



ABSTRACTS



PLATFORM AND POSTER PRESENTATIONS

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Note: Abstracts are presented alphabetically, according to first author's last name, separately for platform (first, page 2) and poster (second, page 77) presentations. Asterisk denotes student presenter.

PLATFORM PRESENTATIONS

Catch, release, and harvest characteristics of tournament and non-tournament bass anglers, J. Strom Thurmond Lake, Georgia and South Carolina

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Ten years of creel survey data collected from J. Strom Thurmond Lake were compiled to evaluate temporal changes in catch rates, release rates, and harvest by largemouth bass anglers. Period 1 surveys (1991-1995) were designed with non-uniform probabilities and stratified random sampling designs. Period 2 surveys (1996-2000) incorporated geographical stratification. Catch rates for all largemouth bass anglers ranged from 0.34 fish/day to 0.71 fish/day; release rates ranged from 0.30 fish/day to 0.49 fish/day. From 1991-2000, tournament anglers comprised 47%-67% of anglers interviewed that targeted largemouth bass. Tournament bass anglers had higher catch rates and higher release rates than non-tournament bass anglers during five of the ten years surveyed. Tournament anglers harvested more fish per day on weekend days than weekdays; non-tournament anglers harvested more largemouth bass per day on weekdays during September (Period 1). The average lengths of largemouth bass harvested ranged from 362 mm – 397 mm; tournament anglers harvested larger bass than non-tournament anglers in only one year (2000). From Period 1 to Period 2, there was a 42% reduction in the harvest of largemouth bass <355 mm by tournament anglers. During the same time frame, there was a 16% reduction in the harvest of largemouth bass <355 mm by non-tournament anglers. Harvest of fish <305 mm ranged from <1% - 8.5% during Period 1 and 0 – 3% during Period 2 for all bass anglers combined. Managers should consider these angler characteristics when evaluating management options for largemouth bass in J. Strom Thurmond Lake.

Determination of striped bass spawning locations on the two major tributaries of Lake Texoma

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The striped bass, *Morone saxatilis*, has been stocked in numerous reservoirs in the southeastern United States. Lake Texoma is one of approximately ten reservoirs in which striped bass reproduce, doing so in both major tributaries (Red and Washita rivers), thus eliminating the need for maintenance stocking. Striped bass recruitment from the Red River is being threatened by proposed desalinization projects. The objectives of this study were to compare the relative catch of striped bass eggs in the Red and Washita rivers and to locate spawning sites on each river. We netted striped bass eggs using 500 μ plankton nets in the two rivers on alternate days at three

sample sites per river in order to determine the relative abundance of eggs in both systems. Peak egg production followed stage rises in both rivers. We staged eggs to determine age in hours and back-calculated approximate spawning areas according to water velocity. There were three major spawning areas on the Red River and two on the Washita River.

Population genetics of red porgy *Pagrus pagrus* throughout the Atlantic

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The red porgy, *Pagrus pagrus*, is a protogynous sparid associated with reefs and hard bottom habitat throughout the warm-temperate Atlantic Ocean. We collected red porgy from the eastern North Atlantic (Madeira and the Azores), the western North Atlantic (off of the Carolinas) and Brazil to look at genetic relationships among these disjunct populations. Using microsatellite and mitochondrial DNA markers, we found significant differentiation among these three regions, as well as allele and haplotype frequency differences between the Azores and Madeira. At coding sequences within the mitochondrial DNA molecule, sequence differences among the three regions averaged 2%, with no shared composite haplotypes among regions. At the microsatellite loci, fixed differences were found at two loci and allele frequency shifts at the others. These data support the conclusion of well-separated populations in the northeastern and western Atlantic.

Analysis of movement patterns of stream-dwelling bull trout in response to sampling

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Blocknets are used during stream-fish sampling to restrict fish movement into and out of a sampling site. Fishery biologists, however, often sample streams without the use of block nets due to financial (e.g., personnel) or logistical constraints. Fish movement into or out of a sampling site can bias estimates of fish abundance and detectability. Thus, we evaluated the movement of federally listed bull trout in response to sampling via a mark-resight and recapture

experiment in Washington State. During 2001 and 2002, fish movement evaluations were completed in 18 streams, with one of three sampling methods: day snorkeling, night snorkeling, and electrofishing. Analysis of these data indicated that the response of fish to sampling varied. The highest percentage of fish appeared to move in response to day snorkeling (average 60%) compared to night snorkeling and electrofishing (average 35%). Fish movement upstream (average 32%) also was much greater than downstream (average 15%) and suggested that sampling personnel were driving fish out of sample sites. Movement also was related to instream habitat characteristics. Our results indicate that sampling activities cause bull trout to move out of study sites, potentially biasing estimates of abundance and detectability.

Contribution of stocked fingerling walleye in Lake James

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In 1949, the North Carolina Wildlife Resources Commission (NCWRC) introduced walleye *Stizostedion vitreum* fry into Lake James and a population developed. Walleye stockings were halted after 1955 and the population was maintained by natural reproduction. Due to public pressure, the NCWRC resumed walleye stocking in 1980 to supplement natural reproduction. The objective of this study was to measure the contribution of stocked fingerling walleye in Lake James to the age-1 walleye population. Approximately 30,000 walleye fingerlings were marked with oxytetracycline hydrochloride (OTC) and stocked in Lake James in May 2000-2002. Verification of OTC marks from walleye held 30 days post-marking was 100% each year (N=100) and average mark quality was high. Gillnetting was conducted one year post-stocking in November 2001 and 2002 (2003 scheduled). In 2001, 53 age-1 walleye were captured and 3.7% were OTC marked. Data from the 2002 gillnetting sample have not been analyzed to date. Preliminarily, the proportionate contribution of stocked walleye in Lake James is low and is below the 25% management criteria used to determine stocking success. This study will be completed in 2003.

Largemouth Bass Population Dynamics in Clarks Hill Lake, Georgia – South Carolina

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Population dynamics of the largemouth bass fishery in Clarks Hill Lake, Georgia – South Carolina was studied in 1991 and 2001. Largemouth bass were tagged with Floy FM – 89SL internal anchor tags both years to determine rates of exploitation. Scales collected in 1993 and 2001 were used to determine growth rates. Annual spring electrofishing samples collected since 1989 provide historical population structure, catch rate, and condition indices data. A mail survey of Clarks Hill Lake anglers in 1994 provides insight on catch and release habits of

anglers. Largemouth bass exploitation decreased from 26.1% in 1991 to 14.1% in 2001. Since the early to mid – 1990's, annual electrofishing samples have indicated a trend toward greater catch rate and reduced size structure. Angler release rates, increasing from 50% in 1991 to 62% in 2001, impact largemouth bass population dynamics. A recent infestation of hydrilla and current drought conditions are likely impacting the population as well.

Winter habitat use and movement patterns in selected large river fishes

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Overwintering habitat is limiting in many large river systems. One solution for identifying critical habitat in large rivers is to monitor the movement patterns of dominant large river species. We initiated a radiotelemetry study in the Kanawha River, West Virginia in May 2000 in order to qualify movement patterns of large river fishes. Among species large enough to accept a radio tag, we selected the two most abundant species, the common carp and smallmouth buffalo, plus the game species flathead catfish, freshwater drum and hybrid striped bass. The objective of this paper is to show the winter movement patterns of these species during the winters of 2000-2002. We found that fish tended to use the main channel area over the shoreline areas. Additionally, fish tended to concentrate in the upstream areas of the pool rather than the downstream area. We feel that this is related to the cooler temperatures of the shoreline and backwater areas. Main channel areas are frequently disturbed by commercial navigation which may affect overwinter survival of fish. Understanding winter patterns of habitat use in large rivers is extremely important yet poorly understood. We hope that our research provides insight for planning flow regimes in large rivers.

The effects of seasonal water levels on recruitment of shad, largemouth bass, and crappie in Hugo Reservoir, Oklahoma

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The objective of this study was to determine the effects of maintaining high summer water levels (4.5 feet above conservation pool) on recruitment of largemouth bass *Micropterus salmoides*, shad spp. *Dorosoma* spp., and white crappie *Pomoxis annularis*. The study design called for holding elevation at normal pool (404.5 feet above sea level) for two years (1995 and 1996); followed by two years (1997 and 1998) with summer pool (April 15 to July 15) increased to 409.0 and the elevation held at 404.5 the rest of the year; followed by two years (1999 and 2000) with elevation held at 404.5. Elevation data were summarized as number of days elevation

exceeded target values (404.5, 406.0, and 409.0) by season and year. Seasonal elevation (number of days elevation exceeded target values) were regressed against mean monthly (June through September) estimates of age-0 shad from the trawl samples. Seasonal elevation data were also compared to age-0 crappie estimates from June trawl samples and fall trap-net samples. Largemouth bass recruitment was estimated using fall electrofishing. No relations were found between elevation and age-0 crappie catch in trawls or trap nets. Number of days above normal pool (404.5) in winter ($r^2=0.78$; $P=0.05$) and days above 406.0 in summer ($r^2=0.93$; $P=0.008$) were positively related to largemouth bass recruitment. Although not significant at the 0.05 level, largemouth bass recruitment appeared to be related to number of days > 409 in spring ($r^2=0.73$; $P=0.065$) and number of days >409 in summer ($r^2=0.69$; $P=0.08$). Linear regression indicated a significant relation between shad catch in trawls and number of days winter elevation exceeded 406.0 for all months tested ($r^2 > 0.85$ in all months). Results of this study indicated that a water level management plan that calls for holding water in the flood pool during winter and summer would enhance recruitment of shad and largemouth bass.

Modeling the effect of alternative harvest regulations on the New River muskellunge fishery

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Although most muskellunge *Esox masquinongy* fisheries are managed to produce trophy-sized fish, the regulations used to achieve this management goal differ markedly within the species current range. While minimum length limits as high as 50 and 54 inches have been established in some northern latitude systems, statewide 30-inch minimum length limits and 2-fish-per-day creel limits are in effect in many southern areas. We used the Beverton-Holt dynamic-pool yield model to evaluate whether altering these regulations might increase the production of trophy-sized fish in the New River, VA. Muskellunge growth rates were determined by aging and back calculation of cleithra, otoliths, and sectioned fin rays. Due to uncertainty associated with natural and fishing mortality rate estimation, results were generated assuming several different mortality rates. Angler support for a regulation change was ascertained during a creel survey conducted on the New River. We found that increasing the minimum length limit to at least 40 inches would increase the proportion of trophy fish catch and that most muskellunge anglers would support an increase in the minimum length limit. Because anglers rarely harvested 2 fish per day, decreasing the creel limit would have little effect on the New River muskellunge fishery.

Short-term mortality and dispersal of stocked fingerling largemouth bass

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To determine if stocking strategies are cost-effective, mortality and dispersal of stocked fish need to be evaluated. We tagged fingerling (30-46 mm) largemouth bass *Micropterus salmoides* with coded wire tags and stocked them at six sites (3,000/site) in a Texas reservoir to monitor dispersal and to determine if predation, starvation, and transport stress were important sources of mortality within the first days after stocking. For most stocked fish, dispersal was limited; however, a few stocked fish moved greater than 1500 m within 5 d. In addition, dispersal differed across sites. Mortality associated with transport stress averaged 4% after 72 h and did not differ among sites. Starvation was unlikely because most stocked fish fed within 12 h of stocking. Predation may have been a significant source of mortality at some stocked sites. Assuming only 10% of the predators were collected, greater than 20% of the stocked largemouth bass may have been consumed within 12 h of stocking. Individual predators consumed up to 1% of the stocked fish for a given site and predators included largemouth bass, smallmouth bass *M. dolomieu*, freshwater drum *Aplodinotus grunniens*, and white bass *Morone chrysops*.

Muddy waters: the angst of benthic lifestyles in southeastern fishes

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Summary of life history strategies within natural faunal assemblages can expose shared responses to environmental conditions. In a study of imperilment among Southern Appalachian fishes, a prominent pattern was disproportional imperilment in benthically-adapted fishes. Contingency analysis of spawning orientations—benthic, epibenthic, or pelagic—disclosed that imperilment was significantly higher in benthic spawning species ($n = 369$, Chi-Sq = 13.16, $df = 2$, $p = 0.0014$). Because excessive sedimentation is a ubiquitous problem in southeastern rivers, it was inferred that sedimentation could negatively affect reproductive success in benthic spawning fishes. A simple ANOVA experiment was used to test the effects of suspended clay fines on reproductive success in the tricolor shiner *Cyprinella trichroistia*. Spawning adults were placed in tubs with clay suspensions of 0 (control), 100, 300, and 600 mg/L. The sediment concentrations were derived from daily measures of suspended sediments within the range of the tricolor shiner. The response variable was the proportion of eggs and larvae spawned/mature ovarian eggs. Mortality was negligible; however, the numbers of spawns were inversely proportional to sediment concentrations ($R^2 = 0.99$, $p < 0.003$). By weighting the experimental results by the number of days above each sediment concentration during the spawning season, we estimated that 20% fewer eggs would have been laid (if conditions were like the controls).

While this is a simplistic extrapolation, it provides insight into how chronic sedimentation contributes to population extirpation, particularly in a short-lived species. Clearly, mitigation of excessive sediments is an important management action for the conservation and recovery of imperiled southeastern fishes that spawn in benthic habitats.

Evaluation of a 356 mm minimum size limit for redear sunfish, Merritts Mill Pond, Florida

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Virtually all legal redear sunfish *Lepomis microlophus* harvest was eliminated in Merritts Mill Pond from 1998 through 2002, with the implementation of a 356 mm TL minimum size limit. Total angler effort decreased substantially from 1991-94 to 1998-2002, most of which was species directed effort for redear sunfish. Sunfish composition changed dramatically from a population that was dominated by bluegill *L. macrochirus* (84%) prior to extreme drawdown (1990), to one that was comprised mostly of spotted sunfish *L. punctatus* (74%) following an extreme 18 month dewatering (1996) and finally to one in which redear sunfish comprised the majority (54%) by the end of this study. Relative weights of redear sunfish have declined significantly ($P < 0.05$) since implementation of the regulation, probably due to extraneous causes unrelated to the regulation. Mean length at age of redear sunfish indicated slower growth than previously determined and probably was one of the reasons very few fish ever reached the 356 mm TL minimum size limit. It was recommended to lower the minimum size limit to a more obtainable goal (254 mm) that would allow harvest of quality redear sunfish.

Littoral zone restoration of Lake Istokpoga: enhancing aquatic habitat, flood control, and water quality

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Lake Istokpoga, the fifth largest lake in Florida at 27,692 acres, produces a \$6 million sport fishery, provides flood protection, and is used as a water supply for agribusiness. Lake hydrology was modified as part of the Central and South Florida Flood Control Project and natural lake level fluctuation has not occurred since 1961. Four decades of restricted lake level

fluctuation resulted in the encroachment of over 1,800 acres of littoral zone by *Typha* sp. and floating vegetative mats (tussock) with associated organic detritus. Advanced succession of the littoral shelf reduced habitat required by fish and other wildlife, degraded water quality, impeded navigation and recreation, threatens flood control, and reduced lakefront property values and aesthetics. Major littoral zone restoration was accomplished during spring 2001, when 1,308 acres of tussock (21 miles of shoreline) were mechanically-removed during lake drawdown, and 2,370,320 yd³ of tussock/muck were either transported to upland sites or consolidated into in-lake islands. Project cost was \$2,749,690 or \$1.16/ yd³. Rapid lake refill to high pool occurred and cleared areas demonstrate improved water quality, recruitment of desirable aquatic plants, utilization by fish and wading birds, improved aesthetics, and other benefits.

Costs of doing business for North Carolina's northern commercial fishers

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From 1998 through 2001, the North Carolina Division of Marine Fisheries with funding provided by NOAA through the Atlantic Coastal Fisheries Cooperative Management Act conducted interviews with commercial fishermen from the Albemarle, Pamlico and Core Sound areas. Over 400 in-person and telephone interviews were conducted. The topics in the interviews included fishery participation, vessel characteristics, operating expenses, sociodemographics, anthropological constructs, and opinions about fishery management. This presentation will focus on expenses and business costs specifically related to blue crab, shrimp, southern flounder, and shellfish harvesting. Results will emphasize economic differences among species, locations, and self-reports of expenditures and profitability. Additionally, relationships among economic factors and sociological/anthropological variables such as community support, self-efficacy, and user group conflicts will be presented.

Managing spotted bass in a reservoir with a 15-inch length limit and high catch and release

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A 15.0-in minimum length limit on black bass *Micropterus* spp. in Table Rock Lake, Missouri was implemented in 1976 to improve catch rates for bass anglers and increase harvest rates of fish ≥ 15.0 in. Generally, this regulation is popular with anglers, who consistently release >50% of the legal bass they catch. Spotted bass *M. punctulatus* comprise about 20% of the

electrofishing catch of black bass, but they may contribute over half of the legal bass caught during some seasons. However, because they grow slowly (taking almost 7 years to reach 15 in), only 10-15% survive to legal length. Spotted bass, therefore, may be better managed with a lower minimum length limit. Results from equilibrium yield models indicate that a 12.0-in minimum length limit could double the number of spotted bass harvested yet would only decrease the number of 15.0 in and larger fish by 25-40%. However, the widely-held catch-and-release ethic of Table Rock Lake anglers, combined with the seasonally high catches of legal spotted bass, have made it difficult to convince anglers that other management options exist for spotted bass.

Urban fishing opportunities provided by Alabama's community fishing program

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The Alabama Division of Wildlife and Freshwater Fisheries has been partnering with communities and non-profit groups to make fishing available in local communities. During 2001-2002, Alabama had 59 partnered events attracting 10,800 participants. Local Kiwanis clubs or Departments of Leisure Services sponsor the largest events. Money to stock fish (catfish and feeder bass) and personnel to work the event are obtained from within the community. The Division does not stock fish for these events, but the Division does provide technical assistance, publicity, and equipment such as block-off nets and loaner rods and reels. Free tickets are used to control crowd numbers for events with limited space. These one-day events vary widely in size due to locations and demographics, and the fish stocked are usually available for other anglers after the event.

Interpretation of relative weight in two bluegill populations: a cautionary tale

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Our objectives were to discover generalizable relationships between relative weight (W_r) and physiological status in two wild populations of bluegills through an annual cycle. We hypothesized that differences in W_r would be related to variations in tissue composition (lipid,

protein and water) and weights of internal organs. Although statistically significant ($p < 0.05$), regression models did not explain much of the variability in W_r ($r^2 = 0.13$). The most significant variable was lipid content ($r^2 = 0.07$), although correlations fluctuated from 0.00 to 0.23 when parsed by season and population. Because the magnitude of unexplained variability limits the usefulness of W_r as an indicator of physiology, we examined the limitations of regression to detect such relationships. Specifically, functional relationships could be obscured by truncation of physiological data ranges typical of wild populations. We compared our data to those from a laboratory population of bluegills that had a high correlation of lipid content to W_r ($r^2 = 0.70$). Confining these data to a W_r range typical of our populations reduced r^2 to 0.21. We concluded that natural conditions can limit the range of physiological responses such that detecting functional relationships is difficult using data within or among similar wild populations.

Forage fish populations in Lake Jocassee during an extended drawdown

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Multiplexing hydroacoustic data for evaluation of forage fish distribution and density were collected during winter (November or December) and spring (March) mobile surveys of Jocassee reservoir from November 1998 through November 2002. This period included a significant reservoir drawdown resulting from recent drought conditions. Previous work indicated that a sustained drawdown greater than 4.3 m. might lead to increased fish entrainment at a pumped storage hydroelectric facility. We employed side-scan split-beam (insonifying the top 2 m of the water column) and down-looking dual-beam (insonifying from 2 m to bottom) transducers operated simultaneously to detect surface-oriented and deeper fish, respectively. Lake Jocassee was divided into three zones, the surface area of each was adjusted for diminishing lake levels, and an average fish density and population estimate calculated for each zone. Average zonewide densities of blueback herring and threadfin shad ranged from 9 to 3548 fish/ha. The lake zone comprising the Toxaway River arm of Lake Jocassee typically had the highest fish densities. Lakewide population estimates (the summation of the 3 zone estimates) for this oligotrophic reservoir ranged from 1.2 to 6.5 million fish. Population estimates in March of each year were typically low (except for 1999) and rebounded to approximately 4 million fish by November of each year. Lake levels as low as 7 m. below full pool did not appear to affect November population estimates.

Effects of hypoxia on habitat use of demersal fishes on the Louisiana Continental shelf

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The Mississippi River is a conduit connecting a drainage basin that encompasses much of the central United States with the northwestern Gulf of Mexico continental shelf. Large areas (15-20,000 km²) of hypoxic bottom water (dissolved oxygen <2.0 mg/l) are a re-current feature in the Gulf during the summer that may impact demersal species. We conducted a spatially intensive hydrographic and trawl survey during July 2002 in one region (~6,000 km²) of the hypoxic zone. This sampling effort was designed to provide a high-resolution map of dissolved oxygen in the study region and assess fine-scale (< 1-2 km) distributional responses of demersal species, particularly in relation to the hypoxic edge. Our results indicate the spatial structure of hypoxia is complex with reticulate edges and pockets of oxygenated habitat within the interior. There is considerable variation among species in the effects of low dissolved oxygen on habitat use, with evidence for avoidance and displacement both inshore and offshore of the hypoxic zone, and, in some cases, increased use of hypoxic regions and oxygenated interior habitats. Understanding distributional responses to low dissolved oxygen provides a basis for evaluating indirect effects of hypoxia on growth and mortality.

Exploitation of bluegill and redear sunfish in Lake Panasoffkee, Florida

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Annual exploitation (u) and total mortality (A) of bluegill *Lepomis macrochirus* and redear sunfish *Lepomis microlophus* was investigated on Lake Panasoffkee, Florida from 1998-2000. Average u of fish ≥ 15 cm was 0.14 for bluegill and 0.13 for redear sunfish during the two-year period. Exploitation increased with fish size for both species. Total annual bluegill mortality (A) increased from 0.36 in 1998 to 0.64 in 1999. Mean Total annual redear mortality increased from 0.53 in 1998 to 0.68 in 1999. Natural mortality (v) was estimated to be 0.48 (75% of A) for bluegill and 0.53 (78% of A) for redear. Modeling predicted that an 8-inch minimum size limit would decrease total harvest of bluegill and redear but would increase harvest of fish ≥ 20 cm for both species in both years. Creel surveys revealed a decline in the number of bluegill over 23 cm

in two years after angler effort was higher than average, suggesting that angler harvest could potentially alter population size structure. A minimum size limit would potentially reduce total harvest but could increase harvest of large fish.

Abundance trends of sub-adult American eel (*Anguilla rostrata*) relative to environmental factors in Northwestern Pamlico Sound and Lake Mattamuskeet, North Carolina

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American eel (*Anguilla rostrata*) has four life stages in coastal North Carolina waters. Yellow eel and silver eel have been reported in a variety of marine, brackish and freshwater habitats within and adjacent to Pamlico Sound. Lake Mattamuskeet, connected to the Pamlico Sound by four canals with water control structures, contains eels but abundance and habitat utilization have never been quantified. Seventeen permanent sampling stations were monitored in 2002-2003 for eels, water quality, and physical habitat attributes. Strong associations were noted between eel occurrences, water quality parameters, and location. A total of 298 eels were captured in the spring; the majority was collected in tidally influenced (Sound) habitats. The majority of the 116 summer eels were caught in tidally influenced habitats with high dissolved oxygen content and high salinity. High eel mortality was noted in the summer at locations with strong thermoclines, which produced hypoxic and anoxic conditions in bottom waters. Few eels have been collected from various lake habitats even though environmental conditions suggest that higher abundance should be present. Reasons for this apparent discrepancy between lake and canal abundances is unknown at this time; however, it is likely that lake eels are dispersed within a substantially larger habitat compared to the narrow canals. Water control structures may also play a role in lake access by migrating eels.

A national mercury database for marine species

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Mercury levels in fish and wildlife have long been a concern of the U.S. Environmental Protection Agency (EPA). EPA has been compiling state provided mercury tissue data over the last seven years; however, the majority of these data are for freshwater species. Information on mercury in marine species of recreational importance, is not readily available. In 2002, RTI International began compiling existing data on mercury concentrations from 6 national, 20 state, and 3 regional monitoring programs into a relational database with GIS mapping capabilities for EPA's Office of Wetlands, Oceans, and Watersheds. This new effort was undertaken to improve

understanding of the extent of monitoring in coastal areas and knowledge of mercury contamination in marine species. Preliminary data analysis has provided information on both the extent of monitoring in various coastal areas and on levels of contamination in a variety of marine species of recreational importance. The analysis also has identified species where little or no mercury residue data are currently available. EPA's Mercury Database for Marine Species can serve as a resource for state environmental, fish and wildlife, and public health managers who may use the information in identifying areas of contamination, designing monitoring efforts, and in evaluating public health concerns associated with mercury contamination in recreational species.

An aquatic outreach formula for success: North Carolina's urban fishing opportunities and outreach services

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The North Carolina Wildlife Resources Commission's Community Fishing Program, Tackle Loaner Program, and Fish-For-Fun Events have been integrated with the Commission's other aquatic outreach efforts to cultivate angler interest and increase angler participation in recreational fishing. The Commission has developed partnerships with the federal, state and local governments as well as private industry, conservation groups and private citizens to cultivate greater interest in fishing. In addition, the Commission operates a mobile aquarium and conducts special fishing events as outreach tools during National Fishing and Boating Week, established by the Recreational Boating and Fishing Foundation.

Is phenotypic variation in central stonerollers (*Campostoma anomalum*) related to ecological function?

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How environmental factors influence and change individuals within populations can have important implications for population dynamics. I hypothesized that adult and juvenile central

stonerollers (*Camptostoma anomalum*) would display phenotypic variation along a longitudinal gradient in Bear Creek, Arkansas. Fish were sampled from a downstream and upstream reach and compared using landmark-based geometric morphometrics on scaled photographs. Multivariate analysis of variance on partial warp scores, that describe uniform (parallel) and non-uniform (non-parallel) shape deformations between individuals, was used to determine differences among groups. Analyses showed significant differences in body shape between adults and juveniles within a location, as well as significant differences between locations for each size class. Individuals in the downstream location were more streamlined than in the upstream location and adults were more streamlined than juveniles. The results suggest a link between body form and ecological function that may be related to differences in discharge.

Assessment of water quality in Virginia's non-tidal streams using a probabilistic sampling design

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The Virginia Department of Environmental Quality's biological and ambient water quality monitoring programs have historically used a targeted approach for monitoring the Commonwealth's aquatic resources. This sampling method is necessary for monitoring regulatory compliance of pollution sources and tracking local pollution events. However, this method does not produce an unbiased view of Virginia's statewide water quality. In 2001, DEQ began a five-year probabilistic monitoring program for non-tidal streams. This program incorporates a random tessellation stratified survey design that allows us to produce an accurate assessment of chemical, physical, and biological conditions in 1st through 5th order streams. This is the first survey that will provide policy-makers and the public with estimates of the status of Virginia's aquatic resources with statistical confidence. Additional objectives include establishing ecoregion reference sites and conditions for integration into the current biological monitoring program. First year results include data from 60 sites that were sampled for benthic macroinvertebrates, physical habitat and water chemistry. Watershed land use was also evaluated at each site and will be utilized to locate ecoregion reference sites and to correlate land cover with water quality conditions.

Understanding catch and release fishing in Virginia reservoirs.

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In Virginia reservoirs, there are four principal fisheries: black bass (mostly largemouth bass), crappie, catfish (channel, blue, and flathead), and striped bass. Creel surveys conducted since 1994 indicate that voluntary catch and release fishing is prominent in black bass fisheries. Release rates of angler caught black bass typically range between 95-98% although in several smaller reservoirs (300-500 ha), anglers harvest 10-15% of black bass caught. Annual survival estimates for reservoir largemouth bass are usually greater than 70% and although largemouth bass are managed with a variety of length limits, populations seem to be affected more by environmental variables (productivity, hydrology, etc) than harvest. Conversely, anglers tend to harvest a higher percentage of crappie (71%), catfish (75%), and striped bass (42%). Population dynamics data on catfish are limited, but annual survival estimates for striped bass and crappie typically range from 40-60%. Despite the higher harvest rates, there are no length limits on any catfish population, one length limit on crappie, and a 508-mm minimum length limit statewide for striped bass. The propensity of catch and release in black bass fisheries virtually eliminates the effective use of length limits as a management tool. However, there may be an opportunity to use length limits to manage fisheries that receive a higher rate of harvest.

Using quality-augmented GEDD to analyze pelagic longline fishery regulations

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Fisheries managers seek cost-effective regulations to reduce bycatch in pelagic longline fisheries. Developing such regulations is complicated by significant price heterogeneity across longline target species and across quality grades within species. General Equilibrium Derived Demand (GEDD) analysis measures the net economic impacts of regulations affecting the interrelated landings of multiple species. We extend GEDD analysis to capture the economic impacts of changes in catch quality as well as catch quantity. The modeling framework is used to analyze the potential for improved catch quality to offset reduced catch quantity in regulated longline fisheries.

Atlantic needlefish *Strongylura marina* in Lake Mattamuskeet, North Carolina: evidence for anadromy?

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The Atlantic needlefish, *Strongylura marina*, is a coastal epipelagic species with little commercial or recreational value. A population exists in Lake Mattamuskeet, the largest natural freshwater lake in North Carolina. This coastal lake is connected to Pamlico Sound via 4 manmade canals, and fish access to and from the lake is controlled by water control structures. Based on anecdotal reports in popular literature and state reports, we believe that this species may exhibit anadromy and perhaps use the lake as a spawning habitat. Specimens were collected in 1997-1998, and 2001. Fish collected in the spring had a high gonadosomatic index (GSI) compared to those collected in the fall, which had post-ovulatory follicles (POFs). However, no eggs or young-of-year were captured in the lake during the summer. Examination of gut contents confirmed that the needlefish is a top level predator in the lake feeding mainly on soft-rayed fish. Age and growth work is progressing using otoliths; preliminary results will be presented.

Federal ecosystem restoration projects in a dredged creek and an urbanized estuary

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Dial Cordy and Associates is assisting the U.S. Army Corps of Engineers with Section 206 (Water Resources Development Act of 1996) aquatic ecosystem restoration projects at Mill Creek (Bryan County, Georgia) and Stevenson Creek (Pinellas County, Florida). Investigations elucidated the nature of impacts at the two sites, contributed to the establishment of ecological baselines, and allowed us to determine restoration needs and formulate remedial actions. The focal reach of Mill Creek, a rural freshwater stream dredged nearly four decades ago, exhibits low dissolved oxygen levels (<1mg/L), explosive production of floating vegetation (*Lemna* sp., *Alternanthera philoxeroides*), and low fish diversity (<6 spp.). Stevenson Creek estuary, in the City of Clearwater, has been severely impacted over the last century by depletion of vegetated riparian zones and wetlands, and siltation that resulted in deposition of up to 4 feet of muck in one reach. Restoration goals include enhancement of Essential Fish Habitat at Stevenson Creek by dredging muck, backfilling with sand, and creating mangrove islands. Our designs for restoration at Mill Creek include increasing residence time of waters in adjacent wetlands, backfilling some areas, and restoring sinuosity to areas of the stream. Fish assemblage characteristics will be used as success criteria for both aquatic habitat restoration projects.

NPS-ing the silt problem in the bud

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Sediment is the number one pollutant in water in Arkansas and in the United States, smothering fish eggs, fry, and fish food organisms to the degree that whole aquatic communities may be altered due to silt's negative impacts. Streambank erosion is one of the top five sources of sediment in streams. Fisheries biologists in Arkansas have been using a variety of stream rehabilitation techniques over the last 8 years to decelerate this input of sediment into their state's streams and other waterbodies in order to protect the high quality aquatic habitat still found in that state. While some of these techniques are relatively inexpensive to put on the ground (i.e. revegetating riparian zones), others may cost from \$100 to \$300/linear meter, and so partnerships to defray the expensive costs of rehabilitation are important. The authors partnered with one federal, one state agency, and 2 landowners to obtain Section 319 (Nonpoint Source Pollution Abatement - CWA) grant monies to survey and repair erosional sites on an Ozark stream. At one site, approximately 240 tons of sediment was kept out of the stream annually due to NPS-funded streambank rehabilitation. An example is also given of reducing sediment into a stream by funding an alternative watering source for cattle outside of the riparian zone. At one site, approximately 240 tons of sediment was kept out of the stream annually due to NPS-funded streambank rehabilitation. An example is also given of reducing sediment into a stream by funding an alternative watering source for cattle outside of the riparian zone.

Fish community response along a disturbance gradient

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Many streams in the Cheat River watershed are impacted by acid mine drainage (AMD). Fish communities in impacted reaches are greatly reduced in species richness and are dominated by highly mobile, tolerant fishes. We examined three streams that differ in the relative location and severity of AMD degradation. A small, aluminum-rich tributary enters Roaring Creek approximately at its midpoint. AMD is treated near Beaver Creek's headwaters is treated, however an abandoned mine discharge downstream gives rise to an assemblage of highly mobile, tolerant stream fishes. Muddy Creek is a large (~21,500 acre watershed) tributary to the Cheat River responsible for a large percentage of the acidity and heavy metals entering the Cheat River. The upper 12,000 acres of the watershed are unimpacted by AMD. AMD impacts downstream

reduce fish species richness compared to upstream reaches. Water quality improves downstream of the initial AMD inputs due to the flocculation of heavy metals and dilution of AMD. Fish communities respond to improved water quality until a series of AMD seeps eliminate fish populations in Muddy Creek. In the Cheat River watershed, fish communities are a useful indicator of AMD impairment to aquatic systems.

Is it a big lake or a small ocean? An application of early-life history data to fishery management in Lake Michigan

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Annual recruitment variability in fishes is often significantly affected by survivorship during the larval phase. This is particularly true of marine fishes that produce small pelagic larvae, which are widely dispersed and subject to a highly variable environment. Yellow perch (*Perca flavescens*) is a freshwater fish that produces small pelagic larvae similar to marine fishes and is found in systems varying in size from 1 to 52,000 km². However, most of the population analysis for yellow perch has been conducted in systems close to the small end of this continuum. Can we rely entirely on experience and data collected in smaller systems when we address management of perch populations in a larger system like Lake Michigan (i.e., big lake approach), or is it more productive to turn to lessons learned for similar species in the marine environment (i.e., small ocean approach)? The latter assertion is supported by evidence for offshore advection driven by wind events, inshore-offshore zooplankton differences, a latitudinal gradient in hatch dates, and genetic data suggesting population mixing. These data form the basis for a series of broad management recommendations based on lessons from comparable species in the marine environment.

Effect of heating rate on measurement of chronic lethal maxima in rainbow trout, brook trout and brown trout

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Thermal tolerance in fish is commonly assessed by measurement of critical thermal maximum (CTMax) – the average temperature at fish reach loss of equilibrium (LOE) under conditions of rapidly increasing temperature (8 to 24 °C per day). Similar evaluation using a slower heating

rate (1 to 2 °C per day) is termed a chronic lethal maximum (CLMax) test. Although logistically more difficult, CLMax has been promoted because the test conditions more closely resemble the stress of extended exposure at slowly increasing temperatures which fish experience in a natural or culture system. To test the effect of heating rate on thermal maximum measures in salmonids, groups of rainbow trout, brook trout and brown trout were simultaneously exposed in tests with heating rates of 24, 8, 4 or 2 °C per day. At 24 °C per day, average time to LOE was lowest in rainbow trout and greatest in brown trout. At 8, 4 and 2 °C per day, the order for rainbow trout and brook trout was inverted, and the differences between species became increasingly distinct as heating rate decreased. Measurement of chronic lethal maximum using a slow heating rate (2 °C per day) provided the greatest sensitivity to differences in thermal tolerance between trout species.

Do angler's tell the truth? Examining revealed and stated preferences for conservation

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There are many reasons an angler might catch and then release a particular fish species. The angler may choose to release a fish because it is not suitable for his consumption, he may be forced to release the fish due to regulations, or he may choose to release the fish voluntarily for conservation reasons. The National Marine Fisheries Service (NMFS) collects catch and effort data from recreational anglers through its Marine Recreational Fisheries Statistics Survey (MRFSS), including information on released fish and the reason for release. As a result, NMFS has data on an angler's revealed preference for conservation. Through a series of economic add-on surveys to the base MRFSS, NMFS has collected stated preference data on the same conservation decision. A simultaneous probit system is used to analyze the decision to actually release a fish for conservation purposes contingent on the angler's stated preference for conservation. The preliminary results show that while the decisions are linked, the linkage is relatively weak.

Economic impacts of marine recreational angling in North Carolina

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In 1998, the National Marine Fisheries Service (NMFS) launched the first marine recreational angler expenditure survey in the Northeast (NE) management region. This series was extended to the Southeast (SE) management region in 1999. These surveys were designed to collect the data needed to estimate average and total angler expenditures, by state and resident status, on trip expenses and durable goods for use in economic impact assessment. IMPLAN was used to

estimate the economic impacts of these expenditures. Across the United States (US) anglers spent \$20.4 billion with the SE contributing \$12.5 billion. North Carolina has the second highest expenditures in the SE after Florida and the third highest in the US after Florida and California. Anglers in NC spent \$170 million on trip expenditures and \$1.4 billion on durable goods for a total of \$1.6 billion in 1999. Selected economic impact estimates will be presented for the state of North Carolina.

Oklahoma's "Close-to-Home" fishing program, a city-state partnership

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The Oklahoma Department of Wildlife Conservation (ODWC) and the Oklahoma City Parks and Recreation Department (OCPR) are working cooperatively to enhance fishing opportunities in the greater OKC metro area under a "Close-to-Home Fishing Program" Memorandum of Understanding. The OCPR employs a full-time fishery biologist who oversees a fish rearing facility, conducts fish population assessments on city ponds and lakes, and teaches youth fishing classes. Expenditures of the OCPR program are being used as in-kind match for ODWC Sport Fish Restoration funds. This is allowing for expanded summer channel catfish and winter rainbow trout stockings, improvements in fishing access, and an increase in Aquatic Resources Education fishing clinics and outreach events.

Fish passage through water control structures into a North Carolina Coastal bay lake

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Lake Mattamuskeet, located in Hyde County, NC, is a unique coastal bay lake in that it is connected to Pamlico Sound via four manmade drainage canals. Situated in each canal is a concrete water control structure (WCS) containing 3-7 flap-gates. Fish passage through one of these canals was monitored using specially designed fish traps from March 15 to May 7, 2001. During this period, 306 fishing hours yielded 5808 organisms, representing 19 species. Target species were white perch *Morone Americana* and alewife *Alosa pseudoharengus*, and constituted 49% and 16% of the total catch respectively. Drought conditions during 2001 however, prevented the flap-gates in the WCS from opening during the summer and fall. Between July 1 and December 31, 2001, the flap-gates opened for a total of only 8 hours. This prolonged period of closure prompted an experimental pilot study in which one gate was manually opened. During 21.5 fishing hours approximately 10,967 fish and invertebrates representing 25 species were

captured. Management recommendations to the staff at Lake Mattamuskeet National Wildlife Refuge include installing a winch system on the flap-gates to allow manual opening during critical migration periods of certain anadromous species utilizing Lake Mattamuskeet as a spawning ground.

Are fishes and shrimps significant sources of ammonium in tidal salt-marsh creeks?

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In general, nekton are known to influence ecosystems through their processing of organic matter. Consumption of prey has been relatively well studied, but the associated release of by-products to the water has not. Thus, the potential for nekton to impact nutrient cycling has received little attention. To address this question, we quantified ammonium generation by nekton in North Inlet Estuary, SC, using a combination of field and mesocosm experiments. In the field, excretion was measured in closed experimental chambers. In laboratory experiments, we determined the relative importance of nutrient generation through excretion and sediment resuspension related to the animals feeding activity (bioturbation). Excretion was identified as the major mechanism for ammonium generation by nekton, and rates distinctly differed among species. Overall, ammonium production by the nekton assemblage was distinctly higher in summer, when nekton biomass peaked, than in winter. These values will be compared to ammonium concentrations measured in North Inlet creeks and to amounts generated by other ecosystem components to determine whether nekton are primary sources for dissolved nitrogen in the system.

Effects of a severe drought on fish populations in three small streams of the Piedmont, NC

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The Piedmont region of North Carolina suffered severe drought conditions during 2002. By comparing the results of surveys from previous years with those completed during summer and fall 2002, *Youth Partners* will investigate the effects of the drought on three small Piedmont streams. For each stream, *Youth Partners* will compare species richness and diversity, total number of individuals captured, relative abundance of sunfish/bass, suckers, minnows, and other families in each sample, relative abundance of pollution tolerant/intolerant species, and relative abundance of insectivores, piscivores, and omnivores. Indices of community similarity will also

be used to relate pre-drought populations with current samples. Stream sampling has been completed and data analysis should be complete by mid-December, 2002.

Seasonal movements of American eels in Shenandoah River, West Virginia

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The Atlantic States Marine Fisheries Commission recently listed research needs, including analysis of movements, to address management and conservation issues concerning the apparent population decline of American eel, *Anguilla rostrata*. We surgically implanted radio tags into 13 yellow eels (518-810mm TL) during fall 2001 and into seven yellow eels (362-781mm TL) in 2002. These eels were captured, tagged, and released in the Shenandoah River below Millville Dam, West Virginia. Eels were relocated weekly for 16 months using triangulation techniques. Movements of each eel were measured and tabulated per month and season. Movements in spring were associated with changes in water temperature and stream flow. Several eels overwintered near mouths of tributaries with warmer water temperatures (~2-3°C warmer) than the mainstem.

Winter distribution of Gulf of Mexico sturgeon and their benthic prey resources

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The Gulf of Mexico Sturgeon is an anadromous fish seasonally inhabiting rivers and coastal areas in the Gulf of Mexico. After residing in the Suwannee River from late spring through early fall, Gulf sturgeon migrate out into the Gulf of Mexico. The present study examines the distribution of Gulf of Mexico Sturgeon and their prey resources in the Suwannee River estuary and nearshore Gulf of Mexico. Twelve of eighteen Gulf sturgeon ultrasonically tagged in the spring of 2001 were relocated in the Suwannee estuary from November 7th through December 19th 2001 and then again from March 14th through April 17th 2002. Fish could not be located in the Suwannee Estuary during the months of January and February. Gulf sturgeon relocations in the Suwannee estuary were compared to the distribution of benthic invertebrates, especially identified prey resources, and to environmental parameters such as salinity, temperature, depth, and dissolved oxygen. When fish were relocated, they were generally found within 1km of the shore, in depths less than 4 m. These inshore areas were found to have higher densities of invertebrates including those species that have been identified from Gulf Sturgeon feeding habit studies.

Youth and fishing in South Carolina

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This study assessed South Carolina youths' attitudes toward, opinions on, knowledge of, and priorities toward South Carolina aquatic resources and recreational fishing. A telephone survey was administered to youth between the ages of 8 and 18 in South Carolina to examine fishing initiation, motivation, and fishing participation rates among South Carolina youth. Overall, a majority of youth (91%) in South Carolina had fished at least one time in their lives and a majority (53%) of youth would go fishing more often if they could. More male youths participated in fishing than female youths in the past twelve months, and fishing participation and interest decreased as grade cohort increased. There was also a steady decline in interest level in learning about fishing as grade level increased. Survey results indicated that youth fishing occurs almost entirely in the familial context and initiation occurs almost universally through the youth's father or other male family member. A greater proportion of youth in grades 1-4 (23% relative to 16% in grades 5-8 and 10% in grades 9-12) indicated that they fished "to catch fish." As age increased, "to catch fish" became an ever increasingly unimportant reason for fishing. Only ten percent of South Carolina youth could correctly identify the South Carolina Department of Natural Resources as the state agency that managed and conserved wildlife. The results of this study will be used by the South Carolina Department of Natural Resources (DNR) to develop effective aquatic education and fishing programs for youth.

Conservation status of fish and other aquatic resources in the upper Tallapoosa River system, AL

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The native aquatic fauna of the upper Tallapoosa River system (GA and AL) faces present and potential threats from land use changes associated with an expanding human population. U.S. Fish and Wildlife Service considers six fishes, two mussels and two crayfishes to be "at-risk" species in the system. Relative abundance data for the at-risk species were compiled and

augmented with additional field surveys. Thirty-six sites were sampled in 2002 and data were incorporated into our database. Of particular interest was the documentation of fine-lined pocketbook *Lampsilis altilis*, a federally threatened mussel, at 10 new sites. Beech Creek was one of the sites where populations were found; it is the most likely site for a new reservoir. Of the six fishes, stippled studfish *Fundulus bifax* and lipstick darter *Etheostoma chuckwachatte*, were the most limited in distribution (11% and 22% of all sites, respectively). Although muscadine darter *Percina c.f. maculata* sp. was widespread (69% of sites), it was not abundant (2% of all fish in samples). Endemic crayfishes (*Cambarus englishi* and *C. halli*) were also limited in distribution (23% and 36% of sites, respectively). These data will provide a baseline to assess changes in faunal composition with respect to anthropogenic disturbance.

Vegetated filter zones can be greatly improved for sediment and nutrient detention

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From 1989 to 2002, a series of studies was conducted in the Piedmont and Coastal Plain of North Carolina to evaluate the potential to improve the ability of vegetated filter zones (VFZ) to detain sediment and nutrients reaching surface waters from agricultural sources.

The main objective of this research was to evaluate different level spreader designs and configurations for dispersing channelized agricultural runoff and to evaluate them for enhancing VFZ effectiveness. Other objectives included estimating construction and maintenance costs and developing design recommendations. Both forested filter zones (FFZ) and grassed filter zones (GFZ) were evaluated separately and in combination. On one pair of watersheds, a secondary objective was to compare the effectiveness of a recently clear cut FFZ with a FFZ with a mature stand of pines and hardwoods. GFZs functioned very well in retaining solids and nutrients in early summer, but seemed to overload during late summer. FFZs were able to back up the up-slope GFZs when they overloaded. In combination, GFZs and FFZs retained 80 to 95 percent of all sediment and nutrients entering the zones - an extremely effective combination. Vegetation in the cut-over FFZ more than doubled its capacity to effectively retain sediments and nutrients, as compared to when the same zone had a stand of mature mixed pine-hardwood.

A sediment sampler design for monitoring impacts of road construction

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Sedimentation affects fish populations in Appalachian streams, but is difficult to quantify. We designed a sediment sampler with a 4-inch PVC union and removable sediment trap. We conducted a pilot study to determine the efficacy of our samplers by placing 12 samplers upstream and 12 samplers downstream of a current highway construction site. Six samplers were placed in riffle habitat, and six samplers were placed in pool habitat at each site. Sampler bases were embedded in the streambed, and sediments from removable traps were collected without disturbing the surrounding substrate. After a 6 week period sediment samples were collected, dried, and sieved through a set of nested sieves (US Standard Sieve No. 4, 8, 14, and 20). Sediment averaged 123.7 g (SD 77.1 g) for upstream samplers, and 305.4 g (SD 83.7 g) downstream of construction. For each size class, downstream sedimentation significantly exceeded that of upstream reaches ($p < 0.05$) for combined samples. The amount of fines (< 2.28 mm) downstream significantly ($p < 0.05$) exceeded those collected upstream for pool, riffle, and combined samples.

Catch and release attitudes of the Georgia BASS chapter federation

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Some biologists have been concerned that excessive catch and release of legal bass, particularly below slot limits, has hindered our ability to manage bass populations. If resource agencies are to convince anglers to routinely harvest fish, surveys identifying the real reasons anglers practice catch and release will help focus marketing and management efforts. The Georgia B.A.S.S. Chapter Federation (GBCF) is a competitive fishing organization comprised of over 120 bass clubs from throughout the State of Georgia. During April 2002, an informal survey was administered to GBCF anglers to learn more about their attitudes and opinions on catch and release when they were not fishing in tournaments. Not surprisingly, a majority of GBCF anglers practice catch and release regardless of the fishing situation. Anglers indicated the primary reasons they practiced catch and release were related to conservation, or to expectations of increasing the quantity and quality of bass in a fishery. Fish consumption advisories, resource agency concerns, and media sources such as television programs and magazines, ranked lower than conservation related reasons for practicing catch and release.

Seasonal movement and habitat selection of smallmouth bass *Micropterus dolomeiu* in the Holston River drainage

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Seasonal movements and habitat selection of smallmouth bass were studied in the North Fork, South Fork, and mainstem of the Holston River in northeastern Tennessee. In November 2001 twenty-five adult smallmouth bass were fitted with internal radio transmitters and tracked through November 2002. Fish locations and macro-habitat types were digitally mapped and analyzed using ArcGIS 8.0. This study area provided the opportunity to observe behavior of smallmouth bass in a regulated river (South Fork) and an unregulated river (North Fork) that differed in discharge and temperature regimes. The presence of a no-fishing zone on a section of the Holston River also allowed for observation of fish movement and habitat selection within a refuge. During spring, fish made migrations exceeding 16 km. Fish only frequented the North Fork of the Holston River during the spring spawning season. Although some fish were located in the no-fishing zone, no fish remained in that protected reach for the entire year.

Does voluntary catch and release render largemouth bass harvest restrictions useless?

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Voluntary catch and release of largemouth bass *Micropterus salmoides* has increased among anglers over the last 20 years. We evaluated the potential for harvest restrictions to improve a largemouth bass fishery under high rates of voluntary release. We tagged 2,650 largemouth bass ≥ 345 -mm TL to estimate exploitation at Rodman Reservoir, Florida, during 2000-2002. Monetary rewards for tag returns ranged from \$5 - \$100. Total mortality of largemouth bass was estimated from a catch curve and gender-specific growth rates were determined from annuli on sagittal otoliths. An age-structured model was used to simulate the response of the fishery to various harvest restrictions. Although 42% of largemouth bass ≥ 356 -mm TL at Rodman Reservoir were caught by anglers in 2001, exploitation was only 11%. Total annual mortality was estimated at 49%. Length-specific exploitation rates indicated increasing exploitation with fish size. Simulations showed that a catch and released regulation would increase overall total catch (fish ≥ 254 -mm TL) by 12% and catch of memorable-sized fish (fish ≥ 510 -mm TL) by 91%, over the current 356-mm TL minimum length limit. Despite relatively low exploitation

(11%), simulations indicated that a complete catch and release regulation would increase angler catch rates and the occurrence of memorable sized fish in the creel.

Habitat use by three darter species in a Piedmont stream

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We quantified factors affecting microhabitat use for three darter species in a 116m reach in a Piedmont stream, via underwater observation and macro-invertebrate benthos samples, from 24 October, 2001 to 6 December, 2001. Analyses of habitat availability data demonstrated that the reach consisted of a gradient of microhabitats ranging from high velocities and high amounts of small cobble and vegetation, to high amounts of silt and debris. Principle component analysis indicated *Percina nigrofasciata* avoided low velocities and areas with substantial amounts of silt, debris, bedrock and small cobble. *Etheostoma inscriptum* preferred lower velocity microhabitats with lesser amounts of silt, debris, and bedrock, and greater percentages of small cobble. *Etheostoma olmstedii* preferred areas with little bedrock or small cobble. Univariate tests indicated that intermediate sized *P. nigrofasciata* (i.e., 40-50mm, SL) occupied microhabitats with more sand and lower velocities than larger specimens (>50 mm SL). Inter-specific canonical analysis of discriminants indicated that *E. inscriptum* occupied microhabitats with the highest average and bottom velocities and higher amounts of small cobble, whereas *E. olmstedii* occurred in microhabitats with the opposite characteristics. *Etheostoma olmstedii* and *P. nigrofasciata* also occurred over sandier microhabitats than *E. inscriptum*. The role of these differences in coexistence of these species is currently unknown.

Estimating the size of anadromous fish spawning runs using stationary, side-looking hydroacoustics

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Estimates of spawning run sizes for anadromous fishes are difficult to obtain using traditional methods such as capture-recapture. In this pilot study, we evaluate the effectiveness of stationary, side-looking hydroacoustics for estimating the size of hickory shad, striped bass, and American shad spawning runs in the Roanoke River, NC. Hydroacoustic gear was operated during March-May 2001 and provided counts of upstream-migrating fish that were apportioned among species using ancillary catch data from a fishwheel. By estimating the fraction of the river that is sampled and the detectability of upstream-migrating fish, counts are adjusted to produce estimates of run size. Hydroacoustic data showed that migrating fish were evenly distributed across the river channel and that most fish moved upstream within 1.5 m of the bottom, permitting a more refined estimate of the sampling fraction. For striped bass, we also found that the number of fish moving upstream varied substantially throughout the run and that most fish moved upstream during the night. In general, estimates will be most accurate when hydroacoustic sampling is conducted continuously, in order to account for important spatial and temporal patterns.

Efficacy of stocking Florida, F1-hybrids, and Northern largemouth bass fingerlings using oxytetracycline marking techniques

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Nearly 128,000 largemouth bass fingerlings were stocked in May 2002 in four embayments of Chickamauga Reservoir, a mainstream impoundment of the Tennessee River. Fish were marked in transit with 500 mg/L of oxytetracycline (OTC) for 6 h. The OTC marks were visible on 100% of the 240 treated bass held for 30 d. Two embayments were stocked with the Florida subspecies of largemouth bass, one received F1-hybrids, and one received the Northern

subspecies. Two other embayments were not stocked and served as control sites. Largemouth bass fingerlings were sampled approximately 20, 60, and 140 d after stocking along fixed transects in each embayment using DC electrofishing gear and a hand-held anode. Rapid dispersal was observed in one embayment, where 38% of the recaptures occurred more than 700 m away from the stock site after only 20 d. A preliminary analysis of the electrofishing samples and recapture data indicates that stocked largemouth bass represented about 15% of all age 0 largemouth bass observed in the first series of electrofishing samples.

Evaluation of angler and fish population response to a 305 mm minimum length limit for black crappie on Lake Monroe, Florida

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A 305 mm TL (12") minimum size limit was imposed for black crappie on Lake Monroe on 1 July 1998 with the intention of creating a "quality" crappie fishery, thereby increasing angler effort. Concurrently, the statewide bag limit was reduced from 50 to 25 crappie per day. Previous studies on Lake Monroe indicated fast growth and high catch success for the species. Creel surveys were conducted to measure changes in angling pressure. Angler effort was expected to decrease initially but rebound as numbers of quality fish were recruited to a legally harvestable size. Although overall success rates increased, angler effort has remained at a much lower level than pre-regulation estimates. Fish population variables were measured with samples collected by electrofishing. Length-frequency distributions showed an increase in modal size during the initial years of the rule change, but the percentage of fish ≥ 305 mm did not increase. Annual total mortality estimates decreased after the rule was implemented. However, due to only one year of pre-regulation data, the variability of crappie recruitment, and no angler exploitation data, changes in the estimates' significance were considered inconclusive.

Where are they now? Participation decisions of displaced Louisiana gill-netters and implications for multi-fishery management strategies

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In August of 1995 the Louisiana Legislature passed the Louisiana Marine Resources Conservation Act of 1995 (Act 1316), which imposed restrictions on the issuance of strike net (gill net) licenses based on prior licenses held, history of fisheries violations, and share of earned income from fishing. To ascertain the effect of Act 1316 on participation of Louisiana's commercial strike/gill net fishermen in various fisheries, license data from the Louisiana

Department of Wildlife and Fisheries was analyzed to track the license purchases of strike/gill net fishermen affected by Act 1316. Of 1,046 licensed gill netters in 1994, the last year before passage of Act 1316, 675 (65%) were still licensed as commercial fishermen in 2001. License data illustrates that those individuals who remained in the commercial fishing industry increased their participation in the oyster, blue crab, shrimp, and set-line/long-line fisheries by varying degrees. This presentation documents the shifts by license type and recent landings data and analyzes age, tenure in a fishery, and geographic location as factors which may have influenced participation decisions.

Evaluation of the capacity for compensatory growth in black sea bass (*Centropristis striata*) and southern flounder (*Paralichthys lethostigma*)

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Compensatory growth (CG) refers to the ability of individuals to accelerate growth rate following periods of nutritional deprivation. We examined the use of cyclical feeding regimes to elicit compensatory growth in two promising aquaculture species: black sea bass (*Centropristis striata*) and southern flounder (*Paralichthys lethostigma*). During Phase I, 60 juveniles of each species were divided into 3 cyclical feeding treatments and one control group (unlimited ration). Treatment groups were starved for either 2, 5 or 8 days, refed until consumption rates returned to control levels, and then starved again. Treatments were examined for their ability to elicit hyperphagia and CG following at least 3 feed/no feed cycles. During Phase II, deprived treatments were returned to unlimited ration and monitored for additional compensation relative to controls. Preliminary analyses indicate that capacity for CG is minimal in both species. Following Phase 1, controls were larger than deprived treatments for both species, suggesting that cyclical feeding regimes did not elicit a strong compensatory response. Controls maintained their size advantage following Phase 2, further indicating low capacity for compensation. Lipid analyses reveal different patterns of energy allocation in these species.

Post-tournament mortality and movement of black basses

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Most information on mortality of black basses, *Micropterus spp.*, captured in tournaments has been derived from relatively large circuit tournaments (CTs), as opposed to smaller tournaments

run by “local” bass associations (LTs). Information on the movement of black basses following release after tournaments is lacking. We determined mortality of black basses, captured in LTs and CTs held on Lake Dardanelle and Lake Ouachita, Arkansas. Post-release movement of black basses, captured in LTs and CTs, was determined only within Lake Dardanelle, Arkansas. Twenty-two tournaments were sampled from May-September 2002. Specimens were collected, tagged, and held in cages for a period of seven days. Mortality rates were recorded as either initial, post weigh-in, or delayed. Delayed mortality of fish ranged from 0% to 66%, with a mean value of 37% in the LTs. In the CTs, delayed mortality ranged from 29% to 80%, with a mean value of 50.5%. Adjustments, using control fish mortality, lowered the mean value for LTs to 11.4% and that for CTs to 17.2%. Movement trends were determined from twenty-three tag returns. Initial findings show most fish were recaptured proximal to release sites.

Are harvest restrictions promoting catch and release?

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The use of harvest restrictions to manipulate bass populations has been a common practice among state natural resource agencies since the early 1990's. At the same time, the “C&R” (catch-and-release) phenomenon gained overwhelming popularity. However, the latter often renders the former ineffective. An example of harvest restrictions promoting C&R is demonstrated on two similar, adjoining lakes in south central Arkansas. Upper and Lower White Oak Lakes are separated by a single levee. In 1994, a 16-21 inch slot limit and daily creel of 4 (only one of which can be larger than 21 inches) was implemented on Lower White Oak Lake in order to create a trophy largemouth bass fishery. Upper White Oak Lake continued with unrestricted harvest up to the statewide creel of 10 largemouth bass. However, trends from annual sampling of both impoundments revealed no significant differences in PSD's, RSD's, CPUE, age and W_r between the two populations in the nine years since implementation of the trophy regulations. Creel data from 1996 demonstrated that following the implementation of the trophy regulations, anglers on Upper White Oak Lake began voluntarily releasing bass. Although no deleterious effects occurred on either bass population due to the exceptional growth and recruitment of the White Oaks, many lakes in Arkansas are difficult to manage with harvest restrictions in the face of C&R.

Status of urban and community fishing programs in the southeastern U.S.

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Most states have developed urban or community fishing opportunities in towns and cities where suitable aquatic resources exist. We define these local-level urban or community fisheries endeavors as projects; for example, the urban fisheries activities in a single city or county. We define urban fisheries programs as the overall coordinated activity functioning at the state-wide level. In other words, an urban fisheries program may include many urban fisheries projects. Benefits of urban fisheries programs include uniform objectives and priorities among urban fishing opportunities, increased accountability, better ability to program activities (e.g., biologist time, hatchery fish), and control of program development and expansion. This study reports on the status of urban fisheries in the Southeastern U.S. at the programmatic level. Based on survey results from fisheries agencies, we report on the different forms and operations of urban fisheries programs. Specifically for each state agency responding we will document whether 1) agencies have a programmatic focus to urban fisheries, 2) what this program is named and its current goals, 3) whether there is a designated urban fisheries coordinator, 4) how many cities/towns have projects now and at inception of the program, 5) how many projects have been removed from the program, 6) average water bodies managed per project, 7) whether there are designated urban fisheries biologists, 8) whether any cost/benefit analysis has been conducted of the statewide program, 9) how the statewide urban program is evaluated vis-a-vis individual projects, and 10) future goals of the statewide urban fisheries program.

Hydropeaking flow regime: a determining factor on Brown trout and nongame abundance

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The Smith River tailwater (Bassett, VA) supports a self-sustaining Brown trout population and 34 nongame species. Hydropeaking regimes varied widely during 2000, 2001, and 2002. Corresponding electrofishing data shows population estimates and relative abundances (fish per 100 m) were greater in 2002 than 2001 and 2000 at the majority of 12 sampling sites 0.5 to 23.0 km below Philpott dam. June population estimates for age-0 brown trout were significantly greater at 8 of 12 sites and nongame were greater at 10 of 12 sites, though not all significant. Abundance during October was greater at 10 of 12 sites for age-0 and 8 of 12 sites for nongame; by as much as 117 age-0 and 641 nongame per 100 m. The hydropeaking regime from January 2000 through May 2001 was a 7-day/week, 1 hr, 1300 cfs release (50 cfs baseflow). The magnitude declined to a 5-day/week, 2-10 hr, 700 cfs release from June into November 2001. Flow increased to a 5-day/week, 3-4 hr, 1300cfs release in November until February 2002. Flow for the rest of 2002 was only a 5-day/week, 1 hr, 700 cfs release. This reduction in peak flow magnitude may be the cause of increased fish abundance in 2002.

Taking institutions seriously: using the IAD framework to analyze fisheries policy

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Historically, the fisheries management literature has been dominated by three competing paradigms or approaches to fisheries management: the traditional centralized bureaucratic model favoring centralized government regulation; a market-based model favoring individual transferable quotas (ITQs); and a community-based model advocating the self-regulation of fish stocks. In recent years, co-management has emerged as a fourth approach for managing fish

stocks. Co-management represents an emerging hybrid that borrows techniques utilized by the other three approaches in varying degrees with property rights playing an important role. This paper examines these four competing approaches to fisheries management using the Institutional Analysis and Development (IAD) framework. Our analysis demonstrates that the IAD framework is a useful tool for analyzing fisheries policy because it uses multiple measures of success and draws attention to the full range of transaction costs that influence the development and implementation of fisheries management programs. If new fisheries management strategies such as co-management are to take hold and flourish, researchers and practitioners must pay closer attention to questions surrounding institutional design and performance. This will improve our understanding of the relationship between science and human values in decision making. It will also help researchers and practitioners avoid making faulty policy recommendations.

Can stocking be used to assist in the management of red drum?

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There is skepticism among some fishery managers about the role that stocking can play in the recovery of the over-fished red drum population. These doubts are exemplified by the fact that the impact of a large red drum stocking program in Texas is not even considered in the management plan for the Gulf of Mexico. For more than a decade, researchers in South Carolina have focused on systematically addressing the impacts of stock enhancement.

In a series of experiments it was shown that stocked fish survive through at least age 2 at the same rate as wild fish and that stocked fish survived and were collected in spawning aggregations up to 6.5 years after release. Further, using historical abundance data researchers were able to demonstrate that stocking increased abundance and wild fish were not displaced by release of hatchery fish. Genetic analysis of the wild population demonstrated that each year class was dominated by a small number of families, which is similar to what happens in a hatchery program.

These data indicate that stocking may be useful for increasing abundance of the population. However, stocking must be used in conjunction with traditional management measures designed to prevent over harvest.

**Habitat use and movement patterns of hatchery-reared juvenile robust redhorse
Moxostoma robustum released in the Ocmulgee River, GA**

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Radio telemetry was used to evaluate the habitat preference and movement patterns of hatchery-reared juvenile robust redhorse *Moxostoma robustum* released into the Ocmulgee River, Georgia. On March 19, 2002, 30 juvenile robust redhorse were implanted with radio transmitters, released immediately downstream of Lloyd Shoals Dam, and tracked for 90 days with a programmable scanning radio receiver. Habitat use was divided into broad categories of substrate and cover. Average daily movement (in river kilometers; RKM) was determined by plotting changes in latitude and longitude of tracked fish on Delorme Maps® software. Tagged fish were found most frequently over cobble / gravel substrates (70% of all substrate observations) and near woody debris (70% of all cover observations). Overall, most tagged fish moved an average of < 1.0 RKM daily. Specifically, 15 fish moved 0.0 - 0.1 RKM daily, nine moved 0.1 - 1.0 RKM daily, and six moved 1.0 - 2.0 RKM daily. At the end of the study, 70% of the tagged fish remained within the 30-km study site. Of the 10 fish that left the study site, the furthest downstream signal was found near Warner Robbins, GA, about 15 RKM downstream from the release site.

Reintroduction and monitoring of Barrens topminnows

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The Barrens topminnow *Fundulus julisia* is native to spring pools in the Barrens Plateau Region of middle Tennessee and wild populations are known to exist at only four locations. State, federal, and private conservation organizations have cooperated to breed Barrens topminnows in captivity and stock them into new sites in two watersheds. Receiving sites were sampled to determine the composition of resident fish communities. Riparian zones, water quality, and aquatic vegetation communities were also surveyed. Since 2001, more than 1,000 Barrens topminnows have been released at eight springheads. All topminnows were batch-marked with elastomer tags to monitor dispersal and survival and to distinguish stocked fish from subsequent offspring, if any. During summer months at some sites, topminnows could be monitored visually. At other sites and times of year, persistence was determined using a seine, electrofishing gear, and minnow traps. Stocking has been deemed successful at half the sites based on the presence of stocked fish one year later. Those sites were similar in terms of having enough slackwater habitat, moderate amounts of vegetation, and few predators. Persistence and movements of stocked topminnows will continue to be monitored as new cohorts of fish are reared and stocked into additional spring sites.

Effects of electrofishing on injury and mortality of non-game fish

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We conducted experiments to determine if power densities required to immobilize game fish injured non-game fish. Five species including creek chub *Semotilus atromaculatus*, bluntnose minnow *Pimephales notatus*, fingerling channel catfish *Ictalurus punctatus*, tadpole madtom *Noturus gyrinus*, and redbfin darter *Etheostoma whipplii* were treated to various electrical settings in a laboratory tank with a homogeneous electrical field. For each species-electrical setting combination, approximately 10-20 fish were treated to levels ranging between the threshold power density required to immobilize game fish, and 3X the threshold. This tripling of the threshold was intended to simulate the range of power densities that might exist in a heterogeneous electrical field formed during electrofishing in lakes and streams. Individual fish were exposed to electricity for 15 s, held overnight for 18 h, euthanized, radiographed to inspect for spinal injury, and necropsied to inspect for hemorrhages. Mortality averaged 16% (range 0-90 depending on species and electrical setting), spinal injury 5% (0-30), and hemorrhage 3% (0-20). Bluntnose minnows appeared to be the most susceptible to mortality (mean = 52%), and high frequency configurations tended to produce more hemorrhage; no other patterns were immediately obvious.

A tail of two species – do striped bass and hybrid striped bass make good neighbors?

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Sympatric populations of striped bass *Morone saxatilis* (SB) and hybrid striped bass *M. saxatilis* x *M. chrysops* (HSB) were evaluated for similarities in movements and habitat selection (temperature and dissolved oxygen) in Claytor Lake, Virginia. SB (n = 31) and HSB (n = 26) were implanted with temperature-sensitive radio tags and tracked bi-weekly for a period of 19 months to record position and habitat use. MANOVA results indicate differences in temperature and dissolved oxygen use for SB and HSB in Spring and Summer of 2001 and 2002 ($P < 0.05$). Hybrid striped bass selected higher temperatures than SB in spring and summer of 2001 (22.5 vs. 19.8°C and 25.7 vs. 22.5°C) and spring and summer of 2002 (18.4 vs. 16.4°C and 25.5 vs. 24.8°C). Dissolved oxygen selection during thermal stratification was higher for SB in 2001 (5.0 vs. 4.3mg/L) but lower in 2002 (4.7 vs. 5.7mg/L) when compared to HSB. Movement rates (m/day) were similar between species (ANOVA; $P = 0.13$), but averaged higher for SB (411 m/day) than for HSB (384 m/day). If appropriate DO levels are maintained, SB and HSB are vertically separated in a stratified reservoir and habitat overlap is minimal.

Comparison of conversion efficiency of low fat and high fat feed fed to rainbow trout produced and stocked for recreational purposes

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Research has indicated that high-fat diets (16% to 24% fat content) provide benefits for trout culture because they provide improved feed conversion ratios, increased growth rates and reduced waste output. A feed trial was conducted to determine if the high-fat diets used in trout culture for food production would provide similar benefits to a hatchery producing trout for stocking. The trial compared feeding rainbow trout (*Oncorhynchus mykiss*) an open formula diet (45% protein, 12% fat) to feeding a commercially available high fat diet (42% protein, 16% fat). Three replicate trials for each feed type were conducted simultaneously for 171 days. The results of the trial indicated no statistical difference between the diets in terms of feed conversion efficiency or growth rate. Because there was no difference in feed conversion efficiency, it was concluded that there was no difference in the volume of solid waste produced. The results are important because they indicate there are differences in best management practices for state fish hatcheries producing fish for stocking and commercial fish hatcheries producing food fish. Based on this study, relatively lower fat diets may be the best practice for fish hatcheries producing trout for stocking.

Winter habitats used by freshwater drum (*Aplodinotus grunniens*) and channel catfish (*Ictalurus punctatus*) in the Ohio River

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During winter, riverine fishes often use areas with warmer temperatures and lower flows than mainstem sections. Additional studies are needed to understand specific habitat types fishes use during winter in temperate river systems. We sampled habitat types (main channel, tributary mouth, island backwater, island head, island toe, and deep scour hole) with a deepwater boat electrofisher in the Belleville Pool, Ohio River, West Virginia. Sampling occurred during late winter 2002 and water temperatures ranged from 4 to 10 Celcius; the winter of 2001/2002 was unusually warm. Species diversity of tributary mouths exceeded that of other habitat types, but catches were primarily channel catfish and freshwater drum. Tributary mouths had highest abundances of channel catfish (65%, tributary mouth), (15%, backwater), (8%, island head), (2%, island tail), (10%, main channel), and (0%, deep main channel), and freshwater drum (85%, tributary mouth), (3%, backwater), (3%, island head), (0%, island tail), (9%, main channel), and (0%, deep main channel). A second field season will occur during winter 2002/2003, and should provide additional insights on habitats used by Ohio River fishes.

Channel netting in the North Carolina shrimp fishery: a case study of territoriality and local control

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Channel netting is a capture method that has never contributed more than a small amount to the state's annual harvest of shrimp. Still, it is one of the few commercial fishing styles that can be characterized as specifically North Carolinian in both its invention and use. While the capture technology is both interesting and unusual, it is the complex of customs which govern the prosecution of the fishery that offers the social scientist a unique opportunity to add to our understanding of maritime cultures. This paper is part of a larger effort to examine the history and culture of the North Carolina Shrimp Fishery. Within that context, Channel Netting is seen

as a locally controlled harvesting complex. It is based on decades of customs and traditions that have survived within a growing formalized management system. Among the more crucial aspects of the local customs are, first, "laying on a set," which involves a very specific set of procedures for queuing in one's reservation of, and exit from, a fishing location. This protocol is based exclusively on one's village of residence. Second, the physical distance between working fishermen clearly is established. Third, fishermen attempting to circumvent established traditions become the subjects of ridicule, and even threats of physical harm in some cases.

Enhancement of biological production in the Cape Fear River plume

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Since February 2000 we have conducted cruises with the objective of sampling seven stations in and near the Cape Fear River plume where it impacts the coastal ocean. Compared with a control area outside of the plume's influence, the plume contains elevated nutrients, water color, and chlorophyll *a* biomass. Nutrients (in particular nitrate-N) and chlorophyll *a* in the plume were both positively correlated with river flow as measured at a station in the upper coastal plain. However, nitrate was found to be the only nutrient that correlated with flow on the outer edge of the plume. Ongoing nutrient addition bioassay experiments have shown that phytoplankton biomass in summer and fall is stimulated by nitrogen, but not phosphorus. Relatively low levels of nitrate-N (100 µg/L) have led to chlorophyll *a* increases that were 4-7X that of control. Thus, rainfall and subsequent runoff of nitrate in the North Carolina Piedmont and upper Coastal Plain may exert significant control over biological production in the plume of this large riverine estuary. We hypothesize that hydrologically driven nitrogen loading to the plume area will lead to enhanced production and/or survival of tertiary consumers, including zooplankton, benthos, and finfish.

Relative growth and stress tolerance of native Southern Appalachian versus naturalized Northern Strain brook trout

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The southern Appalachian Mountains contain a genetically distinct strain of brook trout *Salvelinus fontinalis*. However, stocking of NC streams with hatchery-reared brook trout of non-native northern origin has occasionally lead to creation of naturalized northern strain populations, or populations of mixed origin where the hatchery fish interbred with native brook

trout. To assess relative growth and stress tolerance of wild hatchery-derived northern versus unaltered native Southern Appalachian brook trout, preliminary tests were conducted on fish collected from 3 streams of each type. No difference in chronic lethal maximum - time to loss of equilibrium (LOE) under conditions of 2 °C per day temperature increase was observed; average temperature at LOE was 25.8 °C. However, Southern Appalachian brook trout were significantly less tolerant than northern strain fish to increasing acidity produced by addition of dilute sulfuric acid which decreased pH from 6.4 to 2.9 over 35 hours; average pH at LOE was 3.33 and 3.18, respectively. In an 8-week trial conducted in an artificial stream supplied with live feeds, average growth of northern strain and Southern Appalachian brook trout was 1.2% and 0.5% body weight per day, respectively. Continued work will repeat these experiments with increased numbers of streams/fish, along with additional behavioral comparisons.

River discharge plumes and fisheries production: the trophic advantage hypothesis

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Estuarine habitats have long been valued as nurseries for estuarine dependent species of finfish and shellfish. The role of nearshore coastal habitats, particularly river discharge plumes, in fisheries production is less clear. Many finfish and shellfish species have offshore larval stages and must navigate river discharge plumes to reach estuarine nurseries. Recent studies have suggested that discharge plumes may enhance fisheries production by providing larval fishes and crustaceans with a trophic advantage compared to adjacent coastal habitats. We are evaluating this hypothesis through sampling in the Cape Fear River Plume, NC. Monthly sampling is conducted at stations inside vs. outside the plume using 705-micron plankton nets to 1) compare larval concentrations and diversities 2) examine vertical distribution and 3) compare recent feeding success and growth rate. Preliminary data indicate that larval concentrations and diversities are higher inside of the plume. Larval concentrations are higher at the bottom than at surface and 1 meter depths, suggesting that larvae are utilizing the salt wedge to facilitate transport into the estuary. Biochemical assays are in progress to evaluate whether plume environments enhance larval feeding success and growth rate.

Retention, distribution and growth of fish early-life stages in the Chesapeake Bay turbidity maximum

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The distribution, abundance and growth of larval and juvenile fish were investigated relative to the Chesapeake Bay salt front and estuarine turbidity maximum (ETM). It is hypothesized that the upper Bay and ETM are important nursery areas that support YOY fish recruitment. In 2001 and 2002, 220 Tucker-trawl and 149 midwater-trawl tows were made to sample larval and juvenile fish. During the spring cruises of both years, striped bass, white perch and *Alosa* sp. eggs and larvae apparently were retained within and above the salt front (1-3 psu) and ETM. In summer 2001, highest abundances of juveniles of each species occurred above and within the ETM and salt front, whereas during summer 2002 juveniles of these species were collected predominantly upbay of the ETM. YOY abundances of coastal spawners (e.g. menhaden, weakfish) were highest within the ETM during 2002. CPUE of YOY striped bass and white perch was lower in 2002 compared to 2001, suggesting higher egg and/or larval mortality in 2002. The lower YOY recruitments of anadromous species in 2002 probably are linked to differences in freshwater flow between the two years. RNA:DNA and otolith-aging analyses are being applied to investigate interannual and spatial variability in nutritional, condition and growth in the ETM region

Seasonal trends of fish assemblages in the lower Flint River Basin, Georgia

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The lower Flint River Basin, Georgia contains diverse aquatic community (including four endangered species) that have recently endured a record fifth year of a severe drought. To minimize the impacts of future droughts, resource managers are investigating the feasibility of flow augmentation reservoirs in the Basin. We studied their potential impact on stream fish assemblages by examining large-scale fish movements and the relationships between physical habitat variables and seasonal, stream fish assemblage structure. We sampled 20 stream reaches in the Flint River Basin during three seasonal periods: summer, winter, and spring during 2001-2002. Species richness and density in low order streams was highest in the spring and summer and lowest in the winter, whereas species richness and density in larger order streams was highest in the winter. Groundwater-dominated reaches also contained significantly more diverse and abundant fish communities during the winter when compared to surface water-dominated sites of similar order. Our results suggested large-scale seasonal movement into larger order

streams and warmer, groundwater-dominated reaches during the winter. The magnitude of influence of individual habitat characteristics on fish distributions also differed among seasons, and suggested that the availability of some habitats during winter may influence population size of some fish species. We recommend that decision-makers consider seasonal movement patterns and habitat needs of stream fishes when evaluating the effects of flow augmentation reservoirs.

Differential lead uptake and excretion in tissues of rainbow trout

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In the 1800-1900's, lead arsenate was utilized as a pesticide in apple orchards throughout the US. Previous field studies suggested that differential accumulation and excretion of lead (Pb) from lead arsenate resulted in differences in the isotopic signatures between different tissues of rainbow trout *Oncorhynchus mykiss* from contaminated streams. A controlled laboratory experiment was conducted to examine Pb accumulation in rainbow trout under conditions of continuous exposure (0.25 ppm Pb, 4 or 28 days), and periodic exposure (1, 2, or 3 24-hour exposures at 1 ppm). Bone, muscle and liver tissues were obtained from samples of fish collected before, during and following exposure, and analyzed for total Pb and Pb isotopic ratios. Fish in the 28-day exposure accumulated Pb progressively in liver and bone, whereas muscle showed minimal uptake. In the 4-day exposure, Pb accumulated in the liver and was almost entirely excreted by day 45, whereas Pb concentrations in the bone continued to increase following removal from the lead nitrate solution. Data for the periodic exposure is pending. Differences in the ability of the tissues to excrete Pb may lead to isotopic variability between the bone, muscle and liver. More importantly, the data suggest that bone may contain a long-term record of short-term inputs of Pb to aquatic environments.

Sexual differentiation in the striped mullet (*Mugil cephalus*) in South Carolina

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The striped mullet (*Mugil cephalus* L.) is found in tropical and semitropical estuaries worldwide from 42° N to 42° S latitude. This study examined the sexual differentiation of juvenile striped mullet in the estuaries of South Carolina. Specimens were collected monthly from October 1997 through December 2000. Striped mullet were sexually undifferentiated for the first 12 months as juveniles and began to differentiate at 13 months with most individuals fully differentiated by 15

to 19 months of age. This 15 to 19 month age category also coincided with the deposition of the first annular increment on the saggital otoliths. The defining morphological characteristics for differentiating males was the elongation of the protogonial germ tissue in a corradiating pattern towards the center of the lobe, development of primary and secondary ducts, and the lack of any type of ovary wall structure. The defining female characteristics were the movement of protogonial germ tissue, in the form of round germ cell nests, throughout the gonad lobe, separation of a tissue layer from the outer epithelial layer of the lobe and a tissue bud growing from the mesovarian stalk which formed the ovary wall, and the proliferation of oogonia and oocytes.

Evaluating the effects of high flows on stream channels and aquatic habitat as part of the hydropower relicensing process

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Large hydropower projects can regulate high flows through flood control, and by operating in a peaking mode to match fluctuating demands for electricity. This presentation will offer an overview of how North Carolina has been evaluating the effects of high flows (or lack thereof) on the downstream channel and aquatic habitat. Potential resource impacts include riparian flooding, stream bank erosion, fine particle transport and aquatic habitat changes. One concept that is being applied is to compare pre- and post-project hydrology, which can then suggest changes that reduce differences between the two. If the hydrograph has been flattened, more variability can be introduced. If flow fluctuations occur more frequently, these can be reduced during critical periods for aquatic organisms. Drawing on North Carolina's hydropower relicensing experience, the presentation will cover the following: 1) Comparisons of pre- and post-project hydrology, 2) An example of how magnitude, duration, frequency, and seasonality can be considered in developing a recommended high flow regime, 3) An adaptive approach to assessing the effect of peaking operation on stream bank stability, 4) Use of Instream Flow Incremental Method studies to evaluate high flow releases and aquatic habitat.

Using SAPS to restore a lake ecosystem

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SAPS (successive alkalinity producing systems) have been used to treat acid mine drainage throughout the Appalachians. In this case study, two SAPS were installed to treat acidic runoff water generated by pyrite-bearing materials exposed by interstate road construction. The study objective was to determine the recovery process of a small lake affected by the acidic drainage from road construction. Extensive water quality analyses, phytoplankton and zooplankton community assessment, fish bioassays, and fish stockings were started in 1997, to be continued through 2005. The two SAPS were effective in improving water quality of the acidic runoff water, and in particular improving a small tributary critical to brook trout. Overall, there were improvements in the lake phytoplankton and zooplankton communities. Finally, bioassays with two fish species indicated that the lake was no longer toxic to fish. Brook trout and rainbow trout were stocked in the lake following the bioassays. Rainbow trout growth and survival were good. Young-of-the-year brook trout were collected in 2002, indicating reproduction in the key tributary, and potentially other lake tributaries. The SAPS were effective in treating acid runoff, allowing a lake system to recover.

Winter distribution, ecology, and energetics of young-of-the-year bluefish in the South Atlantic Bight

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We conducted a trawl survey in Onslow Bay, NC to identify overwintering areas for spring- and summer-spawned bluefish and to test the hypothesis that overwinter mortality affects recruitment of summer-spawned fish. Four transects within Onslow Bay, NC were sampled monthly from

October 2001 to May 2002 aboard the 70' R/V Cape Fear. Each transect ranged from 0.125 to 10 miles from shore. Bluefish muscle samples and whole livers were removed at sea. Lipid content for these tissues was determined using soxhlet extraction. Stomach fullness and diet were determined. The highest densities of bluefish occurred within one mile of the coast. Based on length frequency distributions, spring-, summer-, and fall-spawned cohorts, utilize Onslow Bay during winter. Gut fullness levels were relatively high from October through December but dropped in January concomitant with declines in water temperature. Bluefish were strongly associated with engraulids, which represented 82% of diet. Lipid levels peaked in November and declined to a low point in May; additionally, the condition factor of bluefish collected in February was significantly lower than November collected bluefish. Energy storage was dependent on size with smaller individuals having lower lipid levels throughout the winter; this size-based difference in energy storage may have important implications for overwinter mortality.

Lavage survival rate and food habits of Gulf of Mexico sturgeon in the Suwannee River estuary

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As one facet of defining essential fish habitat for Gulf sturgeon, we focused on determining their food habits in the Suwannee River estuary, in their pre-spawning migration. This study introduces a new lavage method, and its associated mortality, and describes the food habits of wild-caught fish. In total, 150 sturgeon (814-1995 cm total length and 2.75-61 kg) were lavaged. Lavage time averaged 3.3 min per fish, following anesthesia. All sturgeon were checked for external signs of hemorrhaging before and after lavage. A total of 33 of the lavaged fish were then held for varying periods of time (1-120 hours). No mortality or hemorrhaging was observed for any of these sturgeon. Using this method, ~64% had stomach contents recovered. Brachiopods dominated the diet of Gulf sturgeon on a frequency of occurrence, numerical abundance and mass basis. Gammarid amphipods and brittlestars also appeared to be relatively important. Some prey were totally undigested and/or alive when collected, suggesting that they had been consumed in the estuary, just prior to the capture of the fish. Our current studies are focusing on determining the distribution of brachiopods in the estuary to further define essential fish habitat, based on prey resources, for Gulf sturgeon.

Arkansas Game and Fish Commission's efforts to recruit and retain anglers

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Angler recruitment and retention in Arkansas has not kept pace with population growth in the state. Consequently, the Arkansas Game and Fish Commission has increasingly aimed its efforts at halting this trend. The Fisheries Division has adopted a three-tier approach to recruiting and retaining anglers. The Aquatic Resources Education utilizes fishing clinics, localized fishing events, classroom and large mobile aquariums, and tackle loaner sites to recruit and retain school-age anglers. The Hooked on Fishing Not on Drugs Program incorporates sportfishing and Arkansas Department of Education goals and objectives to systematically teach children to fish. The program utilizes localized fishing events, classroom aquariums, tackle lending, and a complete inter-disciplinary curriculum guide for 5th – 8th grades to recruit anglers. Recently, an Urban and Community Fisheries Program was created to aggressively recruit anglers in densely populated areas. The program utilizes intensive management and stocking regimes, partnerships with cities to improve and create inner-city fishing destinations, and a marketing component. Each of these programs works to improve or adjust methodologies based on recent and ongoing surveys and studies. A long-term database of program successes and failures is currently being created.

Erosion and sedimentation control in North Carolina

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The presentation will begin with a short overview of the North Carolina Erosion and Sedimentation Control Program. The requirements of the Sedimentation Pollution Control Act of 1973 and Rules will be reviewed. Erosion and sedimentation control methods and practices necessary to meet the requirements of the Act and Rules, as well as, measures taken for projects in non-compliance with the Act and Rules will be discussed. The presentation will end with a look at the future direction of the Program.

Status of shortnose sturgeon in the Neuse River, North Carolina

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Shortnose sturgeon, *Acipenser brevirostrum*, historically occurred in most major Atlantic Coast rivers from Saint Johns River, New Brunswick, Canada to St. Johns River, Florida. Anecdotal evidence suggests that a population of shortnose sturgeon once occurred in the Neuse River, North Carolina, but their current status is unknown. In compliance with the National Marine Fisheries Service shortnose sturgeon sampling protocol, a two-year intensive gillnet survey was conducted in order to determine the population status of shortnose sturgeon within the Neuse River. The survey included habitat mapping and water quality analysis in expected spawning and summer habitats. No shortnose sturgeon were captured during the two-year study. Habitats where shortnose sturgeons were expected to occur were anoxic from June-September of 2001-2002. Therefore, we hypothesize that shortnose sturgeon are extirpated from the Neuse River due to a lack of suitable summer habitat. A database of physical characteristics of Atlantic Coast rivers is being used to examine differences between rivers that currently do or do not support a population of shortnose sturgeon.

SCUBA evaluation of habitat structures in Lake Anna, Virginia

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SCUBA gear was used to evaluate three types of habitat structures in 3886-ha Lake Anna, Virginia in 2000-2002. Structure types included synthetic Berkley “fish habs”® and “dumbos” (an arrangement of 152-mm diameter corrugated drainpipe) and a conglomerate of cedar trees, block and dumbos (dubbed “combo”). Over three years, 26 dives were made on eight structures (four fish hab, two dumbo and two combo), but sample sizes were unequal (dive totals were 17, 5 and 4, respectively). Preliminary data analysis indicated some significant differences: fish hab and combo structures held more quality largemouth bass, but black crappie (stock and quality) and stock bluegill were more abundant on combo structures. Bass, crappie, redear, white catfish and channel catfish selected horizontal slat alignment on fish habs exclusively, while bluegill selected horizontal and vertical alignments equally. Correlations with physical parameters suggested a negative relationship between crappie and large bass abundance and water temperature. Additionally, a negative relationship existed between bluegill and small bass abundance and depth, while a positive relationship existed between channel catfish abundance and depth. This study suggests that fish habs are a viable alternative to natural materials, but a larger sample size of all structure types and more rigorous statistical analysis are needed.

Sediment accumulation patterns in a hydro-peaking tailwater in Virginia

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Sediment characteristics are altered by river impoundment and this is illustrated by longitudinal sediment patterns in Smith River below Philpott Dam, operated with daily releases for hydropower production. Channel elevation near the dam has degraded since 1980. Upstream reaches were dominated by larger rocks (> 64 mm) and bedrock (80% bottom coverage), whereas pebble and gravel substrates covered a higher percentage of the streambed downstream (40%). Sand and smaller particles (< 2 mm) made-up a higher percentage in downstream reaches (> 12 km from dam; 20 - 50%). Fine sediment (< 2 mm) intrusion into Vibert boxes increased with downstream distance from the dam. Measurements of intragravel permeability highlight the influence of gravel manipulation by spawning brown trout *Salmo trutta* on permeability. Trends in substrate composition are consistent with the combined impacts of hydro-peaking and influx of fine sediment from tributaries that has apparently resulted in a downstream gradient from larger to smaller sized material in the tailwater.

Habitats used by the spotted darter (*Etheostoma maculatum*) in the Elk River, West Virginia

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The distribution of the spotted darter (*Etheostoma maculatum*) is extremely fragmented within the Ohio River basin, which includes a population in the Elk River, West Virginia. While researchers have studied habitats used by spotted darters, habitat usage by the Elk River population has not been determined. We marked spotted darter locations while snorkeling, and later measured water velocity, depth, and rock sizes associated with each location. We found all spotted darters in deeper run areas at the top of riffle habitat; none were observed within riffle areas, possibly due to smaller substrate sizes. Spotted darters were typically associated with rocks larger than 20 cm diameter. In general, our results are consistent with those of other studies on habitats used by spotted darters.

Kentucky's educational fishing programs

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Kentucky initiated Aquatic Resource Education in 1990. From the beginning, community based fishing was established as a corner stone of the program. In the first year of planning, there were nine known fishing events in communities across the Commonwealth. Fishing events grew steadily at first then began to grow exponentially. In calendar year 2002, over 350 fishing programs were performed. Every county held at least one event the metropolitan area of Louisville hosting four separate summer activities that work with nearly 15,000 youngsters annually. There are two keys to the exhibited exponential growth. The first component was complete acceptance from internal personnel. Every division has devoted people and aquatic resources where available to expand the fishing opportunities in communities. The second component was finding individuals who were familiar with certain urban areas of the state to work part time with the Department. These individuals have the trust of their neighbors and can be extremely effective in establishing long lasting fishing programs. Two excellent examples of the latter component were hired in Louisville and Northern Kentucky. The individual hired in Louisville was a retired African American police officer. He primarily focused on churches throughout Louisville and found acceptance in all congregations. In one summer, he had over 160 volunteers working with youth throughout the city. The young lady hired in Northern Kentucky has only worked one year. In the counties where she works, there were 18 fishing programs when she started. By recruiting volunteers and contacting a variety of community related organizations, she averaged 15 programs per month for her 5-month employment, a four-fold increase from the previous year.

Using habitat guilds to develop habitat suitability criteria for a warmwater stream fish community

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The diversity of fish species found in warmwater stream systems provides a perplexing challenge when selecting species for Instream Flow Incremental Methodology (IFIM) studies. A potentially powerful approach may be to use habitat guilds to incorporate the diversity found in these systems. Our goal is to determine the feasibility of developing habitat suitability criteria

(HSC) for the entire fish community using habitat guilds. HSC were developed for both habitat guilds and representative species for each guild in the North Fork Shenandoah River, Va. Each species was placed a priori into one of six habitat guilds: riffle, fast generalist, shallow rheophilic, pool/run, open pool, and pool cover. Habitat data was collected via snorkeling surveys and throwable-anode electrofishing. Guild placement was validated for each species using the collected habitat data. Nonparametric tolerance limits were used to develop guild and individual species criteria. The ability of guild criteria to represent habitat needs of the community was determined by comparing it with individual species criteria from each guild. The ability of representative species criteria to characterize the habitat needs of other members of the guild was also determined. Our approach represents an alternative for incorporating fish diversity into IFIM analyses of warmwater stream systems.

The value of specimen collections in fisheries research and management

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Collections of aquatic specimens offer fisheries professionals a historical inventory of fishes. The primary functions of systematics collections are to collect and preserve specimens and provide tools for education and research, both basic and applied. Exploratory fishing by early collection builders was replaced by documentation of new species and later by scientific sampling. Studies of collection specimens and associated records can help assess changes in populations, biodiversity, genetic diversity, and environmental conditions. We will briefly outline the development of ichthyology collections in Texas, and examine the usefulness of historical data to fisheries workers by presenting examples from Texas and the Gulf of Mexico. Given that important limitations exist for the continued maintenance and acquisition of aquatic collections (including physical space, funding, and institutional support), we will discuss the challenges facing collections.

Reintroduction of lake sturgeon in the Coosa River, Georgia

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The lake sturgeon (*Acipenser fulvescens*) was once an abundant member of the unique fish assemblage of the Coosa River System of northwestern Georgia. Habitat degradation and exploitation after 1900, however, resulted in the extirpation of the species by the late 1970s. Recent conservation and protection measures implemented in this region have greatly improved water quality and other habitat parameters critical for lake sturgeon survival. In December, 2002 the GDNR began the initial phase of a long-term reintroduction program with the release of approximately 1,500 juvenile lake sturgeon into the Coosa River drainage. The continuing goal of this project is to establish strictly controlled scientific protocols to monitor the success of this reintroduction program. Ultimately, the restoration of the lake sturgeon in the Coosa River may serve as a model of fish restoration within Georgia and other southeastern states.

Aquatic GAP and decision-making in the Tallapoosa River Basin, Alabama and Georgia

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Methods for estimating species distributions and classifying stream segments for conservation and restoration have been developed by The Nature Conservancy and MORAP. These methods do not explicitly quantify and incorporate uncertainty nor do they take into account incomplete detectability of species. Hence, their use is limited during formal quantitative decision-making, a

process that allows managers to estimate the potential consequences of each course of action (e.g., conservation strategies), select the most desirable alternative, and prioritize future research and monitoring efforts. We propose alternate approaches to modeling and predicting aquatic species distributions in relation to landscape features at various scales. We illustrate each approach using hypothetical management decisions and empirical species distribution and landscape data from the Tallapoosa River Basin, Alabama and Georgia.

Estimating population size of a mobile exotic catfish in coastal rivers

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Flathead catfish (*Pylodictis olivaris*) were introduced into North Carolina over 30 years ago via a single release of 11 individuals into the Cape Fear River. They are now present in most river drainages in the state and others on the Atlantic slope. We used a variety of sampling designs and capture-recapture models to estimate flathead catfish population parameters in Contentnea Creek and the Northeast Cape Fear River during the spring-summer 2001 and 2002. Our estimates for 2001 were hindered by low capture probabilities and high rates of temporary emigration. In 2002, we employed a "robust-design" framework that allowed estimation of population size and temporary emigration. Population size estimates ranged from 4 to 32 fish/km (>125-mm TL) of sampling reach in Contentnea Creek and 4 to 9 fish/km for the Northeast Cape Fear River. Additional analyses showed high rates of temporary emigration with 98% and 94% of tagged fish leaving the sampling area for some time duration. Radio telemetry results independently confirm our high temporary emigration estimates. Our results are useful to managers concerned with the interaction between exotic flathead catfish and native species. Our approach using the robust design may assist others in estimating population size of other mobile species that are difficult to collect.

Distribution of larval fishes in shelf and Gulf Stream waters in Onslow Bay, North Carolina

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The Gulf Stream (GS) is a major oceanographic process affecting fish recruitment via transport along- and across-shelf in Onslow Bay, NC. To test the hypothesis that the GS is a source of certain larval fishes to Onslow Bay, we (i) identified water masses as shelf, GS, GS front or GS/Shelf; (ii) described larval fish assemblages and concentrations in various water masses; and (iii) compared length-concentration relationships of abundant and larval reef fishes among water masses. Larval fishes were collected with bongo and neuston nets from April 2000-December 2001. For bongo catches, gobiids were abundant in shelf waters and myctophids were abundant in the GS. For neuston catches, triglids were abundant in shelf waters, while mugilids were abundant in the GS. Concentrations of most taxa were low in the GS and higher in shelf waters, suggesting that Onslow Bay is a source of certain taxa, such as gobiids. However, low concentrations of certain taxa, such as myctophids, in shelf waters compared to GS waters also suggest that the GS is a source. Myctophids caught on the shelf in Onslow Bay were associated with GS/shelf and GS front waters indicating cross-shelf transport by a GS frontal event.

Excessive sediment and riverine biota: myth and reality

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Excessive sediment is promulgated as the number one water-quality problem in the United States. A problem this significant can only be rationally addressed if its true space and time dimensions are known. But we know a lot less about this "problem" than we should. We might define excessive sediment as the amount of suspended or deposited inorganic particles < 2mm in size in a stream that deviates from the normal suspended or bedload amounts for that stream type to the extent that it has a detrimental effect on native aquatic life. This definition, to be useful, supposes we can quantify 1) reference sediment loads for stream types in particular physiographic settings; 2) human-induced deviations from the reference conditions; and 3) the relation between a deviation and its effect on aquatic life. My talk addresses these three assumptions and summarizes our current knowledge of sediment dynamics and its relation to the biota of streams typical to the midwestern and southeastern United States.

Effects of double-crested cormorants on largemouth bass and crappie in Lake Chicot, Arkansas

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The mortality of crappie *Pomoxis* spp. and largemouth bass *Micropterus salmoides* populations due to depredation by double-crested cormorants (DCCOs) was quantified and the diet overlap of DCCOs and largemouth bass was evaluated for fall, winter, spring, and all seasons combined in Lake Chicot. The DCCOs consumed between 85 and 863 crappie and between 91 and 1032 largemouth bass per year. The DCCOs consumed an estimate of between 0.002% and 0.02% of the crappie population per year when using rotenone data to estimate population abundance or between 0.01% and 0.32% of the population when using creel survey data to estimate population abundance. The DCCOs consumed between 0.26% and 3.00% of the largemouth bass population using rotenone data to estimate population abundance and between 0.03% and 1.53% using creel survey data to estimate population abundance. Diet overlap was biologically significant (greater than or equal to 60%) in the fall using percentage of total number and weight of prey, and relative importance index values for prey items. However, diet overlap was insignificant for diet measures used in all other seasons and for all seasons combined. Over-wintering DCCOs had little or no negative effects on largemouth bass and crappie populations in Lake Chicot.

Comparative ecology of juvenile striped bass and juvenile hybrid striped bass in Claytor Lake, Virginia

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Since the introduction of hybrid striped bass *M. chrysops* x *M. saxatilis* to Claytor Lake, Virginia in 1993, relative abundance of striped bass *Morone saxatilis* has dropped disproportionately to stocking density. The goal of this study is to determine if age-0 striped bass and age-0 hybrid striped bass are ecologically compatible in Claytor Lake. Although hybrid striped bass are stocked into the reservoir three months later than striped bass, at the end of the growing season mean lengths of each species are approximately 180mm. Preliminary assessment indicates that both species occupy habitat types characterized by structure-free, sand substrate, establishing a habitat overlap index value of 0.90. Both age-0 species feed predominately on alewife *Alosa pseudoharengus* and juvenile *Lepomis* species, resulting in a diet overlap index value of 0.84. The high resource overlaps indicate that the potential exists for competition between striped bass and hybrid striped bass at this early life stage.

Mississippi's community assistance program: opportunities and problems

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The objective of this program is to encourage the development and fisheries management of small community waters for public use by providing funding, technical advice, and fish. The goal is that conveniently located waters will provide successful fishing experiences (i.e. high catch rates) which will attract new anglers, especially children. Since 1995 we have received 46 inquiries and executed 9 agreements involving 11 ponds totaling 42.1 acres. Reasons for failing to sign agreements include: unsuitable sites, inability to obtain land, funding problems and decreased interest. The period from initial contact to agreement execution has averaged 14 months with a range of 6-21 months. New/renovated waters are stocked with fingerling bass, bluegill and channel catfish at rates recommended for farm ponds and closed to fishing for 2 years. Five ponds containing 14.7 acres are open to fishing with 20.9 acres of new/renovated waters scheduled to open in 2003. Internal (agency) problems include: a narrow objective and goal; low priority; inconsistent funding; and use of fingerlings due to limited hatchery capacity. External (cooperator) problems include: loss of interest after initial contact; lack knowledge/commitment to perform routine management activities and poor communication. The agency should reconsider program goals to emphasize the noncatch benefits these waters provide; increase communication and provide formal training of cooperators.

Tennessee's youth and urban fishing programs – an evolving process

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The Tennessee Wildlife Resources Agency has been involved with youth and urban fishing programs for many years. For the most part these programs have been conducted on a local level. Only recently have they tried to become more organized in standardizing the programs on a statewide level. From winter trout stocking into community waters to catfish stocking for youth fishing rodeos, the number of events has increased dramatically over the past 5 years, mostly as a result of better coordination.

A comparison of injectable fluorescent marks in two genera of darters: effects on mortality and retention rates

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Visible implant elastomer (VIE) and injectable photonic dye (IPD), two types of injectable fluorescent marks, have shown promise in previous applications in fish; however, neither has been extensively tested on darters. We marked a species from each of two genera of darters (*Percina* and *Etheostoma*) in a laboratory experiment to determine 1) the influence of VIE and IPD marks on survival, and 2) the influence of mark type, mark color, and body location on mark retention. Short-term (≤ 80 d) survival was similar between marked and control specimens for both species. Long-term (240d), however, the survival rate for IPD-marked *P. roanoka* was significantly lower than that for controls (50 vs. 80%). In *P. roanoka*, retention rate for IPD was significantly lower than that for VIE (80 vs. 94%) by day 80 of the experiment, and retention varied extensively among locations. In *E. podostemone*, retention was similar for VIE and IPD (79 vs. 83%) through day 240. Overall, VIE was a superior mark in one species, but performed similarly to IPD in another. Because of inter- and intra-specific variability in mark performance, we recommend a pilot marking study before initiating field use of injectable marks in an untested species.

Use of an angler incentive program for data collection and management of a trophy bass fishery

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One hundred and seventy-six trophy-size (≥ 3.6 kg) largemouth bass, *Micropterus salmoides*, entered into a privately-sponsored catch-and-release program at Caddo Lake, Texas/Louisiana, were tagged and monitored to assess angler recapture rates, genetic composition, and their distribution within the lake. All largemouth bass program entries were scanned for tags to determine angler recapture rates over a 4-year period. Blood samples were obtained from initial entries and used to determine genetic composition using random amplified polymorphic DNA testing. Genetic data were used to evaluate the success of past stocking activities. Angler-reported catch locations were used to examine temporal and spatial distribution of initial and recaptured largemouth bass entries. Most (77.2%) of the largemouth bass entries were caught

during March (46.9%) and April (30.3%). Twenty-three (13.1%) of the 176 largemouth bass were recaptured at least once and 4 (2.3%) were recaptured twice. The distance between initial and recapture locations ranged from 0.0 to 7.45 km ($\mu = 2.8$ km) and corresponding time intervals between catches for individual fish ranged from 8 to 1,059 days ($\mu = 281$ days) for all tagged fish returns ($N = 27$). Estimated genotypic composition of the entries was 15.5% Florida largemouth bass (*M. s. floridanus*), 45.1% F_1 first generation hybrids, and 39.4% F_x non-first generation hybrids, indicating successful Florida gene introgression following stocking activities that occurred 15 years earlier. Most (85%) of the initial and recaptured largemouth bass entries were caught in the middle portion of Caddo Lake, suggesting habitat associations possibly related to the avoidance of oxygen deficient areas in the lake and/or homing tendencies. Our results indicate this angler incentive program was highly utilized and trophy largemouth bass were recycled. Compared to electrofishing, the program provided a more efficient means for gathering genetic and catch distribution information on trophy-size largemouth bass.

Use of gelatin flavor beads as striped bass *Morone saxatilis* egg surrogates for estimation of egg production in the Red and Washita rivers

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Striped bass, *Morone saxatilis*, have been stocked in inland waters throughout the United States. Lake Texoma, an impoundment of the Washita and Red Rivers on the Oklahoma-Texas border, supports one of only a few self-sustaining inland populations of striped bass in the country. Striped bass reproduce in both the Washita and Red Rivers. However, recruitment dynamics in the two rivers are poorly understood. In addition, desalinization projects proposed for the upper Red River basin potentially threaten striped bass recruitment. The objective of this research was to estimate relative egg production in the Washita and Red Rivers in order to assess the contribution of each tributary to Lake Texoma striped bass recruitment. Gelatin flavor beads, used as striped bass egg surrogates, were released in known amounts and recaptured downstream to determine sampling efficiency. Sampling efficiencies were applied to striped bass egg collections in order to make estimates of relative egg production. Capture efficiency from gelatin bead recaptures were found to be greater in the Washita River (.297%) than in the Red River (.021% and .195%). Estimated peak egg production from three gelatin bead releases indicates slightly greater production in the Red River. Future research will focus on evaluating sampling efficiency at variable flows.

Brown bullhead (*Ameiurus nebulosus*) as an indicator species: seasonal movement patterns, home ranges and habitat utilization within the Anacostia River.

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Elevated liver and skin tumor rates have been reported among brown bullheads (*Ameiurus nebulosus*) from the Anacostia River in Washington, DC. Our objective was to determine if adult brown bullheads are resident in the Anacostia River or if they freely migrate into the Potomac River. Movement data are needed to effectively use tumor prevalence as an indicator of habitat quality. Brown bullheads were implanted with ultrasonic transmitters, released and tracked in the Anacostia River throughout the year. No fish were observed leaving the Anacostia River. During summer, fish (N=10) remained within 100 m of their release location. Mean 95% Minimum Area Polygon (MAP) and linear home ranges were 4.5 ha (ha = hectares) and 0.50 km. During spring, most fish (N=12) traveled upstream of the release location, ending approximately 1 km upriver by the end of the season. Mean 95% MAP and linear home ranges were 19.7 ha and 2.1 km. During fall and winter, fish (N=18) remained within 250 m upstream and 1.25 km downstream of the river release location. Mean 95% MAP and linear home ranges were 11.7 ha and 1.46 km. Based on these results, we conclude that adult brown bullheads are resident in the Anacostia River.

Effects of increased minimum flow and stream temperature on fish community structure in the Ouachita River, Arkansas

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The Federal Energy Regulatory Commission (FERC) currently monitors hydropower facilities in the U.S. FERC considers fish and wildlife issues as part of the relicensing process. Through relicensing of Rammel Dam, located on the Ouachita River in Arkansas, an increase in instantaneous minimum flow from 40 to 200-cfs and a shallower reservoir release regime were implemented. The goal of the project was to assess fish population structure before (2000) and after (2001-2002) modifications were employed. Riffle habitat was sampled at four permanent sites on the Ouachita River using push-barge electrofishing. A total of 56 species were collected. Riffle habitat was dominated by species in the Percidae and Centrarchidae families. The families Percidae, Catostomidae, and Atherinidae increased in relative proportion from 2000 to 2001. Preliminary analysis using Shannon-Weaver and Simpson's D diversity indices indicated shifts

in community structure in riffle habitats. Similar trends were demonstrated using Morisita's index of similarity. Overall diversity increased from 2000 to 2001 and tended to increase downstream. Site-specific diversity decreased from 2000 to 2001 in the site just downstream from the dam. In contrast, downstream sites revealed increased diversity between years. Data for 2002 are currently being analyzed and final results are pending.

Larval striped bass production in the Washita and Red river arms of Lake Texoma

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Striped bass *Morone saxatilis* were initially introduced into Lake Texoma in 1965 and stockings continued annually through 1973 creating one of about ten self-sustaining reservoir populations of striped bass in the U.S. The striped bass fishery on Lake Texoma has become the most valuable recreational fishery in Oklahoma. Striped bass anglers contribute about \$25 million annually to the local economy, with 77% of these anglers coming from outside of the local region. Despite the huge economic impact and relative uniqueness of a self-sustaining reservoir population, little information is available relating environmental conditions to striped bass spawning success or egg and larval survival in the reservoir. Our objective was to estimate relative abundance of larval striped bass in the Washita and Red Rivers. We sampled larval striped bass in both arms of Lake Texoma from April 11 to May 3, 2002. Ten minute net sets were conducted on alternating days between the two rivers, using 0.5 m diameter 500 μ m mesh plankton nets. Preliminary results indicate that larval production was higher in the Red River.

An analysis of congestion measures and heterogeneous angler preferences in a random utility model of recreational fishing

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The potential importance of congestion effects on the management and rationing of recreational facilities and services in the presence of heterogeneous preferences were highlighted nearly twenty-five years ago by Freeman and Haveman (1977). While there have been a number of theoretical models extending and expanding upon this work (McConnell, 1988; Anderson, 1993), empirical research evaluating such impacts is limited. Evidence of the potential impacts of congestion on resource usage is of obvious importance, especially for natural resource managers who understand that congestion can be an effective rationing device and because users likely differ in both their preferences for use and aversion to congestion. It is the objective of this research to compare alternative measures of congestion for explaining site choice within a random utility modeling framework. The congestion measures differ with respect to the time horizon over which they are assumed to be formulated and the measure of central tendency used to represent them. Furthermore, we investigate how the response to these congestion measures may differ across two distinct angler types and the implications of those differences on the per trip willingness to pay for stock enhancement.

Relationship between flow regime, habitat complexity and fish assemblage structure in Arkansas Ozark streams

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Variable flow regimes can affect fish assemblage structure by selecting for disturbance-tolerant fish, whereas habitat variability (i.e., habitat complexity) can reduce the effect of this disturbance by providing refugia. Seven Arkansas Ozark streams were sampled by backpack electrofishing and habitat variables were measured at each site to determine the relationship between stream discharge, habitat variability and fish assemblage structure. Flood frequency was negatively related to fish density, but was not related to species richness. Substrate variability was positively related to species richness, but was not related to fish density. The streams in the Boston Mountains ecoregion had higher habitat complexity, flow variability and percentage of

piscivorous fish than streams in the Springfield-Salem Plateau ecoregion. Habitat and flow variability in Arkansas Ozark streams impact the fish assemblage structure by affecting species richness, fish density, and trophic structure.

Cumulative sedimentation as a limiting factor on abundance of endemic fishes in the southern United States

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The integrity of aquatic systems is jeopardized by many stressors, but sedimentation from erosion of disturbed soils is pervasive. The southeastern U.S. contains one of the richest aquatic faunas in the temperate world, partially due to the high level of endemism. Endemic fishes have been characterized as sensitive to environmental change and are disproportionately listed as imperiled species. We examined the relationship between relative abundance of endemic stream fishes and cumulative sediment load in a metanalysis of data from five physiographic regions. Our objectives were to determine the functional form of the relationship and assess the usefulness of endemic fishes as ecological indicators. At 137 sites where fishes were sampled, sediment load was modeled from watershed land cover and calculated as percent increase over background rates. The shape of the relationship suggested that sediment may be a limiting factor on abundance of endemic stream fishes. Quantile regression models of the upper 10% of data points along the range of sediment loading indicated that for each 1,000% increase in sediment load over background rates, the maximum relative abundance of endemic fishes supported by a stream was reduced by 2.2%. These results need further evaluation with additional data on a region-by-region basis.

Hypoxia tolerance in juvenile estuarine-dependent fishes

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As part of a larger study examining effects of hypoxia on juvenile estuarine-dependent fishes, we investigated direct mortality due to hypoxia in juvenile spot (*Leiostomus xanthurus*) and Atlantic menhaden (*Brevoortia tyrannus*). The objectives of these experiments were to determine how

the extent of mortality varies with the severity of hypoxia and the duration of exposure, and to explore how vulnerability to hypoxia changes across species and temperatures. Each species was tested at two temperatures, 25° and 30° C, and three dissolved oxygen concentrations, 0.6, 0.9, and 1.2 mg O₂/L. Survival analyses were performed on the data, relating survival rate to dissolved oxygen concentration, duration of exposure, and temperature. Spot and menhaden exposed to 1.2 mg O₂/L showed no mortality in 24 hrs at 25° C, and only 30-40% mortality at 30° C. In contrast, both species experienced 100% mortality in 2-6 hrs at 0.6 mg O₂/L. Spot were consistently less tolerant of hypoxia than menhaden and both species were less tolerant of hypoxia at 30° C than at 25° C. Our results indicate that direct mortality due to hypoxia will vary with species and temperature, but will likely only be substantial at oxygen concentrations less than about 1 mg O₂/L.

Winter energetics of YOY bluefish in the South Atlantic Bight: effects of ration and cohort of origin on survival.

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Recent studies have indicated that few summer-spawned YOY bluefish recruit to the adult population. Several hypotheses have been proposed to explain the apparent loss of this cohort, including winter starvation, predation and low temperature mortality. We are evaluating the winter starvation hypothesis using mesocosm experiments to assess the starvation endurance and patterns of energy depletion in YOY bluefish as a function of ration level (*ad libitum* vs. starvation) and cohort of origin (spring- vs. summer-spawned). Spring- and summer-spawned individuals collected during fall 2001 were held in 2,000-liter flow-through tanks at ambient temperatures until spring 2002. Summer-spawned YOY bluefish held without food displayed prolonged (mean = 144 d) survival, suggesting that this cohort can endure winter starvation for extended periods. Biochemical (non-polar lipids, ash content) and morphological (HIS, condition factor) indices of starvation developed from mesocosm subjects were used to assess the energetic condition of wild YOY bluefish collected from South Atlantic Bight habitats during winter. This assessment indicated that although wild YOY bluefish depleted non-polar lipids over winter, few individuals approached critical levels measured in mesocosm experiments.

An information-theoretic analysis of water quality trends in the Blackwater River, West Virginia

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Logging, coal mining, off road vehicles, and land development have affected water quality and fish communities of the Blackwater River. Study objectives were to determine trends in water quality (1980-1993) and postulate causes of trends. Water quality trends from 13 sites in the Blackwater River watershed were examined using information-theoretic methods. Three hypotheses represented conditions in the watershed, and included a model without trend, a trend model, and a landuse model. The landuse model reflected changes in land-use development during the time series, but was rarely selected as the best approximating model. Downward trends in acidity and upward trends in alkalinity and hardness were linked to decreases in hydrogen ion concentration. Conductivity at most sites increased during the time series and may be associated with increases in calcium and nitrate. Dissolved oxygen trended downward due to natural conditions, but remained above biological thresholds. Most trends indicated improved water quality within the Blackwater River watershed, and were consistent with increases in fish species diversity.

A preliminary genetic investigation of the Cherokee darter: implications for conservation and management

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The Cherokee darter (*Etheostoma scotti*) is a Federally Threatened fish endemic to the Etowah River system in Georgia. The range of the Cherokee darter has become increasingly fragmented due to construction of Allatoona Reservoir in 1950 and recent widespread development in the upper Etowah River basin. Further fragmentation of the small to medium sized streams that the

Cherokee darter occuppies presents potential risks to the continued existence of this species. Utilizing mtDNA control region sequence data from more than twenty population samples throughout the range of this species, we are analyzing the population structure of the Cherokee darter to aid in management decisions. Preliminary results indicate three evolutionary significant units corresponding to an upper, middle, and lower division within the watershed. These ESUs correlate, in part to morphological differences in nuptial male coloration. Rapid development and previous land use within the range of the Cherokee darter jeopardizes the majority of populations within these units.

North Carolina coastal habitat protection plans: a new approach

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The North Carolina Fisheries Reform Act of 1997 requires development of Coastal Habitat Protection Plans (CHPPs). The legislative goal is long-term enhancement of coastal fisheries associated with each coastal fisheries habitat. Plan development is a cooperative effort among state agencies with jurisdiction over marine fisheries, water quality, and coastal zone management. The plan organizational framework is based on fish habitat types within watersheds, including wetlands; submerged rooted vascular plants; shellbottom; intertidal flats/subtidal bottom, riverine bottom, and coastal ocean bottom (soft bottoms); water column; and oceanic hardbottom. Eleven geographic management units have been defined within the total planning area, which includes all of the eight river basins that drain to the coast of North Carolina. The initial plan addresses all of the six habitats in eastern North Carolina, discussing distribution, ecological functions, status and trends, threats and management needs. Management unit plans will emphasize delineation of critical fisheries habitats using Geographic Information Systems technology so they can be managed by the appropriate regulatory bodies. The plans will recommend management actions needed to protect and restore habitat, including regulation, and research and monitoring.

A stream tank for evaluating habitat selection of juvenile sturgeon: solving the habitat use/availability problem

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Conservation plans for the endangered Alabama sturgeon *Scaphirhynchus suttkusi* include future stocking of juveniles into riverine systems known historically to be within the range of the species. Stock enhancement programs are more successful if young fish are released into habitats to which they have affinities. We are examining habitat use of juvenile Mississippi shovelnose sturgeon *S. platyrhynchus* as a surrogate experimental fish for the Alabama sturgeon to determine appropriate habitats for stocking. We designed and constructed a 7-m serpentine stream tank where habitat (i.e., depth, substratum, cover, and velocity) may be manipulated and measured. We can create multi-variable habitats and measure specific availability in the tank. Using video recordings, fish distributions relative to habitat types were also quantified. This approach differs from field studies of habitat use for which availability data are often lacking. We are evaluating multiple indices of habitat selection to determine the most robust analysis of our use/availability data. Bare-tank trials (i.e., no habitat manipulated) indicated that tank effects are minimal, suggesting that use/availability data will be valuable for determination of stocking habitats for Alabama sturgeon. In addition, habitat in the Alabama River was evaluated using remote sensing techniques to determine if similar habitats occur in the river.

Backyard fishing Florida style, an overview of the statewide community-based fishing project

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Florida's rapid urbanization and highly diverse social climate create unique challenges for recreational fisheries managers. The Florida Fish and Wildlife Conservation Commission's Community-based Fishing Project was created in 1997 to: 1) restructure its long-standing harvest-oriented, put-grow-and-take urban pond projects; and 2) provide a consistent statewide approach to develop urban fishing programs that better serve an ever-changing customer base. Primary objectives are to: manage urban waters to provide/promote freshwater sport fishing, implement family-oriented fisheries outreach programs, and increase community stakeholder involvement. The Project is comprised of four metropolitan field projects: Jacksonville, Orlando, Tampa, and Miami-area, which oversee 43 areas totaling 718 ha (1774 A) of water.

Regional differences in fish management capabilities and available resources created tailored forms of fishing opportunities such as harvest-oriented, catch-and-release, and quality catch, which better meet angler expectations. Outreach efforts included over 1000 fishing clinics and derbies with attendance of nearly 50,000 from 1997 through 2002. Community partnerships created unique angler access opportunities, funding sources, and expansion of education programs with less expenditure of manpower and budgets. Creative management, opportunity promotion, and increased community participation produced cost-effective projects that have enhanced freshwater sport fishing opportunities and awareness for Florida's urban citizenry.

A bioenergetics analysis of the factors influencing mean growth and individual variation among striped bass in reservoir populations

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Striped bass (*Morone saxatilis*) populations in some southern reservoirs experience summer stratification events that force fish into water warmer than their preferred maximum temperature in order to avoid low oxygen levels. While this situation has long been known to influence the growth and condition of reservoir striped bass, high forage availability may be able to offset some of the additional costs associated with high summer temperatures. This study uses bioenergetics modeling to compare the influence of temperature and forage availability on growth of striped bass in Badin Lake and Lake Norman, two reservoirs in North Carolina. Forage availability appears to strongly limit mean growth in these systems. This result suggests that the traditional view of habitat suitability for striped bass, based primarily on temperature and dissolved oxygen characteristics, should be expanded to include prey dynamics. However, the degree of individual variation in growth is more closely linked to the severity of physical conditions, indicating that habitat selection, likely based on preferred temperatures, mediates growth patterns. Since both mean growth and growth variation affect population dynamics and the success of a fishery, this type of analysis provides an important tool for ecological studies and for management applications.

Juvenile fish use of artificial structure, Kanawha River, West Virginia

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Artificial structures have been used in the past to increase fish concentrations and potentially increase fish production by providing cover, feeding grounds and spawning areas. The Kanawha River, West Virginia, is a large river intercepted by lock and dams and characterized by barge travel, coal operations and bank development. As a means of improving habitat for

fishes, and as a form of mitigation for navigation-related impacts, the US Army Corps of Engineers has constructed a series of dykes within the Marmet Pool. The dykes are designed to provide additional habitat for fish thus increasing the overall production of the fishery. This study is designed to determine if juvenile fish are more abundant in the dyke areas than in areas of similar conditions lacking the structures. If no differences exist it seems unlikely the structures represent an effective mitigation tool in this river. Data collection from the first summer (2002) shows a seasonal pattern in juvenile fish use of the structures. During the summer there was no significant difference between the numbers of fish found with or without structures. However, by fall a significantly greater number of juvenile fish were found near dyke structures versus without the structures. Dykes are found to house several species of juvenile fish including minnows, sunfishes, and bass. A seasonal pattern may erupt between fish and structure use as their needs for food and cover change. This study will continue in 2003 and beyond as we examine the effects of structure age upon juvenile fish use and also examine year-to-year differences in use patterns.

Applying an Index of Biotic Integrity as a water quality monitoring tool: the North Carolina experience

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The Division of Water Quality has been developing and applying an Index of Biotic Integrity to stream fish communities since the late 1980s, but only recently has the Index advanced sufficiently to once again be used as a reliable and defensible water quality monitoring tool. The Index proceeded through a series of early successes in the 1990s, but biocriteria that were not based upon reference sites and the Index's inability to differentiate least impacted from degraded sites led to the discontinuance of the Index as a monitoring tool in the early 2000s. The first step towards re-calibrating the Index hinged upon developing a hierarchy for identifying and selecting regional reference sites. Reference sites represented the least or minimally impacted streams and the overall biological conditions that could be obtained by these streams in the 21st Century. Using reference sites-derived data and river basin-based metric criteria, the Index was re-calibrated. Variability in how the Index performed spatially and temporally at reference sites and at disturbed sites was also examined. Finally, biocriteria were refined for wadeable streams in three regions of the state – the Western and Northern Mountains; the Inner Piedmont, Foothills, and Eastern Mountains; and the Outer Piedmont. Adhering to a Standard Operating Procedure, the Index is now used in the Division's Basinwide Management Program, for Aquatic Life Use Support ratings, identifying streams for placement on the Impaired Streams List, identifying watersheds in need of restoration, and in Supplemental Water Quality Classifications.

The Texas Parks & Wildlife urban fishing program

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As the Texas population faces ever-increasing urbanization, the need for effective outreach programs and accessible urban fisheries grows increasingly important. Texas Parks and Wildlife Department (TPWD) utilizes numerous outreach events, fishing programs, and facilities in its efforts to recruit and retain anglers. These programs and events range in size from department-wide events such as the Texas Wildlife Expo, which has up to 44,000 participants during a two day period, to small events conducted by individual field offices, which may have as few as 10 to 15 participants. Currently, TPWD manages 567 Community Fishing Lakes (CFL's). Annually, TPWD stocks approximately 275 CFL's with up to 220,000, 9- to 10-inch total length (TL), channel catfish (*Ictalurus punctatus*). In addition, TPWD partners with federal, local, and private entities to stock around 90 CFL's each winter with an average of 250,000, 8- to 10-inch TL, rainbow trout (*Oncorhynchus mykiss*). Texas Parks and Wildlife Department is trying to increase effectiveness of its outreach efforts by assessing its current programs; increasing coordination across departmental divisions and non-departmental entities; marketing to non-traditional constituents; determining angler opinions; and increasing compliance of urban fishing regulations.

Swimming endurance of fingerling Channel Catfish, *Ictalurus punctatus*, Blue Catfish, *Ictalurus furcatus*, and Hybrid Blue x Channel Catfish

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Pond raised fingerling channel, blue and hybrid catfish were subjected to swimming endurance tests in a 100-L Blazka-type swim tunnel at 19-21°C. Swimming endurance was measured at fixed velocities from 30-120 cm/sec, and sustained, prolonged, and burst swimming speeds were identified. Channel catfish demonstrated the highest sustained swimming speed (no fatigue after 200 min) of 50 cm/s while blue and hybrid catfish sustained speeds of 30 cm/s and 40 cm/s respectively. A curvilinear relationship was found between swimming endurance and speed over the prolonged and burst speed range. Hybrid catfish exhibited the highest burst swimming speeds obtaining speeds of 120 cm/s. ANCOVA's were used to determine statistical differences between species and morphological measurements were made to determine if body shape contributed to differences in swimming ability. Swimming ability of channel, blue and hybrid catfish was comparable to data reported for other species. Swimming endurance data was used to determine the capabilities of fish in their natural environments and to help better understand channel, blue and hybrid catfish habitat competition and selection.

Assessment of in-stream habitat improvements in a southeast Oklahoma tailrace

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A year-round trout fishery was established in the lower Mountain Fork River below Broken Bow Dam in 1989. Even though it has been a socioeconomic success, inadequate in-stream habitat and channel unit homogeneity limit fishable area, movement of trout from stocking sites and subsequent potential of the fishery. Our objectives were to: 1) increase structural habitat density and mesohabitat diversity in a study reach; 2) encourage dispersion of trout to unstocked stream segments; and 3) evaluate in-stream geomorphic success of habitat enhancement strategies. Geographic Information Systems technology and geomorphic surveys were used to measure changes in usable habitat area and channel morphology, respectively. Over 60 habitat enhancement structures were installed which substantially increased both structural habitat density and diversity. Pools and channel unit dynamics were successfully increased using low and medium stage check dams. Improved trout distribution was facilitated by flow deflectors, channel constrictors and a cross vein. Sediment transport deficits near Broken Bow Dam necessitated use of geotextiles and supplemental gravel during installation of habitat structures. Excessive aggradation of coarse sediment caused failure of one structure type. Study results are being used to streamline habitat improvement methods for tailrace fisheries in Oklahoma.

Flathead catfish movement and habitat selection in North Carolina Coastal Plain rivers

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Flathead catfish *Pylodictis olivaris* were introduced into the Cape Fear River in 1966 and have expanded their range to include most major drainages in eastern North Carolina. Our objectives were to determine movement patterns and habitat selection of these introduced fish in three coastal plain rivers. This was accomplished by radio tracking 12 to 24 fish in each river. Over 9 to 18 months, 95%, 55%, and 42% of tagged fish emigrated from the 2-km tagging areas in

Contentnea Creek, Lumber River, and Northeast Cape Fear River, respectively, with four individuals relocated 40 km downstream. Fish tagged in June 2001 and tracked through December 2002 in Contentnea Creek showed long, seasonal movements likely related to spawning, discharge, and water temperature. Following a flood event in August 2001, 55% of fish were relocated in Contentnea Creek (25% returned), while 70% of fish returned to the tagging area in spring 2002, presumably for spawning. Flathead catfish strongly selected deep, low velocity pools and slow-moving runs with some form of cover; particularly undercut bank, tree roots, and woody debris near shore. Our findings demonstrate the high mobility and habitat specificity of this species that warrant concern for their expansion within a drainage once introduced, and for management planning at the watershed scale.

A tag-based analysis of annual exploitation and catch rates of Atlantic striped bass

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Striped bass (*Morone saxatilis*) support economically-important recreational and commercial fisheries along the Atlantic coast. Through July of 2002, cooperators with the Cooperative Striped Bass Tagging Program have tagged and released 385,891 striped bass, and recreational and commercial fishers have recaptured and reported 70,118 tagged fish. These tagging data have many potential uses, but primarily aid managers in estimates of striped bass mortality rates. Annual catch rates and annual exploitation rates were estimated with tag recoveries of striped bass released by seven cooperators (1987 - 2001). Catch and exploitation rates were estimated from recaptures of two size groups (≥ 18 inch and ≥ 28 inch) during the first year after release. Trends of annual catch rates and annual exploitation rates should reflect fishing effort and exploitation, respectively. Overall increases in annual catch rates and annual exploitation rates occurred during 1987 - 1998, but recent estimates have decreased for most tagging programs.

Temporal and Spatial Distribution of Estuarine-Dependent Species in the Savannah River Estuary

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We investigated the spatial and temporal (seasonally and annually) distribution of estuarine-dependant fishes in the Savannah River Estuary (SRE) during 2000-2002. We used a variety of gears (i.e., ichthyoplankton nets, a drop sampler, and marsh-edge and tidal creek seines) to collect monthly samples in eight 2-km reaches. This effort caught 92 species totaling 67,831 fish. Fish abundance, distribution, and assemblages varied among four salinity-defined habitat (polyhaline >15ppt; mesohaline 5-15ppt; oligohaline 1-5ppt; and tidal freshwater <1ppt) and seasonally (fall, winter, spring, and summer). Ichthyoplankton density was highest in mesohaline habitat, and richness was greatest in polyhaline habitat. Ichthyoplankton density and richness were highest in summer and lowest in fall. Among marsh-edge and in tidal creeks, fish catch and richness was highest in oligohaline habitat and lowest in tidal freshwater habitat; fish catch and richness were highest in spring and lowest in fall. *Anchoa mitchelli* (Bay anchovy), *Brevoortia tyrannus* (Atlantic menhaden), *Micropogonias undulates* (Atlantic croaker), *Leiostomus xanthurus* (spot), *Bairdiella chrysoura* (silver perch), and *Paralichthys lethostigma* (Southern flounder) were the most abundant species and comprised 68% of the total catch. Our results demonstrate the importance of the SRE for all life stages of many economically and ecologically important fishes.

Blueback Herring Diets in Hiwassee Reservoir, NC

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Blueback herring *Alosa aestivalis* have been introduced into several southeastern U.S. reservoirs and are now the dominant forage fish in many of these impoundments. Anglers perceived that the increase in blueback herring abundance in Hiwassee Reservoir correlated with decreases in walleye *Stizostedion vitreum* catch rates. Previous studies of blueback herring feeding ecology have detected piscivory, thus raising concerns that the expanding blueback herring population may reduce sport fish populations through predation. The objectives of this study were to 1) evaluate the effectiveness of electrofishing for collecting blueback herring, 2) characterize the diet of blueback herring in Hiwassee Reservoir, and 3) examine day and night differences in

diets. Samples were collected every other week, during both day and night periods, from four locations on the reservoir. We collected 1,147 blueback herring in 1,595 total min of electrofishing. Invertebrates, primarily insects and zooplankton, were the most common prey items and occurred in 97.1% of diets, whereas fish and fish eggs occurred rarely (< 1.5% of diets). Log-linear analysis detected significant differences in diet composition between day and night samples. Our study agrees with several other recent studies that fish are a minor component of blueback herring diets in the southeastern U.S. and suggests that blueback herring are not impacting Hiwassee Reservoir sportfish populations through predation.

Some socioeconomic effects of *Pfiesteria*

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There is general agreement in the literature that environmental values tend to vary with culture and gender, but sometimes overlap among professions and income groups. Yet the distribution of knowledge about certain environmental phenomena like pollution and risk determines has been shown to differ between socio-economic groups. The probability of cross-class and cross-racial concern and reaction increases when there is a lack of scientific consensus about the phenomenon. The characterization of the toxic dinoflagellate *Pfiesteria piscicida*, and its potential for risk to human health certainly fit this category, as there are many questions than answers concerning both. This study displays the socio-economic groups of responses to specific survey questions focused on the economic impact of *Pfiesteria* in the mid-Atlantic region. The results of this analysis show socio-economic stratification as to risk assessment and level of concern, but little in relevance to the identity among those respondents that identify the organism in similar ways.

Characteristics, preferences, and motivations of young adult recreational fishing license holders in Arkansas

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We conducted a mail survey to determine the characteristics, preferences, and motivations of young adult fishing license holders in Arkansas as well as factors that contributed to their participation in recreational fishing. During the summer of 2002, we sent questionnaires to 1,500 randomly selected license holders ages 16 to 18. An adjusted response rate of 44% was achieved. Twenty-four percent of respondents were 16-years old, 40% were 17-years old, and 36% were 18-years old. Eighty percent of anglers were male and 20% were female. Caucasians composed 95% of all respondents followed by African-Americans. Preferred species were largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), and crappie (*Pomoxis spp.*). Ninety-seven percent of respondents had their first fishing experience before they were 11-years old and 94% purchased their first fishing license at 16. First fishing experiences were often associated with family members, which was in contrast to current fishing participation that is mainly associated with friends. Almost all of the respondents were interested in fishing more often. However, work, school, and interests in other activities are constraining fishing participation. Results from this research will assist management agencies in setting priorities to provide improved and more diverse recreational fishing experiences.

Creel Survey of the Ozark trout fishery of Beaver Tailwater

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Between September 1998 and August 2001, an intensive creel survey was conducted on the Beaver Tailwater, a tailwater trout fishery on the White River located in northwest Arkansas. The objectives of this survey were to estimate the amount of angling effort directed at this fishery and to quantify angler success. Angling effort as measured by total angler hours dropped

from 106,682 hours the first year of the survey to 65,181 hours the final year, a 39% reduction in effort. Catch rates remained high (mean = 1.6 trout/hour) over the study period, however, harvest rates declined steadily (mean = 0.31 trout/hour). Total harvest decreased from almost 40,000 trout in 1998 to approximately 16,000 trout in 2000. Concurrent with this decrease in harvest, stocking rates increased during the survey and were higher than historic levels. After adjusting for fish that were protected from harvest by special regulations, average harvest efficiency was 16%. These results suggest that the Arkansas Game and Fish Commission should evaluate