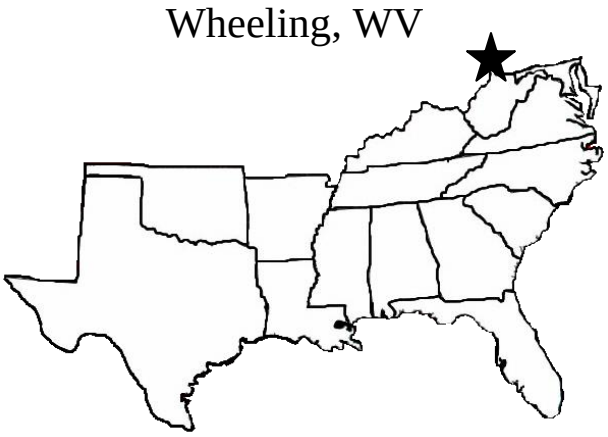

Abstracts for oral presentations and posters presented at the Southern Division of the American Fisheries Society Spring 2008 Meeting

Wheeling, West Virginia

Abstracts for all oral presentations
(Contributed Papers and Symposium)
are listed as they appear in the program.

Poster abstracts are listed separately
following the oral paper abstracts.

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Recruitment of Juvenile Atlantic Sturgeon in the Altamaha River, Georgia

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Recent studies of Atlantic sturgeon spawning runs in the Altamaha River, Georgia, have documented annual run sizes of approximately 300-390 adults. While these studies suggest that the population has recovered significantly since the 1996 Federal closure of the US Atlantic sturgeon fishery, little is known about recruitment rates or mechanisms for this species. The objectives of this study were to quantify current demographic parameters and then, to estimate future population trends. From June to July, 2004-2007, we used variable mesh entanglement gear to sample juvenile Atlantic sturgeon in the tidally influenced portion of the Altamaha River. Using program MARK, we then developed Multi-strata, Robust design, and Pradel models to estimate various demographic parameters of the juvenile population, including annual cohort size and rates of recruitment, survival, and out-migration. Although these demographic parameters were variable among years, we found that age-1 and age-2 juveniles were consistently more abundant than individuals age-3 or older, suggesting that peak juvenile out-migration probably occurs prior to the third year. We also documented an unusually strong year class in 2005, possibly resulting from favorable environmental conditions; however, causal mechanisms and biological significance were difficult to evaluate because of the lack of comparable studies. Nonetheless, our results were consistent with those of other previous studies that suggest the Altamaha population of Atlantic sturgeon has recovered significantly during the past decade.

Key words: Sturgeon, Recruitment, Mark-Recapture

Shortnose Sturgeon in the Ogeechee River, Georgia: A Population in Jeopardy?

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The Ogeechee River of coastal Georgia is thought to contain one of the smallest known populations of the shortnose sturgeon (*Acipenser brevirostrum*). Although this population has been federally protected as an endangered species for more than four decades, the most recent studies suggest that the population has not increased. The objectives of this study were to estimate current population abundance and evaluate age structure. From June–October 2007, we used variable mesh gill and trammel nets to conduct a mark-recapture estimate of the population. Over the 5-month sampling period, we captured a total of 97 individual shortnose sturgeon, with an additional 17 recaptures, yielding a Schnabel population estimate of 368 (244–745; 95% C.I.). Age analyses of 97 pectoral fin spine samples showed that approximately 98% of fish captured were adults. Our results, although preliminary, suggest that while the population may have increased slightly in recent years, it remains recruitment limited.

Key words: shortnose sturgeon, Ogeechee River

Response of White Sucker Densities to Artificial Shading of Pool Habitats in Smith Creek, VA.

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The responses of fishes to ongoing stream restoration projects throughout the southeastern United States are largely unknown. White suckers are thought to be an important competitor with brook trout, a target restoration species, and their response to canopy cover could be an important predictor of restoration success. Because stream restoration can be lengthy, we simulated future canopy by artificially shading pools (80 to 90%). We then measured the short-term (30 days) responses of fish populations between control (unshaded) and treatment (shaded) pools. We selected ten experimental pools with similar riparian and instream cover and mean and maximum depth. White sucker densities in the experimental pools prior to treatment averaged 30.85/100mm^2, with a mean fish length of 204 mm. A total of 707 white suckers were captured and PIT tagged from the ten experimental pools. We then randomly selected five pools for artificial shading and measured white sucker population responses. After 30 days, white sucker densities were similar in the unshaded (control) pools but were significantly reduced ($p<0.05$) in the artificially shaded pools. Mean length did not vary by treatment ($p>0.05$). There were no differences in densities of the other ten fish species between control and treatment pools. Water temperature between control and treatment pools was similar ($p>0.05$) during the experimental period. The preference of adult white suckers for unshaded

pools may result in different interactions between preferred habitat and fish population structure as riparian canopies mature in restored streams.

Key words: white sucker, artificial shading, PIT tag, restoration, Virginia

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Fish Management 1 Oral Presentation

Effects of a Summer High Water Event on Young of the Year Largemouth Bass in the Arkansas River
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Abundance of young of the year largemouth bass in regulated river systems can be impacted by high water events that occur at unusual times. The Arkansas River has a 10-year average flood cycle with peak flow near 150,000 cfs from late March to mid April. In the summer of 2007, the river exhibited a distinctly different hydrograph. The river was over 150,000 cfs from mid-June to early-August. We conducted electrofishing studies to estimate the relative abundance of YOY largemouth bass in ten backwaters of Pool 4 of the Arkansas River following this unusual summer. We also measured weight and length of YOY largemouth bass. CPUE estimates for September 2007 ranged from 1.6 to 22.7 fish/h with an average (SD) of 12.8 (7.5). November CPUE estimates from previous research during a normal flow year ranged from 18.5 to 53.8 fish/h with an average of 35.6 (13.3). The CPUE estimates were significantly different ($p<0.01$) between years. Largemouth bass had an average length of 139.0 (8.9) in 2007 and 162.9 (23.3) in 2003. The lengths from September 2007 were modified to compare to November 2003 data. Length was significantly different ($p<0.01$) between years. Relative weight of largemouth bass was 100.3 (4.5) in 2007 and 103.8 (5.6) in 2003. Condition was not significantly different ($p=0.16$) between years. The unusual flow in 2007 appears to have decreased the fall CPUE estimates and might have caused slower growth in the YOY largemouth bass.

Key words: largemouth bass YOY, Arkansas River

Fish Management 1 Oral Presentation

Lateral Migration of Fishes in the Lower Verdigris River, Oklahoma
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The lower Verdigris River in Oklahoma forms the uppermost portion of the McClellan- Kerr Arkansas River Navigation System (MKARNS). The U.S. Army Corps of Engineers is planning to deepen the MKARNS navigation channel to 4 meters and dredge cutoff channel connections to enhance lateral fish migration. We are estimating fish abundance in three cutoff channels and diel movements of fish during four periods into and out of cutoff channels in the uppermost pool (Pool 18) of the MKARNS. At the cutoff channel connections, we are continuously measuring directional flow, water depth, temperature, and dissolved oxygen during each diel sample. Sampling was conducted during spring-summer high water and summer-fall low water periods of 2007. During the high water period, fish abundance was greatest in the cutoff channel connections during sunrise, whereas during the low water period, fish abundance was greatest during the sunset period. On average, 15 species were captured in cutoff channel connections and 22 species were caught within the cutoff channels during the high water period. Similarly, an average of 13 species was captured in cutoff channel connections and 23 species were caught within the cutoff channels during the low water period. Gizzard shad, white crappie, freshwater drum and bluegill were the most abundant species captured in cutoff channel connections during the high water period whereas gizzard shad, threadfin shad, white bass and channel catfish were most abundant in the low water period. Future research will focus on relating environmental changes to seasonal lateral fish migrations.
Key words: lateral migration

Fish Management 1 Oral Presentation

Initial Fisheries Investigations of a Hydrologically Altered Large River Floodplain
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The predictable annual floodpulse of large rivers is the overlying factor that influences ecological processes of the adjacent floodplain. For example, many large river fishes depend on seasonal high water levels to access the floodplain for spawning

and foraging. The Barataria Estuary is a Louisiana coastal estuary bordered on the east by the Mississippi River's western flood protection levee and on the south by the Gulf of Mexico. The Barataria Estuary historically received Mississippi River water, but is currently separated from the river for flood control. Although the floodplain of the upper Barataria Estuary (cypress-tupelo swamp forest) is occasionally inundated, the duration and timing is unpredictable as water levels depend on local precipitation. We have initiated studies to investigate the fisheries and water quality of the upper Barataria Estuary to explore possible impacts of the altered hydrology on the local fisheries. Although we do not have unequivocal evidence, data compiled from several recent studies conducted within the upper Barataria Estuary suggests that: dissolved oxygen is negatively correlated with water level and dissolved oxygen is not related to temperature; bowfin *Amia calva* spawning is strongly dependant on water level but gizzard shad *Dorosoma cepidianum* spawning is not; gizzard shad, blue crab *Callinectes sapidus*, and larval fish abundance is negatively impacted by low dissolved oxygen levels. The altered hydrology of the upper Barataria Estuary has led to unpredictable periods of floodplain inundation and low dissolved oxygen levels, which may have a long-term impact on the overall fisheries production.

Key words: Floodplain Hypoxia

Fish Management 1 Oral Presentation

Managing Aquatic Resources on a Broader Scale: the Yadkin-Pee Dee River FERC Relicensing Process

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Approaches to aquatic resource management in inland waters have traditionally focused on small, discrete units instead of managing the watershed as a whole. The Federal Energy Regulatory Commission (FERC) relicensing process has forced resource managers to examine aquatic resources from multiple perspectives and at much larger scales than have been used in traditional management approaches. The Yadkin-Pee Dee River system contains seven large hydropower dams and three major riverine reaches along its path through North Carolina. From 2002-2007, North Carolina Wildlife Resources Commission (NCWRC) staff biologists provided input and participated in negotiations in an effort to protect and enhance the aquatic resources of this system. Challenges faced in this process included water management above and below each dam, identifying significant aquatic habitats and protecting them where feasible, identifying needed flows for fish and mussels, and developing fish passage plans for fish that have been cutoff from historical spawning areas for decades. All of these issues were negotiated and in 2007 settlement agreements were reached between stakeholder groups and the two utility companies that operate these dams. Although the agreements have not been converted into new licenses as of yet, we are hopeful that FERC will issue new licenses that include the provisions of the settlement agreements. These provisions represent a significant change in the management of this system that should benefit aquatic resources along the Yadkin-Pee Dee River system for years to come.

Key words: FERC relicensing, fish passage, negotiation

Fish Management 1 Oral Presentation

The Development and Evaluation of Tools for Assessing the Flow Requirements of Fishes in Streams Through out the Lower Flint River Basin, Georgia

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Natural resource managers in the Southeast need accurate and cost-effective tools for assessing the potential impacts of river regulation and water use on streamfishes. Current habitat-based approaches (e.g., Instream Flow Incremental Methodology), are time consuming and can be cost prohibitive. In addition, habitat-based models cannot incorporate dynamic population processes. Thus, their use is limited for estimating the effects of river regulation and water use on warmwater stream ecosystems, particularly over large spatial scales. An alternative approach is to relate streamfish species presence to streamflow and stream channel characteristics. Such an approach may accurately predict species responses to hydrologic alteration over large spatial scales while minimizing data requirements. Hence, we studied fish communities and habitat availability at 29 study sites representing the dominant geomorphologies, channel types, and stream sizes in the Flint River Basin, Georgia. Fishes were sampled and habitat availability was measured during spring, summer, and winter 2001- 2004. Streamflows during this time included among the lowest and highest seasonal flows ever recorded at long-term gauges in the basin. This provided us with a unique opportunity to observe changes in fish communities and habitat availability over a large range of flows. We developed two sets of empirical models (1) relating species presence to streamflow and the amount and type of physical habitats available for fishes and (2) relating species presence to streamflow and stream channel

characteristics (i.e., geomorphology and channel type). Model evaluation indicated both models were relatively accurate, though using stream channel characteristics was a much more cost-effective approach.

Key words: stream fishes, occupancy models, flow regulation, water use

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Fish Management 1 Oral Presentation

Evaluation of Arkansas' Hooked on Fishing, Not on Drugs (HOFNOD) Program
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The Hooked on Fishing – Not on Drugs (HOFNOD) program was developed by the Future Fisherman Foundation to teach children angling skills and ethics, aquatic education, and positive life and social skills. The HOFNOD program was introduced to Arkansas schools in 1997 and is currently in its 11th year of implementation. An annual evaluation of the state's program has been conducted each school year since the spring of 2000 using teacher questionnaires. The number of schools participating in the program has increased from 21 to 48 since annual evaluations began in 2000. Teachers surveyed in 2005 had been participating in the program for an average of 4.6 years and were predominately Caucasian females; however, the percentages of African-American and male instructors have more than doubled since the first evaluation in 2000. Responses have indicated that the HOFNOD program has its most positive effect on student learning motivation, fishing participation, and parent and community involvement in school activities. While fishing derbies remain the most popular HOFNOD activity, most teachers have included several aquatic education lessons into their programs. The HOFNOD program in Arkansas is an excellent aquatic education tool and a successful means of getting students involved in the sport of fishing.

Key words: HOFNOD, aquatic education, youth fishing, program evaluation

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Fish Management 1 Oral Presentation

Post-Hurricane Katrina Cohort Development and Stock Assessment of Flathead Catfish (*Pylodictus olivaris*) in the Pascagoula and Tchoutacabouffa Rivers of Mississippi
Barabe*, R. M. Mississippi State University, Mississippi State, MS rmb237@msstate.edu

Fisheries targeting catfish in south Mississippi are important cultural icons. If degraded or lost, the alternatives available to freshwater anglers in the region are sparse. On 29 August 2005 Hurricane Katrina generated a large flood-pulse in rivers throughout south Mississippi. Hypoxia associated with this flood-pulse event produced massive fish kills in main channel and backwater environments of these ecosystems. Immediate post-hurricane stock assessments raised concern that storm-related impacts to freshwater fisheries resources in these systems were so severe that restocking of principal sport fishes might be necessary. Prior to the initiation of restocking programs, assessments of residual stocks and natural stock recovery processes were recommended. In this regard, our study addresses flathead catfish (*Pylodictus olivaris*) stocks in two of these river ecosystems: Pascagoula and Tchoutacabouffa rivers. During the period May-June 2007, we collected 267 and 65 flathead catfish from the Pascagoula and Tchoutacabouffa rivers respectively, utilizing low-frequency pulsed-DC electrofishing. Pectoral spines were collected and sectioned, and all spines are currently undergoing age determination. River-specific von Bertalanffy growth equations in conjunction with the direct proportion method are used to provide back-calculated lengths-at-age. Relative abundances (catch per unit of effort data) in association with estimates of instantaneous total mortality (Z) from length-frequency distributions, are being used to ascertain recruitment potentials of the flathead catfish stocks in both rivers. Benefits resulting from this study include information on cohort development and growth characteristics of flathead catfish in south Mississippi streams after a major disturbance.

Key words: flathead catfish, Hurricane Katrina, cohort development, stock assessment

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Fish Management 1 Oral Presentation

Passage and Population Dynamics of Alabama Shad in the Apalachicola River, Florida
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Fish passage and population dynamics of Alabama shad were studied below Jim Woodruff Lock and Dam (JWLD) in the Apalachicola River located in the central panhandle of Northwest Florida. We estimated the population size of migrating Alabama shad below JWLD using mark – recapture techniques. The population size of migrating Alabama shad near JWLD

was estimated at 25,935 (95% C.I. =17,715 - 39,535) in 2005, 2,767 (95% C.I. =838 - 5,031) in 2006 and 8,511 (95% C.I. =5,211 - 14,674) in 2007. We estimated the passage of migrating Alabama shad through JWLD by implanting sonic transmitters in 113 Alabama shad during spawning migrations in March and April 2005 - 2007. In 2007 seventeen Alabama shad subsequently passed into the reservoir for a passage success of 41%. Eight percent of shad that passed were detected upriver in the Flint River ~ 9 d after passage, and twelve percent were located upriver in the Chattahoochee River ~ 2 d after passage. Age and growth were estimated by examining scales and otoliths from 203 adult fish collected from 2005 and 2006. Ages of Alabama shad ranged from 1 – 4 years. All sampled spawning males were between 1 and 3 years old, whereas females were 2 - 4 years of age. Scales and otoliths both gave similar age estimates. Growth of male and female Alabama shad is best described by the equations: $L_t = 359.6 [1 - e^{-2.1712(t-0.3757)}]$ and $L_t = 389.5 [1 - e^{-2.3193(t-0.6424)}]$. Mean back-calculated lengths were similar to those of observed values for males and females. Fecundity estimates ranged from 26,095 to 208,494 eggs per female. Variations in fecundity estimates may be contributed to partial spawning.

Key words: Alabama shad passage

Fish Management 1 Oral Presentation

Biological Characteristics of the Middle Island Creek Muskellunge Population, West Virginia

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Muskellunge *Esox masquinongy ohioensis* were examined to determine biological characteristics, movement patterns and habitat preferences, and to evaluate these characteristics between a catch-and-release reach and standard regulation reaches, on Middle Island Creek, a stream in west central West Virginia. Between 2002 and 2007, 245 muskellunge were collected 371 times with pDC-boat mounted electrofishing equipment. Individual fish were measured, and muskellunge great than 450 mm were inserted with two different tags prior to release. Release locations were noted with global positioning system (GPS) and later included into a fisheries geographic information system (GIS). Eighty-seven fish were recaptured 143 times during subsequent electrofishing-based surveys and via anglers. Recaptured locations were noted with GPS, included in the GIS, and compared with initial capture locations. Movement patterns and growth rates varied between sexes. Significant population differences between the catch-and-release reach and standard regulation reaches were not found. Tag retention for both tag types was found to be acceptable. Exploitation by anglers was minimal, and no changes in fishing regulations will be recommended.

Key words: Muskellunge, river, movement, age and growth, tagging

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Fish Management 1 Oral Presentation

An Emergent Walleye Population in Lake Rhodhiss, North Carolina

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After efforts in the 1950s to establish walleye *Sander vitreus* fisheries in downstream reservoirs were unsuccessful, walleye management in the Catawba River chain of reservoirs in North Carolina has been focused in Lake James, the uppermost impoundment in the system. Unexpectedly, recent surveys have indicated that walleye density appears to be increasing in Lake Rhodhiss, the impoundment immediately downstream of Lake James. A total of 133 walleyes were collected as by-catch during routine striped bass *Morone saxatilis* gill-net samples in Lake Rhodhiss (2003, 2004 and 2006). Walleyes were collected up to age 12 (mean = 2.6; SE = 0.2), with a size structure that ranged in length from 314 to 740 mm TL (mean = 484.5 mm TL; SE = 7.9). Length-at-age data for walleyes collected in 2006 revealed extremely high growth rates in comparison to other North Carolina walleye populations. Additionally, relative weight values for fish in the sample ranged from 68.5 to 164.1 (mean = 103.2; SE = 1.0). Exact mechanisms responsible for the perceived emergence of walleye in the reservoir are unknown, but the population is typified by fast-growing fish in good condition. Given the apparent potential of the walleye fishery in Lake Rhodhiss, it may prove prudent to explore the maintenance or enhancement of this developing fishery.

Key words: walleye, Lake Rhodhiss, growth, sport fish management

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Fish Management 1 Oral Presentation

Fish Assemblages on Gravel Bars in the Arkansas River

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Gravel bars are utilized by various fish species during different life history stages and during different seasons. Gravel bars provide sites for spawning, feeding, and refuge. We examined temporal and spatial variability of fish assemblages on gravel bars in the Arkansas River. Surveys were conducted to identify gravel bars in the Pools 7-12 of the Arkansas River. Gravel bars were stratified by depth (deep or shallow) and distance from an upstream lock and dam (0-3, 3-6, or 6-9 miles downstream). Three gravel bars were randomly selected from each strata. Fish assemblages on each gravel bar were sampled three times between August - November 2007. Each sample consisted of duplicate trawls with a 3-m Herzog Armadillo trawl. Sampling will continue through July of 2008. Water quality (temperature, dissolved oxygen, pH, conductivity, chlorophyll, salinity, and surface velocity) and substrate samples were collected on each gravel bar in conjunction with fish samples. Preliminary results indicate that gravel bar habitat in the Arkansas River is primarily utilized by ictalurids, centrarchids, cyprinids, and percids. The five most abundant fish species were blue catfish, channel catfish, silver chub, bluegill, and longear sunfish. Fish species richness decreased with increasing depth, but appeared not to vary with distance from the upstream lock and dam. Fish species richness was also higher during the summer than in the fall.

Key words: fish assemblage, gravel bar, Arkansas River

Fish Management 1 Oral Presentation

Age and Growth of Blue Catfish *Ictalurus furcatus* in Two Tennessee Reservoirs

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The blue catfish, *Ictalurus furcatus*, is one of three catfishes important to recreational and commercial fisheries in Tennessee. To better understand the effects of harvest we compared age and growth of blue catfish collected from two fisheries that supported dissimilar levels of harvest. Kentucky Lake (43,794 ha) experienced a combined recreational and commercial harvest of 9.21 kg per ha in 2006; whereas Fort Loudoun (5,908 ha) is closed to commercial harvest and experienced a small recreational harvest (0.0046 kg per ha in 2006) due to a contaminant advisory on the fishery. Fish markets were surveyed to collect catfish from Kentucky Lake (n = 155) and boat electrofishing and set-lines were used to collect fish from Fort Loudoun (n = 180). All fish were measured (total length, mm), weighed (g), and sexed via gonad inspection before sagittal otoliths were removed. Sagittal otoliths were cleaned, dried, embedded in epoxy, transversely sectioned using a low-speed isomet saw, sanded to the ventral sulcus using 320 grit sandpaper, and aged under 50X magnification. Mean length at age, length-weight regressions, and von Bertalanaffy growth parameters were estimated for catfish from each reservoir. We found that blue catfish growth was much slower in Fort Loudoun than in Kentucky Lake. On average an age 10 fish was 441 mm total length in Fort Loudoun and 704 mm total length in Kentucky Lake. Observed maximum age was much higher in Fort Loudoun (age 33; 874 mm) than in Kentucky Lake (age 11; 740 mm).

Key words: blue catfish, Tennessee Reservoir

Water Quality Oral Presentation

Influence of Wastewater Treatment Plant Effluent on the Reproductive Health of Smallmouth Bass (*Micropterus dolomieu*) in the Potomac River Drainage

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Since 2003 the Fish Health Branch of the USGS, Leetown Science Center has been investigating the unexplained high prevalence of intersex in male smallmouth bass (SMB) in the Potomac River watershed. During the Fall of 2005, in collaboration with the US Fish and Wildlife Service and the USGS Columbia Environmental Research Center, a systematic study was conducted to evaluate the influence of Waste Water Treatment Plant (WWTP) effluent on smallmouth bass reproductive health. Smallmouth bass were collected at locations up- and down-stream of selected WWTPs on tributaries of the Potomac River, Conococheague Creek and the Monocacy River. Largemouth bass were collected at the Blue Plains WWTP. Passive samplers were deployed at all sites to capture chemicals present in the water column. A high prevalence of intersex was identified in male SMB at up- and down-stream sites in both the Conococheague and Monocacy (82-100%). When up- and down-stream fish were compared, significant differences were only noted in fish from the Conococheague. Differences included condition factor, gonadosomatic index, plasma vitellogenin concentration and estrogen: testosterone

ratios. These differences were noted in males and females. Concentrations of most targeted chemicals were present at higher concentrations at the downstream sites. Atrazine was present at all sites and was generally higher at the upstream sites. In vitro analysis of POCIS extracts with strain BLYES from all locations exhibited estrogenic activity. While WWTP-associated chemicals present at these locations may influence SMB reproductive physiology, it is likely that upstream contributions of agricultural run-off have an impact as well.

Key words: smallmouth bass, Potomac, endocrine disruption, vitellogenin, BLYES, POCIS

Water Quality Oral Presentation

Infectious Agents and Parasites as Contributing Factors to Centrarchid Fish Kills in the Potomac Drainage

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Since 2002 there have been kills of centrarchids (primarily smallmouth bass and redbreast sunfish) in various tributaries of the Potomac River, particularly the South Branch of the Potomac in WV and the North and South Forks of the Shenandoah in VA. Findings to date suggest a variety of stressors leading to immunosuppression and an increased susceptibility to opportunistic pathogens. A high prevalence of intersex has been observed at the same sites suggesting certain emerging contaminants (estrogenic compounds) may contribute to the immunosuppression. No specific pathogen has been consistently isolated or observed. A number of bacteria, including *Aeromonas salmonicida*, *Aeromonas hydrophila* and *Flavobacterium columnare*, as well as largemouth bass virus have been sporadically isolated at various sites. Metazoan parasites including trematodes, cestodes, nematodes and myxozoans are observed internally and occasionally on the gills. Some of these parasites cause extensive tissue damage and we have used image analysis to quantify the amount of tissue replaced by parasites in order to compare sites, species and seasonal changes. Since the life cycles of many of these include benthic invertebrates, zooplankton or snails the potential association with water and sediment quality is believed to be important.

Key words: smallmouth bass, sunfish, fish kills

Water Quality Oral Presentation

Assessing the Occurrence of Endocrine Disrupting Chemicals in Fish in the South Branch of the Potomac River

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Humans, fishes, and wildlife experience environmental risk from exposures to naturally occurring and synthetic endocrine-active chemicals in surface water, drinking water, and food. Endocrine disrupting chemicals (EDCs) are those that can potentially interfere (either agonistically or antagonistically) with estrogenic, androgenic, and thyroid-related functions in humans, fishes, and wildlife. An improved understanding of potential environmental risk to water and food quality from EDCs is needed. Intersex in male fishes is a condition in which oocytes (individuals or groups) exist within testicular tissue and is considered to be a biological indicator of reproductive endocrine disruption in a number of fish species. Existence of the intersex condition in male fishes indicates exposure to an environmental estrogen. In this research, water, sediment, and fish tissues were examined to ascertain the chemical(s) implicated in the endocrine disruption of reproductive function in smallmouth bass collected from sites within the South Branch of the Potomac River and selected nearby drainages. Individual fish were analyzed for presence or absence of the intersex (ovotestis) condition and screened for various organic and elemental chemicals. The gonads were sacrificed for intersex analysis, and the remainder of the carcass was used for chemical analyses. The suspect chemical candidates implicated in the intersex condition of fishes in the South Branch of the Potomac River will be discussed.

Key words: endocrine disruption, endocrine disrupting chemicals, Potomac River

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Water Quality Oral Presentation

South Branch of the Potomac Fish Kill Investigations, a Status Report.

Johnson*, A. Wildlife Biologist, West Virginia Department of Environmental Protection, 601 57th St. SE, Charleston, WV 25304

Since 2002, the South Branch of the Potomac River has seen sporadic, yet similar fish kill events. These kills occur in early spring scattered along the entire length of the South Branch River and some of its main tributaries. Species of minnows, suckers, sunfish, and bass have all been affected by these kill events. West Virginia's Department of Environmental Protection, Division of Natural Resources, federal agencies, and some non-governmental organizations have devoted many resources to solving the problem of these fish kills. In 2007, agencies expanded sampling methods in an effort to fill in data gaps and to gain a better understanding of the South Branch River's ecology. Because of that increased sampling, biologists have a better understanding of possible causes of the kills. This presentation will serve as both an introduction and a status report of the South Branch River fish kill investigations.

Key words: South Branch, Potomac, and fish kill

Water Quality Oral Presentation

Investigating the Presence of and Effects from Endocrine Disrupting Compounds (EDCs) within the Mainstem Ohio River

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Endocrine Disrupting Chemicals (EDCs) and other emerging chemical threats are gaining notoriety in both the scientific and popular presses. The extent and persistence of their occurrence in surface waters of the United States remains unclear. In 2005 the Ohio River Valley Water Sanitation Commission (ORSANCO) initiated a project to investigate the presence and effects of EDCs within the Ohio River. The main objective of this project was to establish linkages between estrogenic exposure from wastewater treatment plants (WWTPs), or from 'background' sources in the Ohio River to histopathological abnormalities in males of indigenous fish species. To establish this linkage, we sought to document the presence of EDCs in the water column both distal and proximal to a major WWTP. We detected five of the common hormones during the first sampling run, and detected two hormones during a second run. Detections occurred upstream of the WWTP as well as downstream. EDC detections in the water samples were extremely variable and largely insignificant. We used boat-mounted electrofishing to collect samples of native fish species. Histopathology results from the native fish samples revealed no direct evidence of estrogenic exposure, however abnormalities found in fish collected from both the upstream and downstream locations may indicate exposure to androgenic compounds. We did not observe intersex condition in any of the samples, but did note the significant occurrence of other abnormalities such as sperm necrosis, atrophy and fibrosis.

Key words: Ohio River fish EDCs intersex

Water Quality Oral Presentation

The Influence of Land-use on Contaminants found in Riverine Systems

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As populations in the Southeast increase, the need for clean water resources will increase, as will the amount of anthropogenic contaminants in aquatic systems. Water samples were collected from 12 locations in southeast Georgia during high (spring) and low (fall) flow seasons and analyzed for a group of anthropogenic contaminants, perfluorinated compounds (PFCs). PFCs are found in both industrial and municipal uses, such as stain guard for carpets and textiles, fire fighting foams, and industrial cleaning fluids. The relationship between PFCs and urban land-use and municipal point source discharges in the watershed, as well as seasonal variables (e.g., water temperature and conductivity) were assessed using hierarchical models. Concentrations of PFCs in the water column ranged from 0-65 ng/L, which was below the chronic toxicity level of the most sensitive aquatic organisms (1200 ng/L). However, these concentrations were near, and sometimes exceeded, the chronic toxicity level for resident piscivorous birds (50 ng/L). The concentrations varied substantially between seasons indicating that concentrations to which wildlife were exposed fluctuated through time. PFC concentrations also were strongly and positively related to urban land-use in the watershed. Our predictive model can be used by managers to protect wildlife and preserve water quality.

Key words: water quality, contaminants, urban land-use

Water Quality Oral Presentation

Use of *Micropterus dolomieu* (smallmouth bass) and *Lepomis auritus* (redbreast sunfish) Primary Hepatocyte Cultures for In Vitro Estrogen Screening

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A contributing factor of intersex, the presence of immature oocytes in the male testes of fish, is believed to be the exposure of these fish to estrogenic endocrine disrupting chemicals (EEDCs). EEDCs are often seen in the effluent of wastewater treatment plants. A simple and common way to look at the estrogenicity of water samples is to deploy passive water samplers and extracting the filters with either methanol, for hydrophilic compounds, or hexane, for hydrophobic compounds. Samplers have been deployed upstream and downstream of two wastewater treatment plants, one on the Conococheague River and one on the Monocacy River, both of which are in Maryland. For comparison, one has been deployed in Blue Plains, just outside of Washington, D.C. and one was deployed at a control site in a closed pond at the National Fish Health Research Laboratory in Kearneysville, WV. Primary hepatocytes isolated from rainbow trout, smallmouth bass, and redbreast sunfish will be used to screen for EEDCs in the extracts of the deployed water samplers and vitellogenin induction will be used as an endpoint.
Key words: vitellogenin, hepatocytes, smallmouth bass, rainbow trout, redbreast sunfish, estrogenic endocrine disrupting chemicals

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Water Quality Oral Presentation

Selenium Bioaccumulation in Selected Stream and Lake Fishes of West Virginia

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Selenium toxicity poses a threat to organisms inhabiting aquatic ecosystems influenced by excessive seleniferous inputs; however, selenium is also an essential nutrient in living things and provides antioxidant properties to tissues. Variability in the literature regarding a suggested tissue-based criterion for freshwater fishes and subsequent protective water quality concentrations indicate the complexity of the bioaccumulative processes surrounding selenium. While sublethal considerations of selenium toxicity have been examined in many experimental settings, the manifestation of detrimental levels in the environment serves an equally important role in the establishment of appropriate water quality thresholds. A study was designed to determine the bioaccumulation rates of selenium among the fishes of West Virginia's streams and lakes, and identify potentially toxic effects among exposed populations. Particular attention to vulnerable populations and life stages of fishes was an inherent aspect of the study. Initial results indicate large differences in the biological uptake of selenium by fishes in contrasting aquatic environments. Ongoing research is focused on elucidation of this variable selenium bioaccumulation between and among fish species and their respective environs.

Key words: Selenium Bioaccumulation

Water Quality Oral Presentation

Critical Thermal Limits of Juvenile Lake Sturgeon: Implications for Species Restoration.

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Historically, populations of lake sturgeon *Acipenser fulvescens* were found in large lakes and rivers from southern Canada southward to the Coosa River system in northwest Georgia and northeast Alabama. However, in the early 1900s habitat degradation and overfishing contributed to the extirpation of many populations, especially in the southern portion of their range. Following the passage of the Clean Water Act in 1972, water quality improvements in many former lake sturgeon habitats created new opportunities to re-establish the species in portions of its native range. In the Coosa River, Georgia, initial efforts to re-introduce lake sturgeon have been successful, despite annual summer water temperatures which routinely exceed 32^{O} C. While post-stocking evaluations have shown that some juvenile lake sturgeon survived, the critical thermal maximum (CTMax) for lake sturgeon has not been evaluated. Hence, the objective of this study was to evaluate the CTMax of juvenile lake sturgeon at two different acclimation temperatures. In a controlled laboratory setting, we determined CT_{50} and CTMax for two independent treatment groups of juvenile lake sturgeon after a 7-day acclimation at either 18^{O} or 22^{O} C. The results of our study showed that CTMax of juvenile lake sturgeon is variable among individuals but on average is higher

than previously reported.

Key words: critical thermal tolerance, lake sturgeon, species reintroductions, restorations

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Water Quality Oral Presentation

Alkalinity Enhancement- -Evaluation of a Fluidized Bed Reactor at the USFWS Warm Springs Regional Fisheries Center

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The Warm Springs Regional Fisheries Center relies on springs to provide water required for hatchery and pond production operations. We evaluated performance of fluidized bed limestone (CaCO3) sand reactors designed to increase spring water supply alkalinity, hardness and pH while concurrently reducing free carbon dioxide concentrations following the reactions: CaCO3 + H+ = HCO3 - + Ca2+ (1) CaCO3 + CO2 + H2O = Ca2+ + 2 HCO3- (2) Limestone application is attractive given its cost, on an equivalent acid neutralization basis, represents just 3–26% of the alternative reagents NaOH, Na2CO3 and Ca(OH)2. Its use also eliminates the risks of over treatment associated with strong, highly soluble bases like NaOH. We tested the effects of hydraulic flux, bed height, effluent dilution rate and carbon dioxide level on reactor performance then established design conditions for a proposed treatment plant of 500 gpm capacity. Effluent water chemistry exceeded site requirements at each of the three feed rates tested. The pH, for example, rose in all cases from 5.16 to near neutral values (7.54 to 7.77). Following Equation (2), dissolved CO2 fell 84.5 to 94.9% across the system to concentrations of 2.2 to 5.8 mg/L while alkalinity (non-filtered) increased to a mean of 103.4 mg/L from an influent level of 2.3 mg/L. Differences between filtered and non-filtered alkalinity were small ($P>0.05$) indicating limestone was present in the water primarily in the form of dissolved Ca(HCO3)2. Accordingly, conductivity rose from 16 to between 170 and 184 µS/cm with final hardness concentrations of 80 – 97 mg/L. Changes in dissolved CO2 were not correlated with feed rate ($P> 0.05$) but changes in alkalinity were ($P<0.05$). The ability of the reactor to provide changes in water chemistry variables that exceeded required changes allowed for a dilution ratio, in our test case, of about 0.6. Applying this ratio reduces by 40% the volume of spring water that must be directed through the reactor thus providing a substantial potential savings in energy and capital expenditures.

Key words: Alkalinity, Fluidized Bed, Limestone, Water Conditioning

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Water Quality Oral Presentation

Biological Assessment of Sites Located Downstream of Valley Fills in Twentymile Creek Watershed.

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Surface coal mining techniques which use “valley fills” have impaired the aquatic life in numerous streams in the Central Appalachian Mountains. Unlike some coal mining activities that routinely produce acid mine drainage, mountaintop mining (MTM) in the steep terrain of the Central Appalachian coalfields of Kentucky, Virginia, and West Virginia generally results in alkaline mine drainage (pH>7). Our data on the macroinvertebrate assemblages in mined streams has shown subtle to severe impacts on benthic macroinvertebrate communities and the biological condition was related most strongly to a gradient of ionic strength. In the summer of 2007 we re-sampled 4 sites for fish and macroinvertebrates in MTM areas of West Virginia’s Twentymile creek basin and compared the data to samples collected in 2000. We chose the Twentymile Creek watershed because there are no impacts from residences in the upper watershed and this watershed was studied as part of the EPA EIS. We present a preliminary analysis of this data.

Key words: Mountain Top Mining, Valley Fills, electrofishing survey

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Water Quality Oral Presentation

Effects of Highway Construction on Sediment and Benthic Macroinvertebrates in Two Tributaries of the Lost River, West Virginia

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During a three-year study of two tributaries being crossed by a four-lane highway under construction in the eastern panhandle of West Virginia, we found little difference in the amount of fine sediment collected at upstream and downstream sites. The downstream site on one tributary collected significantly greater amounts of sediment in 2003, prior to installation of sediment fencing. Despite several episodic flow events that caused changes in the streambed, benthic macroinvertebrate metrics did not differ significantly annually or seasonally between sites or between streams. On-site controls effectively checked new sedimentation, and benthic macroinvertebrates were not significantly impacted.

Key words: benthic macroinvertebrates, highway construction, sedimentation

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Water Quality Oral Presentation

Managing Sediments in an Appalachian Brook Trout Fishery

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This study provides a watershed scale approach for identifying and effectively managing non-point sediment sources in a rapidly developing Appalachian watershed. The upper Elk River, located in east-central West Virginia, is one of the premier cold-water fisheries in the eastern United States. However, sediment run-off from timber harvest and intensive residential development threaten the quality of wild trout populations. We examined spatial and temporal variation in total suspended solid (TSS) concentrations throughout the watershed and used geographic information systems (GIS) with satellite imagery to identify landscape attributes associated with elevated TSS concentrations. We found that spatial variation in TSS concentration was primarily explained by human development (partial $R^2 = 0.66$), timber harvest ($R^2 = 0.13$), and road area ($R^2 = 0.08$). Results of a paired sampling design also indicated that significant increases in TSS concentrations were the result of intense development activities rather than timber harvest. Temporal variability of TSS concentration was explained by geological and topographical attributes including the presence of karst geology (partial $R^2 = 0.21$), as well as dry flat ($R^2 = 0.28$), slope crest ($R^2 = 0.11$), and slope bottom ($R^2 = 0.09$) landform areas. Through GIS modeling, we identified critical areas within the watershed where remediation actions have the greatest potential to reduce sediment related impacts. The analytical framework that we describe provides the tools needed to set watershed scale management objectives within the upper Elk River, and the approach may be applicable to other mountainous regions.

Key words: sediments, brook trout fishery, Appalachian

Water Quality Oral Presentation

Evaluation of Quadrat Sampling as an Alternative Method for Estimating the Biotic Integrity of Fishes in Wadeable, Warmwater Streams

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Natural resource managers often use fish community data to evaluate the quality of water resources. Fish collection data are assumed to be representative of the structure and abundance of fish in the waterway, yet complete capture of all individuals or species in a sampling unit is nearly impossible. Incomplete capture of fish due to species, size, behavior or habitat characteristics introduces bias into data that can affect a manager's ability to make sound decisions. Fish biologists typically attempt to account for incomplete capture by increasing sampling effort, often sampling stream lengths of 35 to 40 times mean stream width. Increased sampling effort does not account for incomplete detection and may be cost-prohibitive. An alternative to increasing sampling effort is to employ a quadrat sample design and population estimators to estimate fish community metrics, such as species richness. We evaluated the efficacy of this design using sampling data from 30 streams in the Upper Coosa Basin, GA and compared the amount of effort and accuracy of fish community metrics to data collected with current biotic integrity protocols. Comparison fish data collected from the Upper Coosa Basin, GA from 2001-2003 indicated that species richness and biotic integrity indices were underestimated using current protocols, despite the expenditure of large amounts of sampling effort. In contrast, incorporation of detection probabilities from quadrat sample design provided estimates of fish community metrics that have lower bias and require less effort.

Key words: quadrat sampling,

Water Quality Oral Presentation

Local and Regional Influences on Fish Assemblage Structure in Acid-Impaired Watersheds of North-Central West Virginia

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Mining related impacts are a dominant stressor to aquatic resources in north central West Virginia. A greater predictive understanding of how fish communities respond to local and regional environmental stressors is needed to ensure effective restoration and management strategies in mining impacted watersheds. The objectives of this study were to 1) characterize watershed scale variation in fish assemblage structure within two intensively mined WV watersheds, 2) explain this variation as a function of both local and regional conditions, and 3) develop models to predict fish assemblage response to changes (improvements or declines) in local and regional environmental quality. We used non-metric multidimensional scaling (NMDS) to ordinate sites based on Bray-Curtis similarity and general additive model (GAM) surface fitting to describe the ordination space based on descriptive community characteristics. We also used NMDS, GAM, analysis of similarity (ANOSIM), and paired mantel tests to analyze relationships between fish community dissimilarity, local water chemistry, and landscape physiographic and geographic data for 115 sites in the Cheat and Tygart Valley River watersheds. We found that, while local conditions like water chemistry and stream size are important predictors of local community structure, the regional context of impairment plays an important role in structuring local fish communities. For example, we found clear evidence that good streams surrounded by mining impacted waterbodies possess impaired fish communities. Consequently, effective management of stream communities in these systems must consider the watershed scale context of proposed activities and seek to produce watershed scale benefits through the restoration and protection of interconnected drainage networks.

Key words: fish assemblage, acid-impaired watersheds, West Virginia

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Brook Trout Symposium Oral Presentation

Perspectives on Brook Trout Restoration in the Mid-Atlantic Highlands

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Brook trout are the only salmonid native to the mid-Atlantic Highlands (MAH), which includes the mountainous portions of Pennsylvania, Maryland, Virginia, and West Virginia. Since the early 1900s brook trout populations have undergone a dramatic reduction in size and geographic range. However, biologists agree that thoughtful conservation actions could not only slow the rate of population losses, but could be used to successfully restore and grow an economically valuable brook trout fishery. Although each state in this region has its own brook trout management program, successful brook trout conservation will require the development of a more coherent, interdependent program among states within the MAH. To this end, I propose a region-wide conservation goal to implement strategies that protect, restore, and enhance healthy brook trout populations in the MAH. A healthy population is one that maintains itself through local reproduction (wild), possesses a genetic composition that is appropriate to the region (native); is comprised of a large enough number of individuals across a range of sizes to support angler harvest (fishable); is well connected to other populations in the region through dispersal corridors (connected); is part of a balanced ecosystem and does not threaten the status of other species of concern (balanced); and does not pose a health threat to people if eaten (consumable). In conclusion, I will present evidence from research in West Virginia that our priority conservation actions should include: 1. more aggressive protection of habitats and populations within the core distribution of brook trout; 2. watershed scale management of dispersal barriers and acid precipitation; and 3. harvest restrictions on adult brook trout within larger (often stocked) waterbodies. It is my hope that through this symposium, we can reach a consensus on how best to move forward with effective brook trout restoration within the MAH.

Key Words: brook trout restoration, mid-Atlantic highlands

Brook Trout Symposium Oral Presentation

An Overview of Brook Trout Habitat Restoration Projects in Virginia

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This presentation will discuss a range of both historic and current brook trout preservation and restoration efforts in Virginia. Current and historic distribution of brook trout will be reviewed as well as the current effort to genetically type populations

within the state. Restoration efforts discussed will include the use of limestone sand to restore or enhance brook trout populations impacted by acidic deposition and the use of natural stream channel techniques to restore streams that have been impacted by previous channel manipulation. Finally, initial efforts to try to restore brook trout populations in Virginia's limestone spring streams will be discussed. Brook trout have generally been extirpated from this type of habitat, which once produce trophy class trout.

Key words: brook trout restoration

Brook Trout Symposium Oral Presentation

Brook Trout in Contiguous Habitat Complexes of an Appalachian Mountain Stream
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Since fall 1997, we have collected size and location data on individual brook trout in Shenandoah National Park's Staunton River. Using a combination of PIT tag recoveries and mark-recapture techniques, we examined changes in brook trout numbers and site selection among contiguous habitat complexes within a 965 m reach. Our analysis suggests that brook trout numbers and site fidelity are not consistently related to fine scale measures of habitat quality. However, both growth of individual fish and numbers of fish were higher in a reach affected by a debris flow and flood in the mid 1990s.

Key words: brook trout

Brook Trout Symposium Oral Presentation

Population Genetic Characterization of Southwestern Virginia Brook Trout (*Salvelinus fontinalis*) Populations
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Brook trout, *Salvelinus fontinalis*, was once abundant throughout its range, but environmental disturbances and introductions of nonnative trout species have drastically reduced the number and sizes of wild populations. Genetic evidence suggests a division at the subspecies level between southern- and northern-derived brook trout populations, with the zone of contact roughly at the New River watershed. Before the subspecies structure was recognized, brook trout of northern origin had already been stocked extensively in southern waters. The objective of this study was to determine the phylogenetic origin of brook trout populations in 56 streams in southwestern Virginia using established isozyme markers. Fish were collected by electroshocking, and muscle tissue samples were collected using a non-lethal biopsy technique. The samples were analyzed by cellulose acetate gel electrophoresis for variation at five polymorphic loci. Allele frequencies indicated that 19 of the populations were of southern Appalachian origin, 5 of northern origin, and 32 of mixed genetic origin. There was no apparent pattern regarding where populations characterized as southern, northern, or mixed were located geographically. Limitations posed by allozyme markers and incomplete stocking records compromised the ability to ascertain the phylogenetic origins of New River watershed populations. Screenings of microsatellite DNA markers may be helpful in this regard. Findings were shared with the Virginia Department of Game and Inland Fisheries to support conservation and management planning.

Key words: Brook trout, *Salvelinus fontinalis*, allozymes, New River, genetics

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Brook Trout Symposium Oral Presentation

Spatially Explicit Risk Assessments of Maryland's Brook Trout Populations
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Maryland's brook trout have declined dramatically in both distribution and number. In order to effectively manage and conserve the remaining populations into the future, we need to know how at risk these populations are. However, very little information exists on population sizes or amounts of available stream suitable for habitation to a population. Both space and population size has substantial influence on long-term risk from both genetic and demographic perspectives. We used existing genetic information on a number of populations to calculate their effective population sizes (Ne) and to derive general rules of thumb to apply to populations without genetics information. We used the Ne estimates in conjunction with

estimates of population sizes and habitable stream lengths to generate spatially explicit estimates of long-term risks for many populations and more general estimates of necessary available space for the remainder of the known Maryland brook trout populations. Many of the surveyed brook trout populations currently appear to have adequate space or numbers to maintain genetic diversity over the long term. However, a number of populations are fragmented and cut off from other populations. Our estimates provide a starting point to identify at risk populations and prioritize conservation and management efforts.

Key words: brook trout, effective population size, at risk populations

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Brook Trout Symposium Oral Presentation

Factors Related to Population Stability in Appalachian Brook Trout

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A long-term study of brook trout populations across 25 headwater streams in West Virginia provided the template to examine population stability for the species. The goal was a first look at what habitat and watershed characteristics were associated with stable and fluctuating brook trout populations. Sampling of streams began in Fall 2002 and has continued through 2007. Population variability (densities of brook trout adults and young-of-year) from year to year was compared among the streams to determine stability of populations in each stream. Factors related to highly variable as well as stable, but high trout populations will be discussed.

Key words: Appalachian brook trout, population stability

Brook Trout Symposium Oral Presentation

Brook Trout Restoration and Protection in West Virginia

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West Virginia has long been recognized as a leader in the chemical treatment of impaired streams due to acid precipitation. A brief history of the development of the limestone drums and subsequent use of limestone sand will be presented. Additional information will be given on current and future use of limestone sand to restore and enhance brook trout populations. Several WV state agencies have begun incorporating 'natural stream channel design' into some of their projects. At this time, they primarily benefit warmwater fisheries; but some are being installed to directly enhance trout populations. State water quality regulations affecting trout waters has been a 'hot' topic for several years. A review of the current status of those regulations will be given.

Key words: brook trout restoration

Brook Trout Symposium Oral Presentation

Brook Trout (*Salvelinus fontinalis)* Population Types and Mapping Statewide Population Status

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We compiled data from stream surveys performed over the last 10 years that met the requirements of the study. Using this data as training data and landscape attributes acquired using GIS software, we were able to build models predicting brook trout presence at the reach level for the entire state. We then used only the available data points where brook trout were presence to evaluate brook trout population types. Using multiple brook trout population structure metrics in cluster analysis we were able to delineate several brook trout population types. Using analysis of similarity, we were able, along with a visual display of the groups using non-metric multi-dimensional scaling, to assess strength of groups created using cluster analysis. We also used the non-metric multi-dimensional scaling to describe the groups created. Groups included streams with high young-of-year abundance, high small adult abundance, high total abundance, etc. After we were able to name determine the strength of these groups, we then attempted to predict the groups using the same landscape attributes described above. Once determining the effectiveness of these predictions, we were able to extrapolate the results to the entire state. This allows for increased clarity when classifying trout streams for management and restoration purposes. The results of this research will be used to update the Eastern Brook Trout Joint Venture's distributional map and guide brook trout management actions

throughout West Virginia.

Key words: brook trout, landscape predictive models, stream classification, population types

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Brook Trout Symposium Oral Presentation

Landscape Characteristics of Brook Trout Subwatersheds in the Eastern United States
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We summarized existing knowledge regarding the distribution and status of self-sustaining populations of brook trout *Salvelinus fontinalis* at the subwatershed scale (mean size 8,972 ha) across their native range in the eastern United States, a region that represents approximately 25% of the species native range and 70% of the native range in the United States. This assessment resulted in an updated and detailed range map of historic and current distribution of brook trout in the eastern United States. Based on known and predicated brook trout status, subwatersheds were classified based on the percentage of habitat in each subwatershed still maintaining self-sustaining populations of brook trout. Subwatersheds with greater than 50% of self-sustaining habitat intact (n = 1,660; 31%) were fewer than subwatersheds with less than 50% of self-sustaining habitat intact (n = 1,859; 35%). A total of 1,482 subwatersheds (28%) had all self-sustaining brook trout extirpated. Brook trout are known to be absent in another 278 subwatersheds (5%), but it was not known if they were extirpated or never occurred in these subwatersheds. A classification regression tree using five core subwatershed metrics (% total forest, sulfate and nitrate deposition, % mixed forest in the water corridor, % agriculture, road density) was a useful predictor of brook trout distribution and status with an overall correct classification rate of 71%. A total of 94% of the intact subwatersheds had forested lands greater than 68% of the land base. Continued habitat loss associated with land use practices and existing and new populations of naturalized exotic coldwater and warmwater fishes threaten remaining brook trout populations. The brook trout subwatershed status distribution and threshold metric values can be useful for a risk assessment and for prioritizing conservation efforts.

Key words: brook trout, watersheds, land use

Brook Trout Symposium Oral Presentation

Integrating Trout Unlimited's Conservation Success Index with Local Data to Inform Conservation Strategies for Brook Trout
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Increasing our ability to synthesize and compare fisheries assessment data among species and across geographic boundaries should facilitate a better understanding of the broad-scale condition of fish resources and necessary management strategies. Trout Unlimited's Conservation Success Index (CSI) is a tool to analyze the status of native salmonids and facilitate protection, restoration, reintroduction and monitoring efforts. The CSI provides a framework to evaluate indicators of population integrity, range-wide condition, habitat integrity and future security at subwatershed levels across the historical range of the Eastern United States by combining state and federal from trout assessments with spatial data on habitat and threats at the subwatershed level. Integrating local, higher resolution scientific data and local knowledge about community character, landowner preferences, and political climate can help develop effective strategies for brook trout conservation at different scales across the southern Appalachians.

Key words: brook trout conservation assessment

Brook Trout Symposium Oral Presentation

Brook Trout Enhancement and Restoration in Pennsylvania
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Historically, brook trout *Salvelinus fontinalis* inhabited streams throughout Pennsylvania. However, their historic range has been considerably reduced, mostly due to anthropogenic impacts that have resulted in habitat and water quality degradation. Currently, brook trout populations primarily exist in first and second order headwater systems, with strongholds occurring in the northcentral region of the state. The Pennsylvania Fish and Boat Commission (PFBC) is actively involved with projects focused on sustaining and enhancing brook trout populations through the use of physical habitat manipulations, barrier

removals, water quality improvements, and special angling regulations. During the past two decades, the PFBC has developed a habitat enhancement and restoration program that is partnership driven and uses low cost - low disturbance techniques to improve habitat in wild trout streams. The program utilizes large woody debris and habitat enhancement structures constructed of logs and boulders to increase overhead cover, water depth, and habitat diversity while also functioning to reduce bank erosion. Additionally, the PFBC has an active barrier removal program that has completed over 50 dam removal projects on trout streams during the past 10 years. To assess the impacts of angler harvest on brook trout populations, the PFBC is currently evaluating brook trout enhancement regulations on a subset of streams in the northern tier of the state. The regulations require catch and release of all brook trout while allowing for the harvest of other salmonids under general statewide angling regulations. The presentation will focus on the various management tools currently being utilized by the PFBC to sustain and enhance wild brook trout populations in Pennsylvania.

Key words: brook trout, habitat enhancement, angling regulations

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Fisheries Science and Techniques 1 Oral Presentation

Use of a Fishery-Independent Trawl Survey to Evaluate Distributional Patterns of Sub-adult Sharks in Georgia Waters

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We investigated the utility of a fishery-independent trawl survey for assessing a potential multi-species shark nursery in Georgia's near- and inshore waters. A total of 234 sub-adult sharks from six species were captured during 85 of 216 trawls. Catch rates and size distributions for sub-adult sharks, and the ratio of neonates to juveniles were consistent among areas. The highest concentrations of sub-adult sharks occurred in creeks and sounds. Species composition varied among areas. Atlantic sharpnose sharks were the most abundant species in the sound and nearshore stations, whereas bonnethead sharks were the most abundant species in the creeks. The aggregate of other species occurred with higher frequency in the sounds and nearshore. Sampling characteristics of the trawl survey were compared to those from a fishery-independent sub-adult shark longline survey to assess the similarity of the two gears. A total of 193 sub-adult sharks from seven species were captured during 57 of 96 longline sets, whereas 52 sub-adults from four species were captured during 20 of 48 trawls. Selectivity and efficiency differed between the two gears. The trawl had lower catch rates, caught smaller sharks, and encountered a different suite of species than the longline. General seasonal trends in relative abundance also differed between the two gears, with the longline showing an increasing trend in abundance and the trawl showing a stable trend. Although trawls were not found to be efficient for sampling sub-adult sharks from most species, they can be a useful source of supplemental data.

Key words: Gear comparison, sub-adult sharks, longline, trawl

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Fisheries Science and Techniques 1 Oral Presentation

Potential Gear Bias Associated with Hand-retrieved Longline Catches of Sub-adult Sharks in Georgia Estuaries

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Lunar and tidal phases, along with bait type, were examined as potential sources of bias affecting catch rates of sub-adult sharks encountered with a hand-retrieved longline in Georgia's estuaries. A total of 420 sub-adult sharks representing nine species were caught during the 212 sets conducted during 2001 and 2002. The catch rates of the four commonly occurring species, Atlantic sharpnose, *Rhizoprionodon terranovae*, bonnethead, *Sphyrna tiburo*, blacktip, *Carcharhinus limbatus*, and sandbar, *Carcharhinus plumbeus* sharks, were evaluated along with the aggregate catch rate of sub-adult sharks. Neither lunar cycle nor tidal stage affected catch rates of any species other than blacktip shark. During 80 sets in 2003, 177 sub-adult sharks, representing seven species, were captured. Comparisons between bait types indicated higher overall catch rates with squid and an effect on species composition. Mean sizes of Atlantic sharpnose sharks were significantly different between the two bait types, with larger fish captured on hooks baited with spot. Atlantic sharpnose sharks showed a possible ontogenetic shift in bait preference. Catch of neonates was higher on hooks baited with squid than on hooks baited with spot, whereas catch of juveniles was higher on hooks baited with spot. Although timing of a sampling event did not influence catch rates of sub-adult sharks, bait choice can lead to biased estimates of abundance. Accordingly, bait choice should be considered carefully when baited hooks are used to assess assemblage-related metrics of sharks in estuarine waters.

Key words: sub-adult shark, longline, gear bias, lunar effect, tidal effect, bait preference

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Assessment of Rainbow Trout Collection Methods and Performance in Three Tennessee Reservoirs
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Gillnet, nighttime electrofishing, and trout derby catches of rainbow trout in three Tennessee reservoirs were examined to determine the most cost-effective method for collecting trout. Relative survival rates were compared for rainbow trout stocked inshore and offshore and environmental factors were examined to explain variation in rainbow trout growth and condition. Mean catch rates were low (<1.25 fish / net night) in large (91 x 5 m) gillnets set midwater in each reservoir (Ntotal = 24 replicates). Average trout derby catch rates were low (1.8 fish/angler/tournament), but the number of participants in three tournaments averaged 36 anglers (SE = 10.58) and 127 rainbow trout were collected. Mean electrofishing catches of rainbow trout in 15 10-min transects were 1.5 (SE = 0.95), 3.4 (SE = 0.85), and 13.0 (SE = 4.04) at Dale Hollow, South Holston, and Watauga lakes, respectively. In all, 269 rainbow trout were collected during 45 electrofishing transects. Rainbow trout stocked inshore in late winter at Dale Hollow Lake and Watauga Lake survived through mid-summer at the same rate as fish stocked offshore (, P > 0.09). Growth from March to July was rapid (3.1 – 3.6 cm per month) and did not appear to be linked to lake trophic status. Key words: rainbow trout, stocking, gear comparison, survival

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Seasonal and Habitat-Specific Catch Rate and Length Bias of Electrofishing for Blue Catfish
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Current sampling methods for blue catfish, *Ictalurus furcatus*, appear to be strongly size-biased, making it difficult to accurately access population and size structure. To understand this bias for electrofishing, we conducted seasonal and habitat-specific sampling beginning in June, 2006. Kaw, Keystone, and Oologah reservoirs in Oklahoma were sampled seasonally using 15pps-DC electricity at 1000 volts (4 amps). Season/temperature, habitat, and reservoir section were analyzed to determine which variable yields the highest catch-per-unit-effort (CPUE) and CPUE of preferred length (>762mm CPUEp) blue catfish (which appear to be typically underrepresented in electrofishing samples). Total CPUE and CPUEp for blue catfish was significantly ($p < 0.05$) higher for warmer water temperatures. Catch rates also varied among habitats and reservoir sections. Electrofishing length-frequency bias for blue catfish will be quantified using samples from a population with a known density and length frequency. Artificial 'impoundments' will be stocked with approximately 400 blue catfish which include 50 fish for each 100mm length class. The catch rate and length frequency will be compared with the actual population size and length frequency distributions from each sample lake.

Key words: Blue Catfish, Sampling, Electrofishing, Gear Bias

Effects of Current Type and Voltage Gradient on Survival of Electroshocked Embryos of Two Native Minnows
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Fish embryos can be unintentionally exposed to electric fields during electrofishing and negative effects on survival are possible. If survival of embryos of threatened and endangered (T&E) fishes is impaired following electroshock, population-level effects could occur in isolated populations. For some species reduced survival of even individual fish is a concern. Embryos of spotfin chub *Erimonax monachus* and whitetail shiner *Cyprinella galactura* were used as surrogates for T&E cyprinids and were exposed to electric fields in the laboratory to investigate effects of electroshock on survival to hatching. Independent variables were current type (direct current (DC) or 60-Hz pulsed DC (PDC)), voltage gradient (3-15 V/cm), and stage of embryonic development when fish were electroshocked. Water conductivity was 100-110 (mu)S/cm. Embryos were more susceptible to DC than PDC, and survival to hatching was inversely related to DC voltage gradient. Earlier developmental stages had lower survival to hatching than those electroshocked at later developmental stages. For whitetail shiners, 32% of pre-epiboly embryos survived 6 V/cm DC electroshock. For spotfin chubs, 54% of pre-epiboly embryos survived 7.5 V/cm DC electroshock. Premature hatching was induced in spotfin chub embryos electroshocked in later developmental stages. After electroshock, embryos hatched within 0.5 h (at 5 d post-fertilization (dpf)), while unshocked embryos did not hatch until 7 dpf. Cyprinid embryos are vulnerable to negative effects of electroshock, and electrofishing near spawning habitat of threatened and endangered species should be avoided.
Key words: electrofishing, embryos, spotfin chub, whitetail shiner, electroshocking

Fisheries Science and Techniques 1 Oral Presentation

Comparison of Prepositioned Areal Electrofishing Grids and Two-way Resistance Board Weirs for Assessing Migrating Stream Fish Populations

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Many species of freshwater stream fish are known to migrate seasonally for reproduction or other ecological functions. Quantifying lotic fish communities and their movement patterns provides critical information for management of streams and rivers. We compared catch efficiency and composition of stream fishes during the spring spawning period using two different techniques: (1) prepositioned areal electrofishing grids (PAEDs) and (2) two-way resistance board weirs. We deployed both gears concurrently at two sites in Valley River, a North Carolina mountain stream in the Hiwassee drainage, from March through July 2006 and 2007. Total PAED catch (815 fish) was much higher than total weir catch (285 fish) in 2006 but, total PAED catch (846 fish) was much lower than total weir catch (877 fish) in 2007. Biomass of the PAED catch (127.5 kg, 2006; 233.6 kg, 2007) was much lower than that of the weir catch (209.2 kg, 2006; 1082.2 kg, 2007). Community measures (species richness, diversity, dominance) were higher for PAED catch relative to weir catch. Fish catch in weirs was greatly reduced after a peak in fish spawning. PAEDs provided occupancy data of the community, while weirs described migration chronology for highly migratory redhorses (*Moxostoma* spp.). We conclude that PAEDs are the most valid approach to quantify fish communities, and weirs should be employed when objectives focus on migration.

Key words: Weir, Migration, Potamodromous, PAED

Fisheries Science and Techniques 1 Oral Presentation

Influences of Instream Habitat and Water Quality on Electrofishing Catchability of Puerto Rico Stream Fishes

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Puerto Rico is known for marine fisheries; however, its freshwater stream habitats also support valuable fisheries. Proper management of these stream fish resources requires standardized sampling, an understanding of gear catchability, and accurate population estimates. Our objectives were to quantify electrofishing catchability using a standardized sampling protocol and relate it to environmental variables to improve accuracy of population estimates. We sampled fish in 81 stream reaches island-wide, using a three-pass removal protocol with backpack or tote-barge electrofishers and measured instream habitat and water quality parameters. We estimated fish catchability using the standard maximum-likelihood removal estimator. We employed a correlation matrix to reduce 21 environmental parameters to seven, then developed hierarchical regression models and used AIC model selection to quantify relationships between catchability and environmental variables. Mean catchability among six native species ranged from 0.30 for the smallscaled spinycheek sleeper *Eleotris perniger* to 0.55 for the river goby *Awaous banana*. Among benthic and water-column species, we found no trend relating environmental parameters to variation in catchability. The most influential environmental parameters on fish catchability were water velocity, stream width, and water conductivity. Catchability was negatively correlated to velocity and width and positively to conductivity. These models that incorporate environmental covariates may be used in the future to more accurately predict fish population size using single-pass electrofishing catch. This approach will reduce the effort required to obtain the quantitative data necessary to inform management decisions.

Key words: Electrofishing, catchability, Puerto Rico, stream fish, fish sampling

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Fisheries Science and Techniques 1 Oral Presentation

Patterns of Microsatellite Inheritance in Shovelnose Sturgeon *Scaphirhynchus platorynchus*, Pallid Sturgeon *S. albus* and their hybrids

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North American river sturgeon, genus *Scahpirhynchus*, possess few diagnosable morphological characters for delineation of taxa. Additionally, there is substantial morphological variation within the two recognized sympatric species, *S. platorynchus* and *S. albus*, across their range. Investigations with molecular sequences from mtDNA loci found very shallow divergence

among recovered haplotypes of all three North American *Scaphirhynchus*, despite the time since isolation of *S. suttkusi* in the Mobile Basin, though these loci do demonstrate a discrete clade of *S. suttkusi*. Microsatellite loci have also been implemented to examine population and taxonomic level questions for the sympatric species, and more recently the hypothesis of hybridization (morphological intermediates) between *S. platorynchus* and *S. albus*. However, inheritance patterns of microsatellite alleles from commonly used loci have not been examined in controlled crosses of parental *Scaphirhynchus* species. In this study 60 hybrid offspring from 4 crosses between parental individuals of *S. platorynchus* and parental individuals of *S. albus* were examined for 14 disomic loci. These results were used to assess the utility of current algorithms that are popular for the analysis of microsatellite datasets. Our results indicate that some computer algorithms have a limited ability to diagnose F1 hybrids. The results of these experiments will be presented.

Key words: Sturgeon, Pallid Sturgeon, Shovelnose Sturgeon, Hybrids

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Fisheries Science and Techniques 1 Oral Presentation

Genetic Structure of Largemouth Bass (*Micropterus salmoides*) in Several Arkansas Lakes as Determined by Microsatellite Analysis Following the Stocking of Florida bass (*Micropterus floridanus*)

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The extent and effects of hybridization between the largemouth bass (*Micropterus salmoides*) and introduced Florida bass (*M. floridanus*) in southern lakes has been a great source of debate. Previous genetic studies investigating hybridization of these two species have often lacked sufficient resolving power to distinguish specific hybridization events. The goal of this study was to determine the incorporation of Florida bass alleles into several Arkansas lakes. To achieve this goal, a suite of seven microsatellite markers capable of distinguishing largemouth bass, Florida bass, and their hybrids were employed to categorize over 1200 individuals from 8 southern Arkansas lakes (Lakes Chicot, Columbia, DeGray, Erling, Millwood, Monticello, Ouachita and SWEPCO). These lakes had differing Florida bass stocking histories, ranging from no previous introductions to extensive and continued stocking. DNA extraction was performed on bass fin clips, microsatellite loci were amplified using PCR, and alleles were separated using capillary electrophoresis. The software Structure was used to analyze the distribution of microsatellite loci within individuals and populations, cataloging allele frequencies, and for admixture analyses. Largemouth bass allele frequencies ranged from 0.29 (Lake Monticello) to 0.99 (Brushy Creek of Lake DeGray) for the composite of the loci studied. Allele frequencies and cluster analysis are largely consistent with that predicted based upon stocking histories and protocols.

Key words: largemouth bass, Florida bass, microsatellites, hybridization, allele frequencies

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Fisheries Science and Techniques 1 Oral Presentation

Phylogeography and Conservation Genetics of Redeye Bass (*Micropterus coosae*) Inferred from DNA Sequence Data

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The redeye bass (*Micropterus coosae*) is considered one of the rarest of black bass species due to a limited distribution among a relatively small number of drainages in the southeastern United States. The within-drainage distribution of redeye bass is restricted to those stream segments that lie above the Fall Line. In the early to mid 1980's, private anglers introduced non-native Alabama spotted bass (*M. punctulatus henshalli*) into the upper Savannah River, an eastern drainage within the native range of redeye bass. Subsequent surveys from the upper Savannah River drainage reservoirs indicated concurrent trends of increasing numbers of non-native Alabama spotted bass with decreasing numbers of native redeye bass. Recent genetic work has confirmed ongoing hybridization between the two taxa within the upper Savannah River suggesting that the rarity of redeye bass is being exacerbated by hybridization with non-native Alabama spotted bass. To aid in conservation and management efforts for this species, we generated mitochondrial and single-copy nuclear DNA sequence data from all extant native redeye bass populations. We identify evolutionarily significant units of redeye bass throughout the species range, document the impact of hybridization in this species, and recommend appropriate conservation and management strategies for the species' long-term preservation.

Key words: conservation genetics, redeye bass, *Micropterus*, hybridization

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Determining the Reception Range of Submersed, Bridge-mounted Hydroacoustic Receiver Arrays in the Mississippi River

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The distribution and movements of the federally endangered pallid sturgeon *Scaphirhynchus albus* are poorly understood and a multi-state telemetry project is now underway on the Mississippi River to collect such data. Hydroacoustic tags and submersible receivers have been extensively utilized in haline systems; however, there is limited literature on their use in freshwater systems, particularly in large rivers. Standard methods of anchoring receivers to the bottom of a river yield low retrieval rates or are not suitable for shifting substrate. Mounting receivers to bridges avoids some problems but other issues arise such as how to retrieve the receivers and download data at both high and low river stages. A receiver-mounting system has been developed that consists of conduit pipe attached to the downriver side of a bridge pylon in which the receiver is suspended by a length of cable out the bottom of the conduit. Rates of receiver retrieval and data acquisition using this method are expected to be high; however, the tag-detection range of receivers mounted to bridges is unknown. A protocol has been developed to test the range of the receivers via a series of transects demarcated by GPS and using a submerged hydroacoustic pinger tag to simulate fish passage. Preliminary sampling at three bridges in 2007 revealed that tag detection range varied widely and was influenced by proximity of the receivers to turbulence in the main channel of the river. Follow-up sampling in 2008 will attempt to more precisely define the variables affecting tag detection range.

Key words: hydroacoustic telemetry, pallid sturgeon

Using Fish Otoliths to Explore Mercury Bioaccumulation Patterns in Coastal Fish Populations in the Mobile-Tensaw River Delta, Alabama.

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Mercury (Hg) is a harmful bioaccumulative heavy metal to which humans are exposed primarily through fish consumption. Several consumption advisories for mercury have been issued for fish species along the Atlantic and Gulf coasts of the U.S., including the Mobile-Tensaw River Delta in coastal Alabama. Mercury cycling in estuaries is complex and affected by a suite of abiotic and biotic variables. As a result, little is known about the extent of mercury bioaccumulation in the diverse fish populations within the ecologically dynamic Mobile-Tensaw Delta, Alabama. Using traditional tissue analysis techniques in conjunction with otolith microchemistry and dietary analyses we investigated seasonal and spatial trends of mercury accumulation in largemouth bass, *Micropterus salmoides*, and southern flounder, *Paralichthys lethostigma*, inhabiting the Delta. Adults of both species were collected at sites across an upstream-downstream seasonal salinity gradient during spring and fall of 2005 and 2006 Size-normalized largemouth bass mercury tissue concentrations for 2005 and 2006 increased significantly from downstream to upstream locations with little seasonal variation. Southern flounder mercury tissue concentrations were uniform across the sample area and were lower than those of largemouth bass. Otolith microchemistry analysis showed Sr:Ca ratios may be useful indicators of salinity exposure which may correlate with lowered mercury accumulation. Specifically, Sr:Ca ratios across transect ablations on fish otoliths showed annual patterns for both species that may reflect lifetime salinity exposure. Efforts to detect mercury directly in the otoliths of both species as a way to measure lifetime mercury accumulation trends have met with limited success.

Key words: Mercury, otolith microchemistry, bioaccumulation, largemouth bass, southern flounder, estuary

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Larval Sampling in Freshwater Systems of Puerto Rico

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In the tropics, there is very little published information about freshwater fishes in general, and larval fishes in particular. There is also a growing interest in enhancing native fisheries worldwide. Management of any recreational fishery requires a thorough understanding of the natural life history of the species in question. Effective methods of larval sampling are a necessary precursor to any larval study. Larval sampling in freshwater systems of Puerto Rico was conducted in the mouths

of two rivers, Cañas and Guanajibo, using two sampling methods: drift nets and light traps. Weekly samples were collected at the surface and bottom of each river mouth once per week from June to August of 2007. Drift nets were set for 24-hour periods and light traps were sampled for 12-hour overnight periods. Results indicated night sampling was most effective ($P < 0.0001$), and in night samples, 58% of larvae were caught in light traps.

Key words: larvae, management, drift, light trap

Fisheries Science and Techniques 1 Oral Presentation

Using GIS to Assess Annual Variation in the Volume of Habitat Available to Rainbow Trout in a Tennessee Reservoir
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The Tennessee Wildlife Resources Agency (TWRA) annually stocks about 200,000 rainbow trout *Oncorhynchus mykiss* into Tennessee reservoirs. An understanding of inter-year variation in the amount of habitat available to trout would help TWRA managers prioritize and optimize their stocking program. We defined trout habitat as water cooler than 21° C with a dissolved oxygen concentration above 5 mg/L. Temperature and dissolved oxygen profiles were collected every 2 km in Dale Hollow Lake in the summer and fall of 2006 and historical water quality data going back to 1971 were also obtained. Traditional GIS analysis could not be used to define the volume of habitat available each year because there were not enough sample points in the historical dataset. Instead, a GIS "Tool " was developed using ESRI's arcmap software to perform this analysis. Our GIS Tool performed a series of interpolations using a combination of linear algebra and kriging to create depth layers and then calculated the volume of trout habitat each summer. Over a thirty-five year period, the volume of trout habitat in late summer ranged from 0 to 2.932 X 108 cubic meters. Further analyses will seek to explain annual variations in the volume of trout habitat as a function of hydrological factors in winter and spring.

Key words: GIS, rainbow trout

Crayfish Symposium 1 Oral Presentation

The Conservation Status of Maryland Crayfishes
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Effective management and conservation of Maryland's nine native crayfishes requires detailed knowledge of their status and distribution. To this end, the Maryland Department of Natural Resources is currently conducting the first inventory of Maryland's crayfishes in over 40 years. This survey is scheduled for completion in 2009. Preliminary results indicate that the native species *Oroconectes limosus*, *O. obscurus*, *Cambarus b. bartonii*, *C. carinirostris*, *C. diogenes*, *Cambarus dubius*, and *Procambarus acutus* are stable statewide. However, some populations of these species are threatened by urbanization and introduced species. The current status of *Fallicambarus fodiens* and *C. acuminatus*, perhaps Maryland's most imperiled species, is unclear at this time. Targeted surveys will be conducted in 2008 and 2009 to better determine the distribution of these rarely seen species. So far, the statewide crayfish inventory indicates that non-native crayfishes are an important threat to many of Maryland's native species. Four previously undocumented non-native species *O. rusticus*, *P. zonangulus*, *P. clarkii*, and *C. thomai* were collected in 2006 and 2007. It is believed that these species were introduced primarily as bait or through aquaculture. A fifth non-native species *O. virilis*, first reported from one location in 1885, has dramatically expanded its distribution in central Maryland. The spread of this species has been followed by a concurrent shift in the distribution or loss of populations of *C. b. bartonii*, *O. limosus*, and *O. obscurus*. Based on the apparent displacement of native species caused by *O. virilis*, we are currently tracking the dispersal of the other four non-native species.

Key words: Maryland, crayfish, status, non-native

Crayfish Symposium 1 Oral Presentation

Conservation and Status of West Virginia Crayfishes
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West Virginias crayfishes have received moderate attention since the publication of Jezerinac's et al. (1995) treatment of the states fauna in 1995. Recently an increased effort to understand the current distribution, natural history, and conservation standing of West Virginia's crayfishes has led to several new distribution records and insights into the natural history of the state's fauna. Currently, 22 described species occur in the state of which 4 are given S1 conservation status, and 3 are introduced species. One species, *Orconectes (F.) limosus*, has become extirpated within West Virginia in the past decade. Imperiled species include *Cambarus (P.) veteranus*, *Cambarus (H.) elkensis*, *Cambarus (H.) longulus*, and *Cambarus (P.) nertius*. Three species, *Orconectes (G.) virilis*, *Orconectes (P.) rusticus*, and *Procambarus (O.) acutus* have introduced populations within the state. Native *P. (O.) acutus* also occur in West Virginia, in bottomland forest along the Ohio River Floodplain. Several undescribed taxa also have been identified, and currently are being investigated. In 2007 a statewide survey was initiated in order to document current distribution and conservation standings of West Virginia crayfishes. Methods and results of this study to date are described, as well as future research endeavors within West Virginia's borders.
Key words: Crayfishes, West Virginia, distribution, natural history, conservation

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Crayfish Symposium 1 Oral Presentation

Status of Crayfish in Indiana
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The number of crayfish inhabiting Indiana includes 23 species. Primary burrowers are represented by four species, secondary burrowers by eight species, and tertiary burrowers by eleven species. Six checklists have been historically compiled for crayfish within Indiana; however, little is known about species distributions. From periods between 1891 and 1955 only ten crayfish species were documented and significant confusion existed in our understanding of species distribution, identity, and biology. Most early studies (<1950) were focused on the "blind" cave crayfish of the *Orconectes inermis* complex. Descriptions of *O. inermis inermis, O. pellucidus,* and *O. inermis testii* have caused confusion over the status of *O. inermis testii. Orconectes indianensis* was studied and found to be stable, while conservation efforts are needed for two species. Significant efforts on species distribution have been accomplished. Prior to 1980 less than 150 sites were studied with most done in caves and a few watersheds in northern Indiana. During 1980-1995, nearly 3000 collections were made statewide. Since 1995, intensive watershed surveys resulted in over 2000 sites. Another study included 675 sites that focused on the distribution and ecology of burrowing crayfish species, while additional intensive investigations collected 1080 sites in southern Indiana. Two new species have been described including *Cambarus (Tubericambarus) polychromatus* and *Orconectes (Procericambarus*) *theaphionensis.* Life history studies have been initiated for all crayfish species, which will provide new information on preferred habitat, reproductive biology, age, growth, and diet. Additional species are pending formal description once distributions are known. A minimum of an additional eleven species will be added to the list of crayfish occurring in Indiana. Another two species are hypothetical in occurrence, while hypothetical species considered in the most recent checklist have all been confirmed statewide. It is possible that the actual number of crayfish occurring in Indiana may reach or exceed 36 species.

Key words: crayfish, Indiana

Crayfish Symposium 1 Oral Presentation

Crayfishes of Alabama - What We Do and Don't Know?
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As a first step toward elucidating the current status of Alabama's crayfish fauna, museums known to have significant crayfish collections were queried for their holdings from that state. A total of 4649 records of Alabama crayfishes were obtained from seven museums of which 330 did not have enough information to be geo-referenced. The largest holdings were found in the National Museum of Natural History (2,544 records). Specimen identifications were verified and once verified all records were geo-referenced. Geographic distribution strongly favored upland drainages in the northern and central portions of the state. The Tennessee River drainage was the single most (1,018 records, 23.6% of records) collected drainage. A total of 85 species of crayfishes are reported for the state of Alabama, only *Orconectes virilis* is deemed to be non-native. Even with the total number of crayfish records in museums there is a need for crayfish inventory work in Alabama. Of all the records, a total of 3,107 (76.3%) were collected prior to 1987, and 1,379 (33.8%) were collected prior to 1970. In addition, there is a paucity of records from the coastal drainages of SE Alabama. There is also an under-representation of burrowing crayfishes, primarily those classified as either primary or secondary burrowers. Only 212 (4.9%) of all records are of burrowing species.

Lastly, a limited amount of field work in Alabama has documented the presence of a species previously unreported for the state.

Key words: Crayfish, Cambaridae, Alabama

Crayfish Symposium 1 Oral Presentation

History, Status and Conservation of Crayfishes in Georgia

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Georgia has historically had one of the best known crayfish faunas in the United States, mainly because of the work of Dr. Horton H. Hobbs, Jr. In The Crayfishes of Georgia, published in 1981, Hobbs recognized 66 species and subspecies from the state, which included one probable extinct species, *Procambarus* (*Ortmannicus*) *angustatus*. Current studies indicate Georgia has 69 extant native species and subspecies, one extinct species, and two non-native species. Of these, 18 (26%) are considered endemic. A recent evaluation of the conservation status of United States crayfishes suggests that 6 Georgia species are endangered, 10 threatened, 7 vulnerable, and 1 extinct. The state of Georgia recently revised its state protected species list, and for the first time included crayfishes. Twenty crayfish species were placed on the list including 7 species listed as endangered, 10 threatened, and 3 rare. In addition, new rules were put in place to protect crayfishes from export for the pet trade, while still permitting collection of some species for bait. Taxonomic studies continue on Georgia crayfishes with at least two forms being examined as probable new species. The two non-native species now present in Georgia are *Orconectes* (*Buannulifictus*) *palmeri creolanus* and *Procambarus* (*Scapulicambarus*) *clarkii*. *Orconectes palmeri creolanus* appears to be expanding its range while the status of *Procambarus clarkii* is poorly understood.

Key words: crayfish, Georgia, non-native species, taxonomy, conservation

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Crayfish Symposium 1 Oral Presentation

Crayfish Inventory and Monitoring in Western North Carolina

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North Carolina supports a substantial proportion of the North American crayfish fauna, with 38 indigenous crayfish species presently described, 10 of which are endemic, and three non-native species. In the late 1990's the North Carolina Wildlife Resources Commission (NCWRC) began to inventory and establish baselines for monitoring populations of both native stream-dwelling and burrowing crayfishes and potentially invasive non-native species. In 2004-05, that effort was completed for the Tennessee, New, Santee, and Savannah river basins in western NC. Twenty-seven species were collected from 250 sites sampled. A third of these were terrestrial sites with burrowing crayfish that were located through landowners and other cooperators. Results include extension of the known range of many native species, including a new NC river basin record for *Cambarus reduncus*. Observations of life history traits, such as reproductive condition, fecundity, and habitat use were recorded. We also worked closely with crayfish taxonomists to provide data and specimens to help resolve certain taxonomic problems and to provide material to assist completion of a number of new species descriptions in progress at that time. Data collected during these and previous NCWRC inventories and data obtained from the NC State Museum of Natural Sciences and other cooperators (e.g. NCDWQ, National Park Service, TVA), were incorporated into a detailed GIS project. This was useful in identifying data gaps to guide our sampling efforts and, over time, will provide a tool useful in assessing the status of native crayfish populations and the spread of invasive species, and informing conservation decisions.

Key words: crayfish, North Carolina, status assessment

Crayfish Symposium 1 Oral Presentation

The Crayfishes of the Ohio River

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Very little is known about crayfishes in large rivers. Alteration for navigation and the receiptant nature of upstream pollution have resulted in significant biological and habitat alterations. Since the clean water act improvements in water chemistry and possibly, habitat have opened large rivers for re-colonization or expansion of refugea populations of aquatic species. In particular segments of the Ohio River have seen significant improvements water chemistry, habitats, and biological condition.

Most crayfish biologist have ignored large rivers due to their perceived impacts, including lack of suitable habitat, high predator rates and the difficulties sampling. A series of projects from recent years has led to the sampling of the Ohio River from Pittsburg to Cario, Il. We have sampled using a series of techniques including bank searches and SCUBA transects. From the mouth of the Muskingum River upstream two native species occur in the mainstem. *Orconectes obscurus* accounts for 99% of the specimens in our collections. The invasive *O. rusticus* is the only crayfish we have found downstream from the Muskingum to Smithland Pool. In the Smithland pool, *O. palicidus* and *O. rusticus* occur. Further downstream in pools 52 and 53 *O. palicidus*, *O. pardalotus*, and *Cambarus rusticiformis* were all collected. The dominace of *O. rusticus* in almost 700 miles of the Ohio River mainstem may mean the recently identified *O. pardalotus* could face extirpation. Invasion from downstream *O. rusticus* may jeopardize other Orconectid natives including the federally listed *O. jeffersoni*.

Key words: Ohio River, Crayfish

Crayfish Symposium 1 Oral Presentation

Ecology and Conservation of Western Maryland Crayfishes

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Maryland's crayfish fauna has not received focused attention in recent years. Invasive crayfishes have been identified in Maryland waterways, and determining the true extent and distribution of invasives as well as native species distributions prior to their arrival is of utmost conservation concern. A survey was initiated to document the native and invasive crayfishes of Western Maryland to determine the makeup and conservation standing of each resident species. *Orconectes (C.) obscurus*, *Cambarus (J.) dubius*, *Cambarus (C.) b. bartonii*, and an un-described *Cambarus* species are native to the region. Introduced species include *Orconectes (G.) virilis*, *Procambarus (O.) acutus* and *Cambarus (T.) thomai*. Amongst natives, *O. (C.) obscurus* is widely distributed throughout both Atlantic Slope and Ohio River basins. *Cambarus* spp. occurs in the Ohio River basin and is replaced in the Atlantic Slope with its ecological equivalent *C. (C.) b. bartonii*. *Cambarus (J.) dubius* is distributed throughout the Ohio River basin, with disjunct populations occurring in Atlantic slope basins. Introduced species occurred most frequently in areas of high anthropogenic activity, particularly Deep Creek Lake, with both *O. (G.) virilis* and *P. (O.) acutus* populations isolated to impoundments. *Cambarus (T.) thomai's* presence in Maryland was first documented through this study, and represents one of the first situations globally of a primary burrowing crayfish occurring outside its native range. Major conservation concerns to the regions native crayfish fauna include the potential spread of invasives from impoundments, development in response to tourism, and land use practices.

Key words: Maryland, Crayfishes, *Cambarus thomai*

Crayfish Symposium 1 Oral Presentation

The Conservation Status of Three Rare Crayfish Species in Southwest Virginia

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Southwestern Virginia houses parts of the headwaters of three major North American river systems, the Tennessee, Ohio, and New. In these basins are found many rare and endemic species of aquatic organisms. Fishes, bivalves, snails, and crayfishes all have rare and endemic faunal components in the area. This paper presents the current results of a multi year study of three crayfish species, *Cambarus veteranus, Cambarus jezerinaci,* and an undescribed species of *Cambarus*. Ranges for the species are well known within the state. Life histories, food preferences, habitat quality, and abundances are being determined. Of the three taxa *Cambarus veteranus* is currently the most imperiled. At least one additional taxon with a highly restricted range has been discovered. This new species illustrates a significant problem for crayfish conservation in that many undescribed taxa in the Appalachian region are yet to be named and given conservation status. Currently, though insufficient and declining, moneys are available for studying known species but funds are not available to resolve the many imperiled undescribed species. In addition the purposeful underfunding of the USFWS's endangered species efforts forms a near insurmountable impediment to crayfish conservation efforts.

Key words: *Cambarus*, *veteranus, jezerinaci*, undescribed species, life history, Ohio River, Tennessee River, New River

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The extirpation of *Orconectes limosus* from West Virginia Due to the Introduction of the Non-native Crayfish Species *Orconectes virilis*

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Introductions of non-native crayfish species have resulted in the decline of native crayfish populations in many instances around the globe, including North America. Historically, the range of crayfish *Orconectes limosus*, extended from Maine, southward into northern Virginia, including eastern portions of the eastern panhandle of West Virginia. A survey of Opequon Creek in 1989 by Jezerinac and others resulted in the capture of only two species; *Cambarus bartonii bartonii* and the non-native *Orconectes virilis*. In 2005 and 2006, crayfish were collected from streams within the West Virginia portion of *O. limosus* range, including locations where previously documented captures had occurred. Methods of capture included hand collection (wading and SCUBA assisted), seining, and electrofishing. To date 647 crayfish have been collected resulting in zero *O. limosus* being captured. The non-native *O. virilis* was present at 26 of the 30 sites sampled. The nearly wholesale exclusion of *O. limosus* for this portion of its range, presumably by the non-native crayfish *O. virilis*, does not bode well for the conservation of the species and can be used as a model to show the potentially devastating impact of the introduction of non-native species.

Key words: *Oronectes limosus*, *Orconectes virilis*, crayfish, non-native, invasive, extrapation, West Virginia

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Status and Distribution of the Rusty Gravedigger, *Cambarus miltus*: A Case of Recovery or Neglect?

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The primary burrowing rusty gravedigger, *Cambarus miltus* , is a narrowly endemic species formerly known only from Baldwin County, Alabama. In an effort to determine if listing under the Endangered Species Act is warranted, field surveys were conducted across portions of southern Alabama and western Florida. Our efforts have revealed the presence of new populations of the species and added to our knowledge of it's habitat preferences. Historical field efforts and resulting literature will also be discussed.

Key words: crayfish, primary burrower, narrow endemic, field surveys

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Molecular Systematics and Biogeography of *Orconectes nana* and *Orconectes macrus* Midget Crayfish from Western Ozarks

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Orconectes nana and *Orconectes macrus* have a highly restricted distribution on the western edge of the Ozark Highlands physiographic province. Both species are primarily found in western flowing tributaries of the Neosho River (Arkansas River basin). There is also one known population occurring in the headwaters of the White River basin. A detailed phylogenetic investigation was conducted by extensively sampling each species from throughout most of their range. A total of 105 individuals were sequenced for 650 nucleotides of the Cytochrome Oxidase I mtDNA locus. Phylogenetic analyses indicate two deeply divergent clades that correspond directly to recognized species boundaries. Additionally, and based on our sampling, there are at least two phylogeographically structured lineages recovered within both *O. nana* and *O. macrus* indicating historical subdivision within each of these species.

Key words: *Orconectes*, crayfish, phylogenetics, phylogeography

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Invasive Crayfishes of the New/Kanawha River System in West Virginia and a Comparison of Large River Collection Techniques

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There are six species of orconectid crayfishes historically recorded from West Virginia. *Orconectes rusticus* and *Orconectes virilis* are both non-native invasives. In 1978, researchers found a small population of *O. rusticus* in Four-Pole creek in Huntington, West Virginia and a second population on the Kanawha River. *Orconectes virilis* is historically known from the far eastern panhandle, and limited sites in the New/Kanawha River valley. Recent collections are locating a broader distribution of both species. This study focuses on New/Kanawha River from Bluestone Lake to the Ohio River. Currently there is no consensus means for collecting crayfishes from large rivers. During this project SCUBA provided the easiest means of collecting crayfish from the Kanawha River and deep sections of the New River. Seining proved the best means of collecting in backwater areas and shallow portions of the New River. Underwater transects, pivot searches, meter surber samples, and other techniques were utilized to find the most efficient method for collecting crayfish in a large river environment. The resulting efforts suggest that *O. rusticus* is the dominant crayfish in the Kanawha River mainstem with *O. virilis* being the dominate orconectid species in the New River mainstem. Significant expansion of these two invasives in the New/Kanawha system, Ohio River and other streams in West Virginia warrant greater attention by regulatory agencies, educators, and researchers.

Key words: *Orconectes rusticus*, *Orconectes virilis*, Kanawha River, New River, Invasive, West Virginia

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Preliminary Results of a Multi-year Survey to Monitor *Orconectes rusticus*, a Recent Invader of Maryland

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In June 2007, *Orconectes rusticus* (rusty crayfish) was discovered in a tributary to the Monocacy River, Maryland. Following this discovery, the Maryland Department of Natural Resources joined with local government and academic institutions to begin a multi-year survey of *O. rusticus* throughout the Monocacy River watershed. Our goals were to: 1) determine the distribution of *O. rusticus* and other crayfish species and 2) establish baseline data to examine the effects of *O. rusticus* on native crayfishes in the Monocacy River. We surveyed at all bridge crossings (N=21) on the Monocacy mainstem and tributaries &ge3rd order. We collected *O. rusticus* (N=464) from the six furthest upstream sites. They were the most abundant species (mean relative abundance ± SE) (0.86 ± 0.07) at five of those sites. *Orconectes virilis* composed nearly the entire crayfish community (0.98 ± 0.02) at nine sites within the middle portion of the river. The native *O. obscurus* was the predominant species (0.68 ± 0.06) at the lower seven sites. At 27 of 29 tributary sites sampled, *O. virilis* was the only species present. Non-native species were encountered throughout most of the watershed. A distinct pattern of species replacement by non-natives was evident in the Monocacy River. Only a few sites existed where species coexisted in similar relative abundance. *Orconectes rusticus* has become established throughout the upper 18 km of the Monocacy River in Maryland. If dispersal becomes evident, we hope to document changes in species distribution and community composition.

Key words*: Orconectes rusticus*, rusty crayfish, invasive species, Maryland

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Reproductive Strategies of the Characidae, Cichlidae and Cyprinidae (Pisces: Teleostei) from a reservoir in Ilorin, Nigeria.

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The reproductive strategies of *Hydrocynus forskali*, *Brycenus nurse* (Characidae), *Labeo Coubie* (Cyprinidae), *Orechromis niloticus* and *Tilipia zillii* (Cichlidae) were investigated. The egg size (diameter) was measured using microscope and Fecundity of each fish species were estimated and related to methods of spawning. The results showed that the mean eggs size of *H.fosrkali* was 0.04mm and mean fecundity was 1120. The egg size and fecundity of the *B. nurse* were 0.02mm mean value and mean fecundity was 8274. In *L.coubie* the mean egg size was 0.003mm and the mean fecundity was 18054. In *O. niloticus* the mean egg size was 3.53mm and the mean fecundity was 370 while in *T. zillii* the mean egg size was 1.00mm and the mean fecundity was 2040. In most of the fishes examined small egg size resulted in higher fecundity while large egg size resulted in lower fecundity. The reproductive strategies employed by *L. coubie* and *B. nurse* are great number of eggs and

through the force of number the survival of a portion of the eggs is ensured. In *O. niloticus* the large egg size has greatly reduced the total number of eggs and the strategy of mouth incubation by the female parent is adopted. *T. zillii* is a substratum spawner with moderate number of eggs and the strategy of guarding the nest and warding off intruders is utilized. *T. zillii* is the dominant species in the reservoir which is an indication that the reproductive strategy is successful.

Key words: Reproductive Strategies, Characidae, Cichlidae, Cyprinidae and egg size

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Life History and Ecology 1 Oral Presentation

Natural History of Introduced Northern Snakehead (*Channa argus*) in the Potomac River Catchment

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Northern snakehead (NSH), recently established a population in the Potomac River catchment. This large, piscivorous, air-breathing fish may pose substantial risk to native fishes. To understand the natural history of this invader, we studied its dispersal ability, habitat use, feeding habits, diet, spawning, and growth. We implanted 49 fish with radio transmitters in October 2006, and located them once per month during the winter and twice per week during summer 2007. Habitat (depth, cover, substrate) and measures of water quality (temperature, turbidity, salinity, dissolved oxygen) were recorded at random and NSH locations. We captured NSH for gut-content analysis from May to August 2007. Additionally, we captured co-occuring largemouth bass (*Micropterus salmoides*), yellow perch (*Perca flavescens*), and American eel (*Anguilla rostrata*) to compare diet overlap with North American species. Nests were discovered and monitored, taking larval samples daily. Larval growth was measured through these samples, and adult growth was measured through recapture of tagged fish. Approximately 1/3 of tagged NSH dispersed (some over 40 km) just prior to the start of the spawning season in May. NSH appeared to prefer shallow (<1.5 m) habitats with thick cover. They fed during daylight, almost exclusively on fishes- in contrast with the other species that regularly consumed invertebrates. Indications of spawning were observed from May to September, and guarded nests were found in thick *Hydrilla verticillata*. Larvae grew 1-3 mm per day, and recaptured adults grew approximately 10 cm and 200 g over the year, though much higher growth rates were observed.

Key words: invasive, introduced, nonindigenous, snakehead, Potomac, traits, ecology

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Life History and Ecology 1 Oral Presentation

Preliminary Assessment of Reproductive Potential of Spotted Gar *Lepisosteus oculatus* in the Upper Barataria Estuary, Louisiana

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Classification of individuals by reproductive stage by gonad histology is useful for the determination of reproductive potential of populations. Reproductive potential of spotted gar *Lepisosteus oculatus* is poorly understood. The goal of this study was to provide a preliminary reproductive characterization of a spotted gar population from southeastern Louisiana. We documented the annual reproductive stages of the population using standard histological techniques. This study also focused on sex-specific, seasonal changes in gonadosomatic index (GSI), total fecundity, and sexually dimorphic snout features. From October 2006 to September 2007, spotted gar (N=468) were collected from the upper Barataria Estuary, Louisiana, using monofilament gill nets, hook and line, and electrofishing. Histological samples were used to classify individuals into reproductive stages (immature, developing, spawning capable, actively spawning, regressing, and regenerating). Histological analysis was an effective method for classifying gonad developmental stages for male (N=95) and female (N=124) spotted gar. According to macroscopic examination and preliminary histological assessment of ovaries, over 25% of mature females in this population spawned from March to July, and approximately 73% of spawned females retained and reabsorbed eggs after the spawning season. GSI was highest in March for males (N=215) and in April for females (N=253). Mean fecundity was 6,493±4,225 eggs per fish (N=192; mean TL=579±44 mm). Snout morphology was sexually dimorphic where females had longer and narrower snouts than did males. Our results will be used to determine reproductive potential in the gars using rate of incomplete spawning and the retention and atresia of eggs.

Key words: spotted gar, gonad histology, GSI, fecundity, snout morphology, atresia

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Status Assessment of the Carolina Madtom, *Notorus furiosis*, in the Tar and Neuse River Basins, North Carolina
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The Carolina Madtom, *Noturis furiosus*, is a rare fish endemic to the Tar and Neuse River basins, North Carolina. It is a Federal Species of Concern and a State Threatened candidate. Surveys over the last two decades suggest a decline in historic populations. We conducted 60 surveys at 30 sites with historical records during the spring and summer of 2007 to assess the status of the Carolina Madtom. Data were compared to records from the 1960s to detect any temporal change in occurrence. We also applied a new method to estimate the proportion of sites occupied (occupancy) and detection probabilities for a subset of sites with the computer software package PRESENCE using repeat detection/nondetection data. Additionally, we examined aspects of the general biology and population structure of the Carolina Madtom (e.g., spawning period, size/age structure, CPUE, ect.). Results indicate a significant temporal change in occurrence in the Neuse River basin $((chi)^2 = .30$, $p<.05)$. Frequencies of occurrence decreased from .67 (SE=.05) to .13 (SE=.04) between the 1960's and 2007 data. Only one site surveyed in the Neuse River basin displayed a robust population. There was no significant temporal change in the Tar River Basin $((chi)^2 = 19.2$, $p>.05)$. Occupancy estimates generated from PRESENCE were similar to observed frequencies of occurrence due to high detection probabilities. Availability of nesting locations was an important covariate in estimates of occupancy. Further investigations are needed to determine if estimating occupancy represents an important state variable for long term, large scale monitoring programs.

Key words: madtoms, status, occupancy, detection probability

Graphical Biogeography in an Eastern Highland Darter, *Etheostoma rufilineatum* (Cope), with a Discussion of the Subgenus *Nothonotus*
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The darter subgenus *Nothonotus* currently contains 20 recognized species, six of which are listed as vulnerable or near threatened thus facing a high risk of extinction. Species of *Nothonotus* display a high degree of endemism within all three disjunct highland areas of the Central Highlands, providing the opportunity to investigate hypotheses regarding the historical biogeography of fishes in eastern North America. The phylogenetic position of *E. rufilineatum* within *Nothonotus* is not consistent in the most recently published phylogenies for the group and has confounded attempts at erecting a stable classification for *Nothonotus*. We found that the phylogenetic position of this taxon using mtDNA characters is dependent upon where specimens are geographically located. Distinct geographic differences in coloration patterns have also been discovered within several populations of *E. rufilineatum* distributed throughout the Tennessee, Cumberland, and Duck River systems. Additionally, individuals from the Coastal Plain Province of the lower Tennessee River exhibit smaller sizes in relation to normal individuals that may be characteristic of a form of dwarfism. Genetic variation based on both the complete mtDNA gene cytochrome b (1140 bp) and nuclear intron S7 (540 bp) of individuals from populations within these drainages, as well as from individuals across the entire range of *E. rufilineatum* will be discussed.

Key words: eastern highland darter, graphical biogeography

Conservation Status and Life History of the Frecklebelly Madton (*Noturus munitus*) in the Mobile Basin
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The Frecklebelly Madtom, *Noturus munitus*, is a diminutive catfish [maximum standard length 75 mm (ca. 3 in.)] with a disjunct distribution across the southeastern United States, found in large rivers and tributaries of the Mobile Basin and Pearl River drainage. *N. munitus* has declined since extensive river modification began in the 1960s throughout its range and is likely extirpated from the Alabama River. We collected 225 specimens of *N. munitus* from a gravel island on the Coastal Plain in the Cahaba River in Alabama from May 2005 to March 2007 to analyze aspects of *N. munitus* life history including habitat preference, diet, reproductive maturation and age structure. Based on current data, *N. munitus* is one of the most highly fecund madtoms of the subgenus *Rabida* based on relative fecundity. Fewer males were found in riffles during summer and no young individuals were found outside summer, indicating potential sex and size differences in habitat use. In

the absence of difficult-to-collect data on seasonal movement and habitat use, sex ratio and catch data can be used to infer seasonal changes in habitat use and timing and location of nesting sites. Conservation and protection of *N. munitus* and other imperiled aquatic fauna will depend on knowledge of ecology and life history and the ability of scientists to promote conservation and sustainability of aquatic ecosystems.

Key words: *Noturus*, madtom, Mobile Basin, Cahaba River

Life History and Ecology 1 Oral Presentation

Distribution of the Blacknose Dace Species Complex (Genus *Rhinichthys)* Along a Large Zone of Contact in West Virginia, USA

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The blacknose dace species complex *(Rhinichthys atratulus, Rhinichthys obtusus obtusus,* and *Rhinichthys obtusus meleagris)* are among the most common freshwater fishes in eastern North American. Despite this fact, the taxonomy of this group is still in question, relying largely on drainage for correct taxonomy of individuals. Using the literature suggested characters for taxonomy of nuptual males, we assessed the relationship of the members of this species complex along an unusually large zone of contact in the high Appalachian Mountains of West Virginia. Analysis of the distribution of the subspecies revealed a large proportion were found in drainages outside of their predicted range and in three instances, more than on form existed in a single water body. When the theoretical pre-Pleistocene distribution was applied to the present drainage, nearly all instances of anomalous distribution or the presence of multiple forms were explained. If stream capture is the means of transfer however, applying these principals will be a helpful tool in addressing conservation of species of concern and in general biodiversity in this unique region.

Key words: blacknose dace, stream capture, *Rhinichthys*

Life History and Ecology 1 Oral Presentation

Difference in Trypsin Activity of Age-0 Largemouth Bass Between Reservoirs with Good and Poor Recruitment

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Largemouth bass are typically self-sustaining through natural reproduction; however loss of age-0 fish to biotic and abiotic factors can negatively affect recruitment. Prolonged reduced recruitment can diminish future angler effort, satisfaction, and the economic benefits associated with sport fishing. In Virginia, Briery Creek Reservoir continually produces trophy largemouth bass (>3.6 kg), however, recent electrofishing assessments of age-0 largemouth bass exhibited low catch per unit effort. A potential recruitment bottleneck appears to be occurring shortly after the age-0 largemouth bass leave the nest. In order to examine this potential limiting factor on recruitment, the dietary enzyme important for digesting protein, trypsin, was examined. Trypsin activity is related to food intake and stomach fullness; therefore, starvation or reduced food intake decreases the activity. Initial results indicate that the age-0 largemouth bass from Briery Creek Reservoir have trypsin activity 25% of those from a nearby reservoir. This lower trypsin activity may indicate that poor diet quality is a possible cause of low age-0 abundance in Briery Creek Reservoir. This question of diet quality will be further investigated.

Key words: recruitment, trypsin, largemouth bass

Life History and Ecology 1 Oral Presentation

Competitive Trophic Interactions Among Striped Bass, Largemouth Bass, and Spotted Bass in Lewis Smith Lake, Alabama.

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Striped bass *Morone saxatilis* have been introduced into over 100 USA reservoirs over the last several decades to provide additional sport fishing opportunities and to control abundant shad, *Dorosoma* spp. populations. Stocking of striped bass has been controversial and non striped bass anglers have expressed two primary concerns; 1) striped bass consume sport fish including black bass and therefore reduce the abundance of catchable size fish; and 2) striped bass and other sport fish including black bass compete for limited prey which could reduce the growth rates and ultimately the abundance of black bass. Striped bass, largemouth bass *Micropterus salmoides* and spotted bass *M. punctulatus* were sample every other month

in Lewis Smith Lake, Alabama (8,583 ha) between October 2006 and August 2007. Striped bass diets (by weight) were dominated by shad (64%), while black bass and sunfish comprised 5% and 6%, respectively. Largemouth bass and spotted bass diets were dominated by crayfish, 72% and 75%, while shad comprised 6 and 14%, respectively. Diet overlap values varied seasonally among species with highest overlap in June between striped bass and black bass, but relative weights of black bass did not decline. Partitioning of prey resources between black bass and striped bass was evident and diet overlap was minimal. Bioenergetics modeling indicated striped bass consume between 3 to 28 kg/ha a year of shad and 0.2 and 2.3 kg/ha a year of black bass, while black bass consume between 1 to 3 kg/ha a year of shad, 7 to 25 kg/h of crayfish, and 2 to 6 kg/ha of sunfish. Although striped bass did consume some black bass, impact on the black bass population was low, striped bass and black bass partitioned prey resources, and impact of striped bass stocking on the black bass population was low.

Key words: striped bass, largemouth bass, spotted bass, trophic competition

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Life History and Ecology 1 Oral Presentation

The Effects of Sedimentation on the Seasonal Feeding of *Cottus bairdi*
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Sedimentation of streams (measured as embeddedness) can have adverse affects on the biota within a stream. Aquatic macroinvertebrates can show a reduction in diversity and abundance, which in turn leads to a reduction in the availability and quality of food for their fish predators. I looked at the predator-prey relationship between the mottled sculpin (*Cottus bairdi*) and macroinvertebrates in four headwater stream in Garrett County, MD. Two streams had higher levels of embeddedness (above 35%) and two streams had lower levels of embeddedness (below 15%) as determined by the Maryland Biological Stream Survey. Macroinvertebrates and mottled sculpin were sampled every season for a one year period. The influence of embeddedness on selection of prey by mottled sculpin size classes was analyzed based on usage and availability (Johnson 1980); and caloric intake was measured using calories per gram dry mass. Differences among streams and size classes will be discussed.

Key words: sediment, sculpin, *Cottus*, diet

Life History and Ecology 1 Oral Presentation

The Effects of Riparian Logging and Large Woody Debris Addition on Stream Morphology
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Large woody debris (LWD) is an integral part of the ecology of forested headwater streams and has been shown to store organic matter, provide overhead cover, and create pools. Pool creation is of particular interest to resource managers since it forms critical summer refugia for brook trout (*Salvelinus fontinalis*). We investigated the morphological effects of riparian logging and LWD additions within eight headwater streams in central West Virginia. Each stream was divided into three sections: reference (uncut), logged (50% or 90% riparian basal removal), and logged + LWD additions. Each section was 250m long and had a riparian zone defined as being 30m from the stream edge. The sections were logged and had LWD added during the summer and fall of 2006, with stream measurements and LWD surveys during baseflow conditions in 2005 and 2007. As expected, LWD increased in the logged + LWD sections. Pool area, however, did not increase. LWD created new pools but also destroyed some existing pools, resulting in no net gain in pool area. These results indicate that LWD additions affect stream morphology, but the short-term potential for haphazard LWD additions to increase pool area is limited.

Key words: woody debris, stream, pool, riparian, logging, morphology

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Life History and Ecology 1 Oral Presentation

Brook Trout Response to Canopy and Large Woody Debris Manipulations in Appalachian Streams
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Brook trout (*Salvelinus fontinalis*) are the only salmonid native to the Appalachians and are thought to have experienced substantial declines over the past century. They continue to be an important recreational resource and are an excellent biotic

synthesizer of aquatic integrity for forested watersheds. Management of forested watersheds to maintain and even enhance water quality and this specific species are critical to sustainable forest management in this region. We are conducting a set of manipulative experiments in streamside management zones within forested watersheds in order to determine: 1. the effects of increased solar radiation on stream productivity, especially brook trout 2. the effects of increased solar radiation on water quality 3. effects of increased large woody debris (LWD) inputs on stream productivity, brook trout, and water quality 4. effects of increased large woody debris (LWD) inputs on habitat structure (e.g., pools) Our study provides the first quantification of the effect of intensive SMZ manipulation upon brook trout and their habitat in the Appalachians of the eastern U.S. This study provides quantitative evidence of the effect of extensive manipulations of SMZ canopy and LWD additions upon brook trout populations and ultimately suggests what role habitat enhancement and increased solar radiation play in enhancing and protecting native brook trout.

Key words: brook trout, large woody debris, Appalachian streams

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Life History and Ecology 1 Oral Presentation

Contrasting Density Dependent Growth Dynamics Between and within Two Age Classes of Central Appalachian Brook Trout

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Density dependent aggression, emigration, mortality, and, to a lesser extent, growth, have been identified in wild lotic salmonid populations. However, few studies simultaneously address multiple age classes when exploring density dependent growth, and fewer still consider sedentary versus mobile fish. Further, no explicit attempts to quantify density dependent growth have been attempted for brook trout in Appalachia, where the species is strongly food limited and population densities are low. Brook trout populations were intensely monitored over the course of two years at several sites within a watershed in eastern West Virginia. Tagging provided specific growth estimates for fish that remained in sites (i.e. sedentary fish). Young-of-the-year (YOY) brook trout exhibited density dependent growth, but the intensity of density dependence was strongly related to temporal variability, with increasing density dependence as the year progressed. Age 1+ sedentary displayed density dependent growth, but only during periods of warm temperatures and poor feeding, when excess energy acquisition was also found to be density dependent. The strong influence of temporal variability in density dependent processes offers a potential explanation of why studies elsewhere offer contrasting evidence for density dependent growth. These findings have implications for quantifying the importance of stream reaches for brook trout, a species that is increasingly of conservation concern.

Key words: brook trout, density dependence, growth, bioenergetics

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Life History and Ecology 1 Oral Presentation

Landscape Models to Predict In-Stream Water Quality and Ecological Condition in the Upper Monongahela River Basin

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Continuous information on stream conditions (water quality and biological) is extremely valuable for setting restoration and protection priorities at a watershed scale. However, obtaining this information is very difficult and time consuming. In this study, we constructed landscape models to predict in-stream, segment-scale water quality and biological condition (West Virginia Stream Condition Index) continuously throughout the Cheat and Tygart Valley River watersheds in north-central WV. Models were developed based on chemical and benthic macroinvertebrate community data obtained from over 200 sampling locations. Where mining was absent, elevation and the amount of sandstone and limestone were important predictors of water quality and ecological condition. Water with high conductivity and acid mine drainage (AMD) was never observed, and ecological condition was nearly always good in un-mined stream segments. Where mining was present, an index of mining intensity, coal type, distance to upstream mining feature, amount of surface mines, and limestone were important predictors that identified AMD water types and degraded ecological condition. Although most reachsheds within the basins have good or excellent ecological condition and reference type water quality, maps constructed from model predictions identified several regions that are highly impaired. These results provide the foundation from which restoration programs can be designed to maximize ecological recovery at a watershed scale.

Key words: AMD, benthic macroinvertebrates, biological condition, Cheat River watershed, landscape models, Tygart Valley watershed, water quality

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Life History and Ecology 1 Oral Presentation

The Southeast Aquatic Resources Partnership and the National Fish Habitat Action Plan
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The Southeast Aquatic Resources Partnership was recently recognized by the National Fish Habitat Board as one of the first four official Fish Habitat Partnerships charged with implementing the National Fish Habitat Action Plan. The Partnership (SARP) includes fish and wildlife agencies from 14 States of the Southern Division AFS, the Gulf and Atlantic States Marine Fisheries Commissions, the Gulf of Mexico and South Atlantic Fishery Management Councils, the U.S. Fish and Wildlife Service, and NOAA Fisheries. Other partners include USGS, EPA, Corps of Engineers, Southern Company, The Nature Conservancy, and the World Wildlife Federation. The Southeast Aquatic Habitat Plan, an effort that will help guide strategic investments in aquatic habitat conservation across the region, is near completion. A GIS referenced database of characteristics that impact aquatic habitats – everything from land use to water quality – is being developed for the seven-state Tennessee-Cumberland river basin, and funding was recently awarded from the Doris Duke Foundation and the National Fish and Wildlife Foundation to expand this effort to the Red and Sabine river basins (AR, LA, OK, TX) in 2008. SARP, through the National Fish Habitat Action Plan and other means, helps fund and facilitate on-the-ground (or in-the-water) habitat conservation projects. Projects funded in the past two years include riparian area restoration and enhancement on important stream reaches in Tennessee, reservoir shoreline habitat enhancement and riverine gravel bar spawning habitat restoration in Georgia, stream bank restoration in Kentucky, oyster reef restoration in Florida, and salt marsh restoration in Mississippi.

Key words: fish, habitat, restoration, partnership, SARP

Fish Management 2 Oral Presentation

Resolving Inconsistencies in Fish Consumption Advisories between Ohio River Main Stem States
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The Ohio River Valley Water Sanitation Commission (ORSANCO) began collecting fish tissue contaminant data from the Ohio River in the 1980's. By the mid 1990's, the six states bordering the Ohio River began using these data to issue risk-based consumption advisories to the public. These advisories, though often based on the same samples, have sometimes offered conflicting information to the public. Though two states across the river from each other may be using contaminant data from the same sample, differences in the states' advisory development has lead to the issuance of different advisories based on the same data. These inconsistencies are mainly an artifact of the main stem states using different values in the calculations of advisory thresholds (e.g., cancer risk factors, reference doses, number of advisories categories, etc.). Several other factors also contribute, such as differences in reporting segments, use of size classes, issuance of advisories for sensitive populations, and use of unique data. To resolve these inconsistencies, ORSANCO is working with the Ohio River Fish Consumption Advisory Panel, a group made up of members of each state, as well as EPA representatives. Our goal is to create one standard set of values for the calculation of advisory thresholds. While ORSANCO will not issue advisories, we will distribute threshold values which could be used by the states to create advisories to be distributed to the public, eliminating most of the potential to release inconsistent advice to the public

Key words: Ohio River, fish consumption advisory, tissue, contaminants

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Fish Management 2 Oral Presentation
Effects of Benthic Prey Composition and Abundance on Diet and Growth of Black Crappie *Pomoxis nigromaculatus* at Three Florida Lakes

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Factors influencing black crappie *Pomoxis nigromaculatus* growth are poorly understood due to a wide range of potential prey items through the ontogeny of the species and scant research regarding prey abundance and composition. We evaluated the diets and growth of black crappie in relation to benthic food availability at three large Florida lakes (Lochloosa, Marian, and Monroe). Black crappie at Lake Monroe obtained the largest size at age, whereas Lake Marian had the smallest size at age. Manly's (Alpha) index of selectivity resulted in two major trends. Black crappie at Lakes Lochloosa and Marian were consistently selective of Diptera pupae, whereas black crappie at Lake Monroe were consistently selective of Mysidacea *Americamysis almyra*. A similarity index indicated that benthic prey availability influenced consumption of benthic prey

items by black crappie, particularly for the more utilized prey taxa. Differences in prey selection and prey availability influenced diet composition and ontogenetic diet shifts of black crappie among the three study lakes. The diet and prey availability differences among lakes likely contributed to the variation in population growth rates, with the largest growth at Lake Monroe, which had the additional availability of the higher quality prey item Mysidacea.

Key words: benthic prey composition, diet, growth, black crappie

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Fish Management 2 Oral Presentation

Assessment of Road Crossing Impacts on Streambed Morphology in an Interior Highlands Drainage.
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Thousands of bridge crossings were constructed to facilitate silviculture activities in the Ouachita uplift of southeast Oklahoma. Many of these structures inhibit fish movement either directly by crossing design or indirectly by induced changes in channel morphology. The objectives of this study were to: 1) characterize various crossing types in the Glover River drainage; 2) identify changes in channel morphology stimulated by crossing type; and 3) identify considerations for developing a crossing assessment approach to prioritize restoration initiatives. Remote sensing and GIS were used to identify the population of crossings within the project area. A site visit was made to the 207 identified crossings and a visual assessment was made. Detailed morphological assessments were then performed on a sub-sample of 19 sites. Relative comparisons of upstream and downstream conditions were also made. Results show a significant increase in upstream channel width associated with culverts due to constriction at the crossing which causes reductions in sediment transport. Conversely, these factors caused downstream channel incision and narrowing. Coarsening of substrates downstream was significant while upstream reaches had decreased sediment size and reduced interstitial space. Stream crossings were not commensurate with pre-crossing channel metrics, flow magnitudes or drainage area. Circular culverts induced the greatest change in local channel morphology whereas low-water slabs exhibited the least. This work identifies that certain crossing types cause significant changes in channel morphology and reductions in fish movement potential. The results are catalyzing development of a rapid assessment protocol for identifying crossings in most need of remediation.

Key words: stream crossing morphology

Fish Management 2 Oral Presentation

Long-term Effects of Large Woody Debris Addition on Stream Habitat and Brook Trout Populations
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In a previous study, we added large woody debris (LWD) to eight streams in the central Appalachians of West Virginia to determine if stream habitat could be enhanced and brook trout (*Salvelinus fontinalis*) populations increased following habitat manipulation. The LWD additions had no overall effect on stream habitat and brook trout populations. In this study, we resurveyed stream habitat and sampled brook trout populations six years after the LWD additions to determine long-term changes in habitat and brook trout populations. Again, stream habitat and brook trout populations remained unchanged by the LWD additions. The assumption of such habitat manipulation studies is that a lack of LWD is limiting stream habitat complexity and trout populations. In high gradient streams, habitat complexity may be governed more by the abundance of boulders and LWD may have a lesser influence on trout populations.

Key words: brook trout, stream habitat, habitat management, large woody debris

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Fish Management 2 Oral Presentation

Evening Hole and Lost Creek Restoration Project at the Lower Mountain Fork River, Oklahoma
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The Oklahoma Department of Wildlife Conservation (ODWC) completed enhancements to a 2,800-foot portion of the lower Mountain Fork River trout fishery in 2006. Our objectives were to: 1) improve quality, diversity and availability of trout

habitat; 2) increase total length of the trout area; and 3) increase wetland habitat and associated biodiversity. This project involved implementation of a multi-faceted restoration plan. The plan was based on collected morphological data, 3D and hydrological modeling results and available aerial and topography information. Applied fluvial geomorphology (AFG) techniques were then used to design plans that mimic local natural channels. Adaptation of these techniques while implementing the plan in the tailrace environment was a primary challenge. Improvements at the 1,600-foot Evening Hole reach included a hydraulically improved low-flow channel with enhanced in-stream habitat and addition of a two-acre wetland. A new 1,200-foot trout stream named Lost Creek was also constructed which provides additional trout angling opportunities. Habitat improvements were also employed in Lost Creek to provide riffles, runs, pools, woody and overhead cover. Vegetation, grade control and bank stabilization structures were strategically installed in both areas to insure channel stability. Morphological surveys are being used to evaluate project success over time. Completion of these projects demonstrates successful implementation of AFG techniques in a tailwater system. This work was made possible by angler donations and matching Federal Aid in Sportfish Restoration funds. ODWC also enjoyed enthusiastic cooperation from key state and federal agencies. It was this private and public support that made this project possible.

Key words: applied fluvial geomorphology restoration

Fish Management 2 Oral Presentation

Tank Production of Sunshine Bass Fingerlings Using *Artemia* From Microcysts

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Protocols for culture of sunshine bass larvae to fingerling size in tanks involve an initial feeding of rotifers before larvae are weaned to *Artemia* nauplii and prepared feed. Maintaining rotifer cultures requires space, time, equipment, supplies, and trained culturists. The rotifer cultures are often unstable, which increases risk of poor sunshine bass fingerling production in tanks. Elimination of the use of rotifers would greatly enhance the feasibility of reliable tank culture of fingerlings and should reduce production cost. This experiment was comprised of three treatments with three replicates per treatment. In one treatment, larvae were initially fed rotifers (*Brachionus plicatilis*) and then weaned to *Artemia* nauplii (0.48 mm X 0.19 mm). In a second treatment, larvae were fed *Artemia* nauplii throughout the experiment. In a third treatment, larvae were fed microcyst *Artemia* nauplii (0.43 mm X 0.18 mm) for the entire experiment. Sunshine bass larvae, 4 dph, were stocked into 100-L tanks at 75 larvae/L. Larvae were fed according to the three treatments until 14 dph. Only 4.3% of the larvae fed *Artemia* nauplii survived. Survival was significantly higher for larvae fed microcyst *Artemia* nauplii and larvae fed rotifers and *Artemia* nauplii (37.9% and 93.6%, respectively). Larvae fed microcyst *Artemia* nauplii (7.26 mm SL) and larvae fed rotifers and *Artemia* nauplii (7.13 mm SL) were significantly longer than larvae fed *Artemia* nauplii (6.86 mm SL). This experiment is the first time that sunshine bass have been cultured to 14 dph on *Artemia* nauplii without rotifers at first feeding.

Key words: Sunshine bass, *Morone chrysops* X *M. saxatilis*, rotifers, *Artemia nauplii*, Tank Culture

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Fish Management 2 Oral Presentation

Effect of Fry Stocking Density on the Production of Rosy Red Fathead Minnows in Pools

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The fathead minnow is widely cultured as a bait, forage and feeder fish, with farm-gate sales of $9.85 million in 2005. Fathead minnows are typically produced using the spawning-rearing pond method, which provides little control over fish sizes. New indoor hatchery methods now provide fathead minnow fry for stocking. This study was conducted to examine the relationship through regression analysis between initial fry or final fish densities and production parameters. Rosy red fathead minnow fry (1-3 d) were obtained from jar hatching of sodium sulfite-removed eggs and stocked volumetrically at densities of 292; 1,168; 2,044; 2,920 and 3,796 fry/pool in 10, 5.9 m^2 continuously aerated, plastic-lined pools. Stocking rates were equivalent to 0.49 – 6.42 million fry/ha. Fish were fed daily with a prepared minnow feed, sampled at 3-week intervals, and harvested after 81 days. Survival ranged from 19.7 to 57.7% and did not differ significantly among densities. Mean fish weight per pool decreased logarithmically with final fish density (R^2 = 0.953).Yield generally increased with initial stocking density (Power function, R^2 = 0.846). While results from pool studies should be extrapolated with caution, at stocking densities equivalent to 2.0 million fry/ha and above, yields were in the range of 1,000 to 1,500 kg/ha. These results suggest that large quantities of small fathead minnows can be produced by stocking of fry. However, the economics of this alternate

culture system remain in question.

Key words: rosy red, fathead minnow, fry stocking density

Fish Management 2 Oral Presentation

Harvestable Hybrid Striped Bass Stocking in an Urban Fishing Program: Fishing Success, Angler Acceptance, and Influence on Pond Prey Communities

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The Arkansas Game and Fish Commission (AGFC) recently expanded its statewide Family and Community Fishing Program (FCFP) to include seasonal put-take stockings of hybrid striped bass (HSB; *Morone chrysops* x *M. saxatilis*). The goals were to provide a unique fishing opportunity for urban anglers and influence size structure of stunted bluegill *Lepomis macrochirus* through predation. This study examined fishing success, angler satisfaction, and HSB influence on pond prey communities during the first year of stocking. In October 2006, HSB were stocked at two densities in three ponds each. Three additional ponds did not receive HSB and served as reference ponds. Creel surveys were used to collect angler catch, effort, and satisfaction data. Electrofishing was conducted prior to stocking to assess bluegill size structure, and was repeated the following summer for comparison. Creel surveys showed highly variable effort, catch, and harvest of HSB. At least 51% of the HSB stocked were estimated to be caught within one month following stocking, with a harvest rate of 63%. Despite high initial removal of HSB, significant increases in bluegill size structure and condition were observed, suggesting HSB can be used to improve bluegill growth rates and maximum size while simultaneously diversifying urban fisheries.

Key words: hybrid striped bass, urban fishing, creel surveys, prey control

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Fish Management 2 Oral Presentation

Experimental Stocking of Florida Largemouth Bass to Enhance Sport Fish Recovery in Pascagoula River Oxbows Following Hurricane Katrina

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Being one of the last physically unmodified river systems in the United States, the Pascagoula River in southeast Mississippi is a national icon for conservation of wild ecosystems. It has historically supported popular fisheries for black bass *Micropterus* spp., sunfishes *Lepomis* spp., crappies *Pomoxis* spp. and catfishes *Ictalurus* spp. and *Pylodictis olivaris*. In August 2005, Hurricane Katrina devastated these fisheries, washing large amounts of organic matter into the river, which led to hypoxia. Subsequently, extensive fish kills were reported and losses were estimated at 60.8 million fish worth approximately $20.5 million. Stock assessments conducted in oxbows during summer 2006 revealed that upstream, relatively disconnected oxbows contained overabundant young-of-year (YOY) bluegill *L. macrochirus* and few catchable (>180 mm TL) largemouth bass *M. salmoides*. Given the tragedy that Hurricane Katrina imposed on the psyche of local residents and the pressing desire by local anglers to reconnect to Pascagoula River fisheries, predator-prey balance was considered inadequate to immediately support catchable bass and bluegill stocks in these upstream oxbows. We hypothesized that stocking advanced fingerling bass (200-356 mm TL) would improve predator-prey balance in the oxbows, thus enhancing angling opportunities in the short-term. During December 2006, we stocked 15 advanced fingerling Florida strain largemouth bass *M. salmoides floridanus* per acre in five randomly selected oxbows. Five other randomly selected oxbows were left unstocked, serving as a control. We sampled the oxbows during fall 2007, and the effect of stock enhancement on bass and bluegill abundance and size-structure will be discussed.

Key words: hurricane, oxbow lakes, sport fish restoration, disturbance, stock enhancement

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Fish Management 2 Oral Presentation

An Approach to Designing Acoustic Stock Assessment Surveys in Lakes

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Hydroacoustics is a well established technique for quantifying fish density, abundance, and size distribution. Despite studies showing the validity of hydroacoustics in assessing fishes in marine and freshwater systems, it has seldom been applied in inland systems of the southern U.S. Sonar allows large areas of the lake to be sampled, and has the advantages of: short duration; low impact on the fish studied; is independent of catch statistics and population history; and allows for absolute abundance estimates. New developments in software, speed, and smaller size of sonar equipment have made its use by management agencies more appealing. We developed a simple annual sampling protocol to estimate population trends in resident fishes for the Ugashik Lakes in Southwest Alaska using hydroacoustics and gillnets. Using the Alaskan data as an example we illustrate the approach and methods fisheries personnel in the southern U.S. might use in their systems for stock assessment.

Key words: hydroacoustics, stock assessment, fisheries techniques, inland fisheries management.

Life History and Ecology 2 / Policy Oral Presentation

Development of a Watershed-based Predictive Model for a Freshwater Mussel in the Appalachians

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The eastern United States contains the greatest diversity of freshwater mussels in the world, and many of these species are in decline. Knowledge of the factors influencing these declines can provide a base for conservation efforts. Although management plans are often designed at a watershed scale, the peer-reviewed literature contains few studies that have sought to evaluate limiting factors for mussels at that scale. In addition to analyzing occurrence at the scale of 6th-level hydrologic unit watersheds, our study predicts occurrence across a significant portion of the range of the species. Because survey data for uncommon and federally listed species were limited, we obtained the best available data for spike (*Elliptio dilatata*), a widespread, relatively common species. We used classification tree analysis (CTA) to create an easily interpretable model using survey data in the upper Ohio drainage region of the Appalachians. We included anthropogenic and environmental variables calculated for each watershed and upstream of the watershed that were believed to influence freshwater ecosystems. We applied the CTA model to all of the watersheds within the study area to create maps of predicted occurrence and compared the predictions to independent collection data to develop an error matrix. Our model is important because predictions of the distributions of freshwater mussels are an important consideration in regional conservation decisions. In addition, the variables retained in our CTA models are those that may limit the distributions of freshwater mussels in the Appalachians, and these influences can be targeted in future studies and conservation efforts.

Key words: freshwater mussels, predictive modeling, watershed, cumulative effects

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Life History and Ecology 2 / Policy Oral Presentation

An Evaluation of Habitats as Sampling Strata for Freshwater Mussels in a Large Lowland River in the Southeastern U.S.

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Understanding the habitat use patterns of aquatic species is crucial not only for determining species resource requirements, but also for the development of effective monitoring protocols. However, all individuals and species in a sample unit are generally not captured during sampling, which can bias estimates of population size, distribution, and habitat use patterns. Thus, evaluations of habitat use patterns also need to account for incomplete capture. The goal of our project was to develop and evaluate the efficacy of sampling stratum for five freshwater mussel species in the mainstem Altamaha River (Georgia): *Alasmidonta arcula*, *Elliptio spinosa*, *Lampsilis dolabraeformis*, *L. splendida*, and *Pyganodon gibbosa*. Strata were determined by fitting habitat characteristics such as depth, current velocity, or substrate composition as covariates in predicting detection using occupancy-based models. Occupancy models of mussel habitat use indicated that although some species (e.g. *L. dolabraeformis*) have a higher distribution over a range of habitats other species (e.g. *P. gibbosa*) tend to relate to specific characteristics (low current velocity). Model results allowed us to define strata using three basic hydrogeomorphophic units: slackwater, pool, and swiftwater. Stratum evaluation was based on the comparison of simulated stratified random sampling to complete random sampling and their respective power to detect a population change. Our results emphasize the importance for properly estimating and evaluating habitat based on use and detection in large watersheds so managers can develop an efficient, least biased monitoring design when more elaborate estimators are cost prohibitive.

Key words: Georgia, Altamaha River, unionids, occupancy, estimation, detection

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Life History and Ecology 2 / Policy Oral Presentation

The Use of Biotic and Habitat Indices as Indicators of Freshwater Mussel Habitat in the Tyronza River, Arkansas.
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The Tyronza River, Arkansas has been designated by the Arkansas Department of Environmental Quality as a channel altered stream for the Mississippi Alluvial Valley - Delta Ecoregion. The Tyronza River has been suggested as a candidate for habitat restoration and a potential refuge for the endangered fat pocketbook mussel, *Potamilus capax*. The objectives of this study were to: 1) complete a qualitative mussel survey of the entire river to obtain species distribution, relative abundance, and catch per unit of effort (CPUE) data; 2) quantitatively sample nine mussel assemblages based on the qualitative survey results; 3) assess habitat and water quality using USEPA protocols for fish and aquatic macroinvertebrates; 4) characterize stream habitat using the Basin Area Stream Survey; and 5) analyze cumulative watershed effects. A total of 70.4 river km of the Tyronza River were qualitatively surveyed during autumn 2006 and spring 2007 resulting in 363 sample sites and a total of 33 species being observed, 8 of which were only collected as relic shells. Quantitative sampling of 9 mussel assemblages resulted in 25 live species, 2 of which were not present in the qualitative survey, *Toxolasma lividus* and *T. parvus*. Mean densities per site ranged from 1.0 to 1.9 mussels / m^2 with an overall mean of 1.4 mussels / m^2 (± 0.3 SD). The results of this study will aid in the development of a Habitat Restoration Plan (HRP), which is essential information for updating of the 1989 US Fish and Wildlife Service recovery plan for *P. capax*.

Key words: freshwater mussels, *Potmilus capax*, Tyronza River

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Life History and Ecology 2 / Policy Oral Presentation

Instream Flow Assessment of Spring-Associated Fishes in Southcentral Oklahoma
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The Arbuckle-Simpson aquifer is a sensitive groundwater basin located in southcentral Oklahoma that has been recently been targeted as a water source for municipalities in and around Oklahoma. The aquifer is vital to the groundwater dependent rivers, streams, and springs and the fish species that occupy these habitats. We used the Physical Habitat Simulation (PHABSIM) component of the Instream Flow Incremental Methodology (IFIM) to assess the impacts of water withdrawal on flow regime and fish habitat. PHABSIM simulates the quantity and quality of fish habitat based on a combination of measured stream channel structure, hydrologic variables, and species-specific habitat suitability criteria. We used snorkel surveys to identify habitats being used by four species (least darter, orangethroat darter, southern redbelly dace, and redspot chub) associated with springs and then collected data on depth, flow, substrate, and cover at each location. Study sites were located in the Pennington Creek watershed (1 site) and Blue River (2 sites) watershed. Stream flow at the sites is dominated by groundwater and has minimal seasonal variation in temperature. The sites were typified by low fish diversity and dominated by cyprinids and darters. The results of the habitat simulations show that groundwater removal will result in reduced flows in the Arbuckle-Simpson springs and streams, which will cause a loss of fish habitat. This study will be used to direct the management of the Arbuckle-Simpson aquifer in order to preserve the unique groundwater dependent ecosystems that occur there.

Key words: instream flow, PHABSIM, springs, fish habitat, Oklahoma

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Life History and Ecology 2 / Policy Oral Presentation

Electrofishing Surveys and Radio Tracking for Robust Redhorse (*Moxostoma robustum*) on the Pee Dee River, North and South Carolina
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The robust redhorse (*Moxostoma robustum*) is a large, long-lived member of the sucker family that is currently only known

from the Pee Dee River basin of North and South Carolina, and the Savannah and Altamaha basins of Georgia and South Carolina. This species is endangered in North Carolina and is a federal species of concern. The Robust Redhorse Conservation Committee (RRCC) is a cooperative, voluntary partnership formed between state and federal resource agencies, private industry, and the conservation community to direct the recovery of the species. One of the major goals of the RRCC is to evaluate the population status and distribution of this species throughout its known range. Our objectives in the Pee Dee River are to determine the status of the robust redhorse population, document habitat use, and determine migratory patterns. A total of 51 robust redhorse were captured from 2000-2007 (including 14 recaptures). Forty-nine adult robust redhorse have been captured in large Piedmont shoals and side channels in a 20 rkm reach immediately downstream from Blewett Falls Dam in North Carolina. To improve our catch rates and to learn more about their life history, a radio tagging study began in 2005. Telemetry relocations and capture data indicate that some of these fish make long distance movements (up to 100 rkm) downstream into the South Carolina Coastal Plain region, use the shoal habitats near Blewett Falls Dam for spawning, and show spawning site fidelity. Efforts on the Pee Dee River will continue in order to further our understanding of their life history requirements.

Key words: robust redhorse, habitat use, migratory patterns, telemetry, Pee Dee River

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Life History and Ecology 2 / Policy Oral Presentation

Variation in Ecosystem Sensitivity to Urbanization between Physiographic Ecoregions in the Southeastern United States.

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The link between decline in stream biotic integrity and watershed urban land use is well established. However, most such work deduces relationships within political boundaries and ignores potentially important variation in stream form diversity. Specifically, streams located within different ecoregions may respond differently to the same degree of urbanization within a watershed. We explore how stream biota and physiochemical parameters respond to urbanization between the Piedmont and Coastal Plain physiographic provinces of Maryland using Maryland Biological Stream Survey (MBSS) data. At both the community and individual taxon scale, benthic macroinvertebrates appear to be more capable of tolerating urbanization gradients in the Coastal Plain relative to the Piedmont. Fish taxon-specific analyses concur with macroinvertebrate trends. Potential physiographic scale variation in physiochemical responses to urbanization between provinces are explored as potential drivers behind the differential responses observed in biotic responses. Possible differential rate changes in drivers such as nutrient and pollutant loads, sediment embeddedness, and hydrologic regime along urbanization gradients between provinces are explored. Findings highlight the importance in considering physiographic variability when establishing lotic ecosystem sensitivity to land use change, particularly in the southeastern United States where the Coastal Plain-Piedmont physiographic boundary extends from New Jersey to Alabama and intersects multiple metropolitan areas.

Key words: urbanization, resilience, communities, physiography

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Life History and Ecology 2 / Policy Oral Presentation

Resilience of Fish Assemblages: Importance of Habitat-Specific Assessments

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The common deterministic view of fish community assemblage suggests that environmental factors drive a community to a characteristic state. A key feature of biological communities is resilience (the ability to maintain compositional integrity following a disturbance). A disturbance exceeding the threshold at which a community maintains its structure results in a shift to an alternative state (e.g., a community dominated by brook trout and sculpin shifts to a community dominated by creek chub and blacknose dace). Alternative states are inherently stable, making it difficult for a community to recover once a disturbance threshold has been breached. We present evidence of habitat-specific reference states in freshwater stream fish communities and differential responses to urbanization across the physiographically diverse state of Maryland. We found that communities are sensitive to different habitat-scale disturbances associated with water quality and riparian integrity, which suggests that habitat-specific assessments of degradation are preferable to region-based assessments. For example, headwater communities are more sensitive to thermally-charged runoff than communities in larger streams. Defining the relative resilience of fish communities to landscape-scale disturbances can offer clues as to the potential pressures that drive a shift away from reference, and alert managers to site-specific vulnerabilities.

Key words: fish assemblages, habitat-specific assessments

Life History and Ecology 2 / Policy Oral Presentation

The Use of Artificial Stream Shading to Evaluate the Feasibility of Brook Trout Restoration.
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Increases in stream water temperatures from the historic and current removal of riparian vegetation are one of the major reasons for extirpation of brook trout throughout their native range. Recent riparian plantings by the Eastern Brook Trout Joint Venture (EBTJV) are long-term restoration efforts and the success or failure may not be known for decades. Understanding and validating water temperature response can be used to evaluate apriori the feasibility of restoration projects. In our study area on Smith Creek (Rockingham County, Virginia), we evaluated the feasibility of this restoration by artificially shading 550 meters of stream to simulate water temperature responses of a full riparian canopy (90% shade). Preferred water temperatures for brook trout are not found in Smith Creek between July 15 to September 15 because of historic land use practices. Air and stream temperature were collected before, during and after (June 2006 to November 2007) the shading experiment (July 26 through October 27, 2007). In 2006, we calculated that the mean daily maximum temperature increased 0.4°C between the upstream and downstream locations. In 2007, after shading, the mean daily maximum decreased 0.8°C. In 2007, the diurnal temperature fluctuations averaged 3.2°C immediately upstream of the shade and 2.2°C immediately downstream of the shade. Based on the shade experiment and the survival of transplanted wild and stocked brook trout in the shaded area, the establishment of suitable stream water temperatures for brook trout looks promising in Smith Creek if a riparian forest buffer can be established.

Key words: artificial stream shading, brook trout restoration

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Life History and Ecology 2 / Policy Oral Presentation

Fish Assemblages and Limnological Conditions Relative to River Connectivity in Floodplain Lakes
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The Yazoo River Basin of Mississippi includes several rivers that drain an area heavily impacted by agriculture that includes hundreds of fluvial lakes created by the meandering of the rivers. We studied 17 of these oxbow lakes distributed over the lower half of the Yazoo River Basin to document fish assemblage patterns and identify environmental variables that might influence these assemblages. Results of multivariate analyses showed that the degree of connectivity to adjacent rivers played a major role on the environment and fish communities. Lakes with direct connectivity tended to be deeper, less turbid, produce less phytoplankton biomass, and had greater fish species richness that included more riverine species. Conversely, as connectivity with the river was reduced or lost, lakes became shallow, more turbid, had higher phytoplankton biomass, and a less speciose lacustrine fish community dominated by centrarchid species. Seemingly, after lakes separate from the river, they trap sediments from annual floods and over years become progressively shallower; this sequence in turn modifies such characteristics as area and substrate composition. These results suggested that the river connectivity could be an important factor in determining not only fish community composition but also in shaping physicochemical conditions of these floodplain lakes. Effects of changes in connectivity of floodplain lakes; the loss or addition of connections to main rivers should be considered in lake restoration efforts. Management goals may be attainable by increasing or decreasing lake connectivity and thereby influencing fish migration and dispersal and modifying the overall physicochemical environment.

Key words: floodplain lake, fish assemblages, water quality, river connectivity

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Life History and Ecology 2 / Policy Oral Presentation

Science-Based Aquatic Conservation Planning: A Call for Transparency and Explicit Prediction
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Contemporary approaches to aquatic conservation planning classify landscapes and waterbodies based on their physical and biological characteristics and use the classifications to identify and prioritize specific areas for conservation efforts. We argue

that these approaches use implicit models of ecological processes and do not explicitly recognize or incorporate the influence of uncertainty regarding ecological system dynamics. We evaluated the relative sensitivity of classification-based planning approaches to uncertainty in ecological system dynamics by developing faunal and landscape classifications with empirical data from the Flint River Basin, Georgia and commonly-used clustering methods. We then evaluated how changes in assumptions regarding the (1) number of landscape classes and (2) the relative influence of stream fragmentation (e.g., impoundments) and anthropogenic development (e.g., urbanization) on conservation potential influence derived conservation priorities. Our evaluation using relatively simple classifications indicated that minor changes in assumptions can substantially affect the prioritization of hydrologic units for conservation. We propose that aquatic conservation planning be based on explicit models of ecological process that produce explicit measurable outcomes as an alternative to the classification-based approaches. We discuss how explicit modeling, which when employed in a framework that includes feedback in the form of monitoring data, can provide the basis for increasing our understanding of ecological processes and improve conservation decision-making.

Key words: conservation planning

GIS Fisheries Symposium Oral Presentation

Practical Applications of Enhanced Water Resources GIS Datasets

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Comprehensive water resources datasets and associated capabilities in Geographic Information System (GIS) format can be valuable tools in water resources management. The National Hydrography Dataset (NHD) has recently been completed at the 1:24,000 map scale for the entire country. In West Virginia and elsewhere, key enhancements have since been made to the NHD dataset, allowing for increased utility. West Virginia also has completed stream segment-level watershed delineation for all stream segments in the 1:24,000 NHD in WV. The spatial framework provided by these datasets allows for detailed watershed modeling and characterization throughout the state, including quantification of: land use/land cover in the contributing watershed of any stream segment, cumulative watershed statistics, and distance to features of interest along streams, such as mines. These capabilities have many practical applications in cumulative impact analysis and ecological modeling. In addition to existing water resource datasets, the state of West Virginia is also in the process of developing even more highly detailed maps of surface water resources at the local map scale of 1:4800 following the NHD data model. Mapping streams at the local scale will allow more accurate capture of stream drainage alterations due to construction, mining, and other activities. This presentation will provide an overview of the use of the NHD and related GIS datasets and tools, including advantages, disadvantages, and limitations of each, and will also include a demonstration of practical applications of water resources datasets developed within West Virginia.

Key words: GIS, NHD, water resources

GIS Fisheries Symposium Oral Presentation

A Cumulative Watershed Network Model for Multiple Scale Restoration

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We have developed a GIS-based decision support system to aid in restoration planning by integrating various chemical and ecological modeling components. Using the popular GIS platform of ESRI ArcMap, computer code was written in Visual Basic .Net environment to develop an extension to visually illustrate remediation and alternative outcomes. Building upon the existing 1:24,000 segment level or delineation of watersheds for all of WV and a network model to examine pass through issues, the user is able to compare treatment options and locations for building spatially explicit abatement and restoration plans. The advantage of our system is its straightforward mass-balance water quality model and logical decision alternative matrix with costs and ecological stream benefits. We are able to visually iterate and illustrate outcomes downstream of various treatment/restoration scenarios. The result is a spatially explicit cumulative watershed modeling framework for quantifying stream conditions at multiple scales. The presentation will include a demonstration of the spatial decision support system in a local WV watershed showing treatment options and ecological unit benefits.

Key words: watershed restoration, GIS, ecological benefits

GIS Fisheries Symposium Oral Presentation

Utilizing the ArcGIS Network Analyst Extension Framework for Quantifying the Effects of Stream Network Structure on Local Biological Conditions
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Several recent studies have demonstrated that local populations and communities are strongly dependent on their position within the broader landscape or drainage network. However, while the geometry of the terrestrial landscape is rather easily quantified using modern GIS technology, the computational complexity of stream network geometry has limited similar analyses in aquatic studies until recently. The objective of this talk is to present a modeling framework that we recently developed for quantifying both local and regional measures of environmental variability among streams. The presentation will consist of 1) a description of the logical framework, 2) a demonstration of the framework's practical utility through a case study relating local and regional measures of water temperature to brook trout and smallmouth bass distributions in a West Virginia watershed, and 3) a technical demonstration of the modeling process using the ArcGIS software package.
Key words: stream network structure, biological condition

GIS Fisheries Symposium Oral Presentation

Modeling Fish Distribution and Abundance Using Spatial Statistics
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Predictive fish habitat distribution models have increased in recent years, partly because of the increased use of geographic information systems (GIS) and statistical analysis techniques. In modeling fish distribution, issues of scale, model type, and available habitat information influence our ability to develop both precise and realistic models. A first step in distribution modeling is the development of a conceptual model. Multiple logistic regression is the most common type of statistical analysis used to predict the probability of occurrence of species or their habitats, although discriminate analysis and artifcial neural network models are also used occasionally. At the local scale, microhabitat variables such as depth, velocity, substrate, and cover were used to predict either occurrence, density or biomass. At the regional scale, probability of occurrence was predicted from macrohabitat variables such as basin size, elevation, water temperature, precipitation, and land cover/land. I will demonstrate the use of some of these statistical analysis techniques and GIS mapping tools using freshwater fish data.

Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

Adult Blue Catfish *Ictalurus furcatus* Movement Patterns using Ultrasonic Telemetry in Lake Texoma, Oklahoma.
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Potential over-harvesting of trophy adult blue catfish *Ictalurus furcatus* across the United States has increased management agencies' concerns about how sustainable the populations are. This is a concern in Lake Texoma, on the Texas-Oklahoma border, which has historically yielded multiple trophy-sized blue catfish >50 kg. An understanding of movement patterns and habitat use is vital to developing sampling protocols that provide representative stock assessment indices. Acoustic telemetry is being used to monitor adult blue catfish movements in the Washita and Red River arms of Lake Texoma. With the assistance of Oklahoma Department of Wildlife Conservation, Oklahoma Fishery Research Lab, capture and tagging of these fish began in December 2006, and monitoring of fish movements will continue through winter 2007-2008.

Key words: blue catfish, telemetry, Texoma

Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

Size Bias and Efficiency of Catfish Sampling Gears
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Although many gears are used to collect catfishes, few have been evaluated for size bias. We used mark-recapture to directly estimate size bias of tandem hoop-net series for collecting channel catfish *Ictalurus punctatus* and low-frequency DC electrofishing for collecting blue catfish *I. furcatus* and flathead catfish *Pylodictis olivaris.* To examine spatial and temporal

variability, size bias was estimated in river and reservoir habitat during June, July, and September 2005 (N = 6). Over the course of study, about 30,000 blue catfish, 12,000 channel catfish, and 450 flathead catfish were collected. Hoop nets collected channel catfish ≥ 250 mm total length in proportion to their abundance. Likewise, blue catfish ≥ 250 mm were fully recruited to low-frequency DC electrofishing. Flathead catfish ≥ 150 mm appeared to be fully recruited to low-frequency DC electrofishing, although sample sizes of fish ≥ 500 mm were too small to examine bias. The size at which fish recruited to the gear was not affected by habitat (i.e., river and reservoir) or month sampled for any gear or species. Although large numbers of blue catfish were collected with low-frequency electrofishing, overall recapture rates (our measure of capture efficiency) were frequently < 1% per 2 h of electrofishing. Electrofishing capture efficiency also varied; recapture rates were greater in river habitat and highest in July and September. Such variation may limit the use of electrofishing data when estimating relative abundance (i.e. CPUE). Although some limitations were noted, the combination of tandem hoop-net series and low-frequency DC electrofishing can provide accurate size structure data for adult catfish populations from river and reservoir habitat.

Key words: catfish sampling gear, size bias, efficiency

Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

Benthic Trawling as a Supplement to Electrofishing on the Ohio River

Musser*, B.D., Jones, T.G, Swecker, C., Reese, S. Donahue, K., Smith, G., Marshall University, Watershed and River Program, Thomas, J. and Emery, E., ORSANCO, musser6@marshall.edu

Over the past 40 years, the Ohio River Valley Water Sanitation Commission (ORSANCO) has been sampling the Ohio River main stem and its' tributaries through various methods such as boat electrofishing and rotenone lock chamber surveys. The goal of these methods is to assess the river wide fish assemblage. A third method, benthic trawling, was started within the last two years in an effort to sample the benthic fish communities, which is being underrepresented by traditional methods. In 2006 and 2007, benthic trawling was conducted at 118 electrofishing zones to determine the utility of this method as a secondary collection technique to better characterize fish populations of the Ohio River. Two, one minute and two, two minute trawls were conducted at each 500 meter electrofishing transect at different depths and/or at different segments of the transect. An 8' wide trawl was used for all sampling. In 2006, 240 trawls were conducted with a 72% (n=172) success rate. Trawling regularly captured species either rarely caught or never caught by conventional electrofishing yet yield was often lower than electrofishing in both numbers (2323 to 9157) and species (22 to 62). While average time spent trawling at each 500 meter transect was comparable to time spent electrofishing (~45 min), electrofishing returned many more individuals (9157 to 2323) and species (62 to 22). In 2007 data continued to support this pattern. These result support the use of trawling as a supplement to electrofishing for a more inclusive assessment of large river fisheries.

Key words: benthic trawling, Ohio River, protocol development

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Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

Transparency and Temperature Effects on Benthic Trawl Efficiency in Large River Habitats

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Small benthic fishes in large rivers are understudied group. Multiple states list many of these fishes as rare or even endangered. Conventional sampling techniques may be inefficient in properly sampling benthic fish populations. Missouri type trawling is a recent innovative technique that may effectively sample benthic fish communities. As a part of a larger project to develop an effective trawling protocol, we observed a pattern of transparency and temperature impacting catch rates of small benthic fishes. This study attempts to further elucidate these patterns. From May, 2006 through December, 2007, over 800 trawls were conducted along the entire length of the Ohio River and several large tributaries to assess small benthic fish populations. Specific collection locations were selected based on a series of project goals. During each sampling event both transparency and temperature were recorded for each site with a number of other variables. Two to five trawls were completed at each site. Mean catch rates and species counts were calculated for each site. Both non-parametric statistical tests and multi-variate analysis identified temperature and transparency as impacting trawling outcomes. Overall colder, murky conditions led to high catch rates and greater species diversity by study site.

Key words: Ohio River, benthic trawling, protocol development

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Trawling as an Alternative Method for Collecting Benthic Fishes in Large Rivers
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Due to the complexity of large river systems, methodologies for sampling are numerous and often used in conjunction to appropriately characterize a system. Strategies such as boat electrofishing, and rotenone surveys are most commonly used. Each method has their respective strengths and weaknesses. Benthic trawling in large rivers is being used as an alternative technique of sampling fish communities. In the late 1990's the first study was done using benthic or bottom trawling in the Missouri River. During 2006 and 2007, Marshall University has sampled the Ohio River with the goal of determining a robust protocol using this technique. The current protocol utilizes four trawls at each site. Trawls A, and B are conducted near shore, in less than 2 meters of water. These trawls are one (1) minute in length. Longer trawls in this location led to much higher snag rates. Trawl C is conducted on the slope of the channel for two minutes, trawl D on the channel plain of the river for 2 minutes. Longer trawl times of 3 to 10 minutes have not resulted in increased catch rates or species number. Throughout the seven pools sampled, trawls A, B, and C have returned the highest numbers of species and catch rates. Trawl D has been retained because it represents the vast majority of the river substrate. Sampling at these areas allows us the best coverage at that particular site in an effort to sample all of the habitats available.

Key words: benthic trawling, Ohio River, protocol development

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Application of Hierarchy Theory to Guide Sport Fish Management in Mississippi Wadeable Streams
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Wadeable stream ecosystems are hierarchically structured through space and time. Climatic, geologic and land use practices on watersheds and riparian zones constrain the structure and function of stream biota and their habitats at smaller scales. This hierarchy can influence the success of habitat restoration for and predictive modeling of sport fishes in small streams. Using a variety of multivariate analyses (canonical correspondence analysis, principle components analysis and Mantel tests), I found that Mississippi wadeable streams exhibited a spatial hierarchy among watershed, riparian and channel-scale environmental characteristics. Consequently, I chose the watershed-scale as an appropriate scale for modeling and managing catchable sport fish CPUE (fish/angler-hour) in Mississippi wadeable streams. Using best-subsets multiple linear regression, I found that total CPUE (all species combined), total bass CPUE *Micropterus salmoides* and *M. punctulatus* and total sunfish CPUE (all *Lepomis* spp. combined) were associated with percent forest cover, stream density, rural road density and total road density ($R2>0.80$; $P<0.01$). I performed model evaluation procedures with an independent dataset and found that models for these fish catch characteristics were accurate, albeit relatively imprecise (Sign test; $P>0.05$; classification rates <24%). However, these watershed variables explained >71% of the total variation in total CPUE, total bass CPUE and total sunfish CPUE from the independent data. These watershed-scale models performed reasonably well and should be used by fisheries managers to identify candidate reaches where restoration and management will be successful with regard to enhancing and promoting angling opportunities in Mississippi's wadeable streams.

Key words: scale, predictive models, watershed, angling, stream hierarchy

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A Recreational Angling Survey of Lake Norman, North Carolina
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A creel survey was conducted at Lake Norman, North Carolina from 1 September 2006 to 31 August 2007. The primary objective of this survey was to estimate angling effort, catch, harvest, and trip-related expenditures at Lake Norman. Two roving creel clerks travel along a fixed circuit in selected areas of the lake and counted and interviewed both boat and bank anglers. A total of 1,645 interviews were conducted during 418 scheduled creel sessions. Anglers expended an estimated 320,933 angler-h of effort, caught 169,716 fish, and harvested 54,667 fish during the 12-month creel period. Boat-based anglers accounted for 80% of the total estimated effort. Of the fish harvested, 52% were harvested from boat-based anglers who launched from public boating access areas, 41% were harvested from bank anglers, and 7% were harvested from anglers

who launched from private access areas. Largemouth bass *Micropterus salmoides* was the most sought-after species receiving 48% of the total estimated effort, while striped bass *Morone saxatilis* and crappie *Pomoxis* sp. received 16% and 10% of the estimated effort, respectively. Estimated trip related expenditures for all anglers during the 12-month creel period were US$4,270,630. These results reaffirm the importance of this fishery to the region and these data will be used to develop a Lake Norman fisheries management plan.

Key words: creel survey, Lake Norman, striped bass, largemouth bass

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Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

Norfork Lake Creel Survey - One Way to Obtain Night-time Pressure Counts

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Previous creel surveys have largely been limited to day-time. While angler interviews can easily be conducted at night, pressure, total catch and harvest estimates are more difficult. Unless the water body has one access point, these estimates are usually obtained by repeatedly flying the entire water body. Here, we used night vision equipment to count anglers at night. In the 3-year survey, we conducted 16 day and 16 night interview sessions per month. Fish harvested were identified and measured and anglers estimated the size of all fish released. Harvested stripers and hybrid stripers were weighed. The lake was flown 8 times per month obtaining pressure counts. The creel clerks also motored the lake using night vision equipment to get pressure counts on interview nights. They interviewed 3016 parties (5640 anglers). Of these, 1255 parties (2377 anglers) were interviewed at night. Norfork Reservoir received 67.1 Hrs/Ha of angling pressure of which 21% was at night. Anglers caught 55.3 fish/ha/year harvesting 16.4 fish weighing 13.2 kg/ha. Had the creel survey been limited to daytime only, we would have overestimated the proportion of the angling directed at crappie and striped bass while greatly underestimating angling directed at walleye, catfish, sunfish and, in normal years, white bass). In the daytime, walleye and catfishing made up 3.7% and 3.4% of all targeted trips but at night those species made up 9.3 and 10.3% of fishing trips respectively.

Key words: Lake Norfork night-time creel survey

Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

North Carolina Trout Angler Opinion Survey

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The North Carolina Wildlife Resources Commission (NCWRC) is interested in the views of its angler constituencies; however, a program-wide opinion survey of our trout anglers was lacking. In May 2007, a telephone survey of 1,504 licensed trout anglers was conducted to document opinions regarding current trout management and potential program changes. Of the estimated 131,055 resident trout anglers in 2006, a majority preferred to fish hatchery supported streams (put-and-take or delayed harvest), on public lands, within a 50-mile radius of their home. Wild waters managed for natural reproduction with restrictive size and creel limits (including catch and release) were the second most preferred type of waters to fish. The most common reason cited for trout fishing was for sport (37%) or relaxation (24%) and only a small minority of anglers (10%) indicated they fished primarily for food. The demographics of the traditional trout angler in North Carolina are changing from a rural resident, with minimal education, that prefers to fish locally for stocked trout to one that resides in the urban piedmont, has a college degree, travels significant distances to fish, and practices catch and release angling for wild trout or stocked trout managed under catch and release regulations. Although angler interest in wild trout fisheries appears to be increasing, relatively few North Carolina anglers are members of organized angling groups, such as Trout Unlimited (8%) or Federation of Fly Fishers (2%), that actively promote wild trout fisheries. As angler constituencies change and license sales remain flat, it becomes increasingly important that management agencies collect, utilize, and implement human dimension information in the administration of their coldwater management programs.

Key words: North Carolina trout angler opinion telephone survey

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Fisheries Science and Techniques 2 / Creel Surveys Oral Presentation

Catfish Angling and Harvest Statistics with an Emphasis on Trophy Blue Catfish Management in Oklahoma.
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Increasing angler interest in the pursuit of "trophy" catfish in Oklahoma has led to agency focus on better understanding and managing catfish fisheries. In light of recent studies which indicate slow growth rates of reservoir blue catfish populations, management of trophy fisheries becomes challenging. In an effort to better understand catfish angler and harvest statistics, Oklahoma Department of Wildlife Conservation Law Enforcement Division personnel agreed to count and measure catfish harvested by anglers during routine law enforcement duties. Number of anglers per party, angling method, and catfish species data were recorded by ODWC officers during a total of 1876 angler contacts. Data were collected from 3968 catfish anglers on 66 bodies of water from mid-May 2006 through October 2007. Most anglers pursued catfish using rod and reel (59.3%), followed by juglines (27.7%), trotlines (12.1%), and limblines or noodling (0.9%). Rod and reel angling accounted for the most catfish harvested (4394) followed by juglines (2151), and both methods were equally efficient with catch rates of 1.9 fish per rod and reel angler and 2.0 fish per jugline angler. Just 2.6% of rod and reel anglers and 1.2% of jugline anglers reached the daily creel limit (15 blues and channels in aggregate). Only 3.9% of all anglers harvested trophy (>30 inches) blue catfish, but within this small group over half (51.6%) harvested more than one trophy blue catfish. The majority of trophy blue catfish (59.5%) were harvested in cool water months (November through May). The mean length of blue catfish harvested in cool water months was significantly greater than the mean length of blue catfish harvested in warm water months (June through October), 21.9 inches (N=2745) versus 19.4 inches (N=2612) respectively. Even though trophy blue catfish harvest is low (2.9% of total blue catfish harvest), this percentage still exceeds the percentage of blue catfish over 30 inches in population samples (0.5%). Agency discussion of potential management strategies and trophy management of blue catfish is ongoing.

Key words: catfish, blue catfish, creel survey, management

Crayfish Symposium 2 Oral Presentation

Effects of Habitat, Landuse, and Water Quality on Freshwater Crayfish (Decapoda: Cambaridae) Across an Agricultural Gradient in West-Central Indiana
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We studied the associations of crayfish assemblages with reach-scale variables measured by instream habitat and water quality and watershed scale variables measured by riparian and catchment land use, runoff, impervious surfaces, and soil characteristics in west-central Indiana. The western portion of the study area has been heavily impacted by agricultural land use, while the eastern portion is more heavily wooded and less impacted. Crayfish assemblage structure was measured by abundance, species richness, and diversity (Shannon's H) at 180 sites. The ability of variables at each spatial extent to predict crayfish assemblage structure and species abundance was assessed using multiple linear regression models. Reach models were better predictors of all assemblage structure variables than watershed models. Watershed models were better predictors of assemblage structure within the less agriculturally dominated region. Both reach and watershed models developed for individual species were successful in predicting species abundance. Modeling for aquatic species was more successful than burrowing species. A variety of habitat and water quality characteristics at the reach scale, most notably instream cover amount and complexity, appeared as important predictors. Forested riparian and watershed land use appeared as important watershed scale predictors. Understanding the dynamics of crayfish populations under anthropogenic conditions is important for conservation and management.

Key words: crayfish, habitat, scale

Crayfish Symposium 2 Oral Presentation

Differential Production of *Procambarus troglodytes* Across a Large River Floodplain in South Carolina
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The distribution of the freshwater crayfish *Procambarus troglodytes* is limited to parts of South Carolina and Georgia where it inhabits floodplains. The species reproduces in association with flood pulses that seasonally inundate the habitat. We repeatedly sampled *P. troglodytes* at three sites within each of five landscape patch types. Crayfish were sexed, measured, and released. Frequency histograms of crayfish class intervals were visually inspected and used to identify cohorts. Seasonal

shifts in cohorts, field observations of water depths at sampled sites, and historical flood patterns were used to infer the life cycle of *P. troglodytes* at the Congaree National Park in South Carolina. Changes in biomass within sampled locations were used to estimate production, which was then compared across the 5 landscape patch types. *Procambarus troglodytes* had an annual recruitment that coincided with the flood pulse. Production varied across the landscape, with shallower, more ephemeral habitats exhibiting highest production. The study highlights the importance of maintaining the spatial and temporal heterogeneity associated with river flood pulses.

Key words: flood pulse, crayfish, production, landscape

Crayfish Symposium 2 Oral Presentation

Microhabitat Characterization of the Nashville Crayfish (*Orconectes shoupi*) in Mill Creek Watershed, Tennessee
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Orconectes shoupi is one of four federally listed endangered crayfish in the United States and the only one occurring in Tennessee. The Nashville crayfish (*Orconectes shoupi*) is endemic to the Mill Creek watershed, which is located in the southwest portion of Nashville, Tennessee in Williamson and Davidson counties. This watershed drains approximately 280-km^2 within the Nashville Basin. The objectives for this study were to: (1) identify seasonal micro-habitat variables influencing habitat utilization; and (2) develop a predictive habitat model. Fifteen, 200-m long sites were sampled throughout the Mill Creek watershed during the spring, summer, fall, and winter of 2007. Within each 200-m site, 11 transects perpendicular to flow were established at 20-m intervals. Random points along each transect were sampled with a 0.25-m^2 quadrate sampler and 10 microhabitat variables were measured at each point. Logistic regression was used to model Nashville crayfish presence/absence as a function of one or more of these habitat variables. Currently, the Nashville crayfish population appears stable, but because the species is endemic to Mill Creek watershed, which is increasingly undergoing urbanization, this status could change. Hopefully, models generated from this study will be helpful in maintaining and protecting this species.

Key words: *Orconectes shoupi*, Nashville Crayfish, 0.25-m^2quadrate sampler, microhabitat

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Crayfish Symposium 2 Oral Presentation

Ecology of *Cambarus (J.) dubius* in North Central West Virginia
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High elevation burrowing crayfishes have not received focused research attention, leaving much of their life and natural history unknown. In order to conserve high elevation burrowing crayfish, basic natural history parameters need to be ascertained so ecological requirements needed to maintain these population can be determined. In an effort to gather this data, an ecological study of *Cambarus (J.) dubius* was performed at Terra Alta, Preston County, West Virginia. A two tier approach was used, with tier one determining necessary ecological parameters and tier two focusing on *C. (J.) dubius* life history. Ecological parameters with special emphasis included identification of preferred forest associations, burrow portal density in natural and anthropogenic habitats, and morphology and thermal regimes of burrows. Life history parameters included identifying size at sexual maturity, age cohort designation, and behavioral ecology with special emphasis on feeding biology. *Cambarus (J.) dubius* preferred Service Berry/Red Maple associations, though was present in disturbed environments. Burrow portal densities were highest in forested seep habitats and distributed across the forest in a discrete metapopulations system, while anthropogenic habitat burrow portal densities were unevenly distributed throughout the landscape, and less dense than forested environs. Morphometrics analysis for 263 crayfish determined no difference in size at maturity for males and females. Behavioral analysis indicated high levels of active foraging during nocturnal hours, and identified two new stylized burrow portal behaviors.

Key words: *Cambarus (J.) dubius*, primary burrower, crayfish

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Crayfish Symposium 2 Oral Presentation

Status and Distribution of Williams' Crayfish, *Orconectes williamsi*, in Arkansas
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Orconectes williamsi is a rare stream-dwelling crayfish that is endemic to the upper White River basin of Arkansas and Missouri. This study surveyed a semi-random selection of stream sites in the Arkansas portion of this range in order to characterize the crayfish communities, identify co-occurring fishes, and evaluate the status of *O. williamsi* in Arkansas. Collections of a total of 2,372 individual crayfish specimens were made at 68 sites, including 197 *O. williamsi* from 23 sites. *O. meeki* was the crayfish species most commonly associated with *O. williamsi*, occurring at 87% of sites occupied by *O. williamsi*. The fish species most commonly encountered in streams with *O. williamsi*, were *Etheostoma spectabile*, *Campostoma anomalum*, and *Semotilus atromaculatus*. *O. williamsi* was found in the smallest streams sampled, with coarse substrates and no aquatic vegetation. It showed a strong preference for riffle habitats. It is our opinion that the species is somewhat imperiled in Arkansas, and should be considered rare and vulnerable range-wide.

Key words: status, distribution, crayfish, *Orconectes williamsi*, Arkansas, Ozarks

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Crayfish Symposium 2 Oral Presentation

A Recreational Fishery for Longpincered Crayfish (*Orconectes longidigitus*) in Table Rock Reservoir, Missouri: Effects of Season and Environmental Factors on Trapping
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Longpincered crayfish (*Orconectes longidigitus*), native to the White River drainage of Missouri and Arkansas, are among the largest crayfishes in North America, and a recreational fishery for them is becoming increasingly popular at Table Rock Reservoir in southwest Missouri. Possession of a Missouri fishing license allows harvest of 150 crayfish/day with an unlimited number of baited traps. This unusual North American fishery represents a unique opportunity for recreationalists and resource managers. However, no information exists concerning this crayfish's life history, ability to sustain exploitation, or how it may be effectively sampled by biologists. Our objectives were to determine if baited trap catch rates and sex ratios of captured longpincered crayfish vary among seasons and depth, and if they are affected by selected environmental variables. From September 2006 through September 2007 we sampled monthly at two sites representing two habitat types. At each site, 20 traps were deployed along transects at each of three depths (0-2m, 6-8m, 11-13m). Temperature loggers were deployed with each trap line and vertical temperature and dissolved oxygen profiles were obtained at each site. SCUBA was used to obtain substrate composition estimates. Crayfish catch rates were highest in autumn and late spring, low in winter, and generally higher at the gently sloping cove habitat site than the steeply sloping ledge site. Dissolved oxygen, temperature, and reservoir stratification/mixing appeared to influence catch rates at various depths. Results will be used to design future studies to determine effects of crayfish exploitation and ultimately address potential need for modified regulations.

Key words: Longpincered crayfish, reservoir crayfish fishery, sampling, exploitation

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Crayfish Symposium 2 Oral Presentation

Efficacy of Internal PIT Tagging of Small-bodied Crayfish for Ecological Study
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Recent studies have demonstrated the feasibility of using passive integrated transpondence (PIT) tags for tracking crayfish spatiotemporally in streams. PIT tags can be inserted internally for long-term tracking, assuming low tagging mortality, or attached externally for shorter-term tracking until the individual molts. To date, only individuals >30 mm carapace length (CL) have been used successfully for internal cephalothorax tagging. The efficacy of internal tagging for small-bodied crayfish species or juveniles of large-bodied species remains poorly studied. We conducted studies with the small-bodied slender crayfish, *Orconectes compressus*, to assess whether internal placement of small PIT tags (8.5 mm long, 2.5 mm diameter) was a viable methodology for future ecological work. In the field we tagged 63 crayfish and monitored them with a portable transceiver system for 1.5 weeks. In the laboratory we tagged 21 crayfish and maintained 21 control crayfish for 12 weeks. Crayfish averaged 18 mm CL (n = 84). In the field, there was high initial (13 of 63) and delayed mortality (17 of 63). We also observed initial (3 of 21) and delayed mortality (11 of 21) in the laboratory within the first 10 days. Smaller

individuals had higher mortality rates in both studies. We constructed logistic regression models with field (P = 0.01) and laboratory data (P = 0.08) to show the likelihood of tagging mortality as a function of carapace length. Our results suggest that internal PIT tagging could induce undesirably high mortality in crayfish <22 mm CL for most ecological study objectives.

Key words: crayfish, PIT tag

Crayfish Symposium 2 Oral Presentation

Implementation of a Spatial-Temporal Focus to Predict Habitat Locations and Distribution of *Cambarus Veteranus*
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Statewide surveys in 1988 and 1989 found forty-nine *C. veteranus* from only eight locations in the Upper Guyandotte watershed, West Virginia. A pristine stream is speculated as the ideal habitat, yet, the Upper Guyandotte is known for its extensive habitat alteration due to extractive industry. Current highway construction now intrudes on *C. veteranus* territory. Already, thirty-eight percent of all streams in the Upper Guyandotte River drainage are classified as impaired including *C. veteranus*' type locality, Indian Creek, Wyoming County, West Virginia. This impairment plays a role in the creation of habitat patches. Finding suitable habitat is advanced with the use of a geographic information system (GIS). Historical and current biological data provide the baseline validation values for suitable habitat and prediction models. The final suitability map shows optimum habitat locations for *C. veteranus* in the Upper Guyandotte by means of ArcMap® 8.1 thematic maps, spatial and geostatistical analysis. Final analysis reduced the potential search area yet ground verification produced no updates for *C. veteranus.*

Key words: *Cambarus veteranus*, GIS, habitat mapping

POSTERS

Poster

Status of Paddlefish Recovery in the Upper Ohio River Basin
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Historically, free-ranging paddlefish *Polydon spathula* occurred in the upper Ohio River basin at the extreme northeastern extent of its zoogeographic range. The demise of self-sustaining paddlefish populations in New York, Pennsylvania, and West Virginia has been attributed to channelization, dam construction, gravel dredging and water quality degradation. The last historical account of paddlefish in Pennsylvania was at the mouth of the Kiskiminetas River, a major Allegheny River tributary in 1919. In the absence of natural reproduction, stocking programs were initiated under the guidance of the Mississippi Interstate Cooperative Resource Association (MICRA). To date, over 140,000 juvenile paddlefish have been introduced. In order to assess the status of the reintroduction effort, various sampling strategies (gillnetting, benthic trawling, plankton tows, and shoreline electrofishing) have been employed. While the captures to date have included multiple year classes and sexually mature adults, no evidence of natural reproduction exists. In addition, 78 "reliable source" reports documenting sub-adult and adult fish have been received by New York and Pennsylvania conservation agencies. At this time, the success of paddlefish reintroduction into the upper Ohio River basin is best described as equivocal. Therefore, we recommend the continued implementation of the interjurisdictional fishery plan for paddlefish developed by MICRA.

Key words: Ohio basin, paddlefish, restoration, MICRA

Poster

Habitat Enhancement on Wild Trout Streams in Pennsylvania
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During the past two decades, the Pennsylvania Fish and Boat Commission (PFBC) has developed a habitat enhancement and restoration program that uses low cost and low disturbance techniques to improve habitat in wild trout streams. In streams with good water quality, limited physical habitat, especially deeper pools and overhead cover is one of the major factors that limits the productivity of wild trout populations in Pennsylvania streams. To address these habitat limitations, the PFBC uses habitat enhancement structures constructed of logs and stone to increase overhead cover, water depth, and habitat diversity while reducing bank erosion. These structures include overhead cover deflectors, log vane deflectors, log cross vanes, and mud sill cribbing. The typical lifespan of the structures is about 20 years, with many lasting for considerably longer periods.

Significant improvements in the abundance and size structure of wild trout populations has been documented in reaches where monitoring has occurred. For example, a twelve-fold increase was documented in both total CPUE and CPUE of legal-size (> 178 mm) wild brown trout in a reach of Little Lehigh Creek five years post treatment compared to a pre-treatment survey. Pennsylvania also has an active dam removal program that often utilizes habitat enhancement structures following dam removal to help improve instream habitat and aid in the restoration of previously impounded reaches. These restoration techniques have also been shown to considerably enhance wild trout populations in the restored reaches.

Key words: wild trout, habitat enhancement, dam removal

Poster

Reduction in the Numbers of Asian Swamp Eel in Canals of the South Florida Water Management District Using Electrofishing Gear

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Asian swamp eel (*Monopterus albus*) are highly evolved air-breathing teleost, native to Southeast Asia. Their biology makes them well suited for a variety of habitats in Florida, including the Everglades. Asian swamp eels are very resilient, with a minimum population doubling time between 1.4 - 4.4 years. Because of these high fecundity rates an invasion in uncontrolled numbers could pose a significant threat to native wildlife by reducing the abundance of small prey species (insects, crayfish, tadpoles, etc.) that form the food base of fishes, wading birds, and other Everglades wildlife. Moreover, these eels have similar feeding and habitat requirements as American eel (*Anguilla rostrata*). A population of swamp eels has been found in the canals (C-111 and C-113) that border Everglades National Park near Homestead. However, this species has not been found inside the Park. Therefore, our project objective was to use electrofishing gear to reduce the numbers and slow the spread of Asian swamp eels into wetlands in and adjacent to the Everglades National Park. Between June and December 2006, a total of 905 Asian swamp eels were removed from the project area using a 20-foot jon boat with a 9.0 GPP Smith-Root electrofishing unit. The average settings of the electrofisher were 8.0 Amperes, 30 volts DC, and operated until a 1-km transects was covered. The number of eels observed but not captured was 738 (capture efficiency of 55.1%). Twenty-three American eels (<1.3% of all eels) were seen during the collection period.

Key words: invasive species, Asian swamp eel, electrofishing, Everglades

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Poster

Comparative Ecology of *Orconectes (C.) obscurus* and *Cambarus (C.) b. bartonii* in the Cacapon River Basin, West Virginia

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Hobbs described three discrete crayfish behavioral groups based upon a species' propensity to burrow. Two of these groups, secondary and tertiary burrowers, were examined in this study which elucidated differences in abiotic variable use between two sympatric, behaviorally distinct crayfish. *Orconectes (C.) obscurus*, a tertiary burrower, and *Cambarus (C.) bartonii*, a secondary burrower were used as models for their respective behavioral groups. A randomized group of 40, 150m stream reaches were selected by GIS for each sub-basin of the Cacapon River basin within West Virginia. Of the potential sites, 55 were chosen and surveyed in order to calculate catch per unit efforts values for each species at each site. Abiotic variables were also recorded at each site and included dissolved oxygen, Ph, water temperature, stream order, hydroperiod, and stream gradient. Correlations were determined between CPUE and each abiotic variable to determine variable importance for each species. Results indicated that *Orconectes (C.) obscurus* prefers high ordered streams and rivers and *Cambarus (C.) b. bartonii* is better suited for smaller order streams and headwater systems. High gradient, low stream order, and complete drawdown limit the distribution of *Orconectes (C.) obscurus* within the basin. *Cambarus (C.) b. bartonii* is limited by the presence of *O. (C.) obscurus* and large stream orders. Physiochemical variables such as dissolved oxygen, pH, and temperature did not have an impact on either species distribution.

Key words: crayfish, secondary burrower, tertiary burrower

Poster

Implementation of a Catch and Release Brook Trout Regulation on a Watershed Scale

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Maryland's upper Savage River watershed is the state's last remaining contiguous brook trout system, supporting 130 miles of interconnected streams; 85% of the stream miles are on publicly owned land. While historically remote, recent anthropogenic changes in the watershed have increased angler access and pressure. Analysis of 2006 sampling to assess brook trout population attributes relative to ease of angler access showed that sites with the lowest angler access always had significantly more large fish than more accessible sites. High access areas had both fewer and smaller fish. The 2006 results in conjunction with a three decade decline in population density and the number of larger brook trout led to the adoption of a catch-and-release, artificial lures only brook trout regulation for the upper Savage River watershed. Primary objectives of this regulation are to: 1) increase the number of larger fish (>200mm) in the system for biological and angling value; 2) improve overall trout population densities; 3) reduce angler related mortality, particularly of larger fish; and 4) protect the only intact brook trout system in Maryland while still optimizing angling use. Monitoring was initiated in 2006 and will continue annually through 2011 to assess the effectiveness of the regulations.

Key words: brook trout, catch and release, upper Savage River watershed

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Poster

Characterization of Aquatic Macroinvertebrate Communities within the Three Drainages of the Obed Wild and Scenic River System.

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Aquatic macroinvertebrates, especially arthropods, are an important component of aquatic ecosystems and have long been used to measure water quality. Distribution and abundance of aquatic macroinvertebrates are affected by many natural and anthropogenic factors. Habitat variables such as flow, substrate, dissolved oxygen, presence of woody debris, and temperature are natural factors that can affect their distribution and abundance. Land use practices, such as, agriculture, mining, oil drilling, silviculture, and urban development directly influence water quality, and thus aquatic macroinvertebrate communities. All of these land use practices are found in the Emory River Watershed. The Obed Wild and Scenic River is part of the Emory River Watershed, located within the Cumberland Plateau and Cumberland Mountains of east Tennessee. This watershed totals over 2,065 km of streams, of which the Obed River includes over 72 km and includes portions of three drainages: Obed River, Daddys Creek, and Clear Creek. The objectives of this study are to: (1) develop a comprehensive list of aquatic insect species inhabiting the Obed Wild and Scenic River (2) compare biological condition scores between genus and species level ID's (3) determine if longitudinal variation occurs in the benthic community of the Obed Wild and Scenic River and (4) compare land use and its effects on aquatic insect communities in the three drainages of the Obed Wild and Scenic River. * This study is a work in progress.

Key words: macroinvertebrate communities

Poster

Factors Influencing Water Quality and Ecological Condition in an Intensively Mined Southern West Virginia Watershed

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Large scale surface mining in southern West Virginia results in significant impacts to headwater catchments. It is unclear, however, the extent to which these impacts influence conditions in downstream ecosystems, especially in watersheds affected by historic mining activities and more typical urbanization activities. We initiated a study in the upper Pigeon Creek watershed in south, central West Virginia. The objectives of this study are to: 1) characterize spatial variation in habitat quality, water quality, and ecological condition; 2) attribute instream conditions to spatial variation in landscape conditions (residential development and mining); and 3) identify spatially-explicit restoration and protection priorities. Our preliminary results indicate high levels of ecological impairment within this watershed, with condition ratings ranging from a high of 85 to a low of 22. Furthermore, variation in water quality appears to be a predominant factor influencing ecological conditions. For example, conductivity levels exceeding 1200 were commonly observed. Finally, spatial variation in water quality and ecological condition is strongly associated with residential development and untreated human waste. Residential structure density was significantly correlated with sodium and nitrate concentrations and ecological condition scores. Consequently, effectively managing impacts from new mine development must address the prevalence of non-mining related impacts in this watershed.

Key words: mining, water quality, ecological condition, West Virginia,

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Poster

Flow Variability, Water Quality, and Organic Matter Processing in Intensively Mined Headwater Catchments in Southern West Virginia

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Mountaintop removal /valley fill (MTR/VF) mining is a controversial process that may have far-reaching impacts on central Appalachian watersheds. Our project applies current knowledge of organic matter processing to Pigeon Creek, an intensively mined sub-watershed of the Tug Fork River in southern West Virginia. The long-term goal of our research is to restore and protect ecosystem functions in watersheds of the MTR/VF region of West Virginia. The specific objective of this study is to quantify organic matter retention and decomposition across a broad temporal and stream size gradient. To accomplish this we: 1) quantified the effects of valley fills on water quality, flow variability, structural complexity, and organic matter processing rates in small perennial streams; and 2) quantified organic matter processing rates in an entire drainage across a size gradient ranging from ephemeral to large perennial streams. Our study consists of 28 sites where we released artificial leaves and sticks, and placed leaf packs to measure decomposition. Flow variability was measured with continuous flow gages, and water quality measurements were based on seasonal, whole water samples analyzed for all major anions, cations, and metals. After one season of data collection (Fall 2007), we observed significant, but highly variable, effects of drainage area and structural complexity on organic matter retention. Small perennial streams below valley fills possessed higher overall flows than comparable reference sites, which resulted in slightly higher rates of decomposition. Our preliminary results suggest a variable, but measurable, interactive effect of mining, drainage area and stream channel complexity on overall stream function as it relates to organic matter processing. Our study will greatly improve our understanding of organic matter processing within Pigeon Creek and may be applicable to intensively mined watersheds throughout southern West Virginia.

Key words: decomposition; mountaintop removal / valley fill (MTR / VF) mining, organic matter, retention, streams, water quality

Poster

Survey of the Nation's Rivers and Streams

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EPA and its state, tribal, federal and other partners will implement a survey of the nation's rivers and streams in 2008 - 2009. This survey will use a random sampling design to provide regional and national estimates of the condition of rivers and streams. States and tribes will use consistent sampling and analytical procedures to ensure that results can be compared across the country and over time. This survey will combine a first-ever assessment of the nation's rivers with the second national survey of small wadeable streams. Indicators for the assessment include trophic, ecological, recreational, and physical habitat. Fish are included as an ecological indicator for this assessment. The methods employed to sample fish in this national survey were a collaborative effort between EPA, states, tribes, and other federal partners. Recommendations for the fish sampling methods include reach length, sample effort, gear, and vouchering.

Key words: EPA, Survey, Methods.

Poster

Killing Two Birds with One Stone – Removal of Phosphorus from Wastewater with Acid Mine Drainage Sludge

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Excess phosphorus in wastewaters from animal production facilities can result in eutrophication of watersheds, with serious consequences for aquatic life and water quality, especially in sensitive areas such as the Chesapeake Bay and the Gulf of Mexico. An economical method of phosphorus removal from agricultural wastewaters is urgently needed to preserve these receiving bodies of water from further degradation. Current technology consists of addition of aluminum or iron salts to precipitate and absorb phosphorus, but is too expensive for the low concentrations and high volumes often encountered in agricultural wastewaters. The sludge produced by the neutralization of acid mine drainage is composed primarily of hydrated iron and aluminum oxides, but has been considered a waste product in the past because of its low solids content. Research at the U.S. Geological Survey's Leetown Science Center has shown that the sludges have a strong affinity for phosphorus, leading to rapid adsorption kinetics and high loading capacities. Further research has also shown that the sludge can be dried

and used as a sorbent in packed bed contactors to efficiently remove phosphorus from agricultural wastewaters. The technology was recently demonstrated in the field on fish hatchery wastewaters and was operated over a 100-day period with no replacement or regeneration of the sludge sorbent during that time. Analysis of the treated effluent showed a removal of 50% of the phosphorus, even at a very low influent concentration of 0.06 mg/L. These findings show that the process is a practical way of simultaneously solving both the wastewater treatment and the acid mine drainage sludge disposal problems.

Key words: phosphorus removal, water treatment, eutrophication, Chesapeake Bay

Poster

PIT Tag Retention in Small American Eels, *Anguilla rostrata*

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Passive integrated transponders (PIT tags) are commonly used in American eel studies. The placement of the PIT tag differs among studies and researchers have not previously compared tag retention rates among the different tagging locations. The objective of this study was to compare tag retention rates in American eels in three locations: the dorsal musculature behind the head, the dorsal musculature near the dorsal fin origin, and in the abdominal cavity. Eighteen American eels from the Shenandoah River, WV were PIT tagged in the three locations and tag retention was measured for a total of 9 weeks. Tag retention was highest in the dorsal musculature (100%) and in the abdominal cavity (100%), and lowest behind the head (88%). These results are consistent with previous literature. This research was a pilot study to determine PIT tag placement for a study of upstream migration in American eels.

Key words: American eel, PIT Tag, Tag retention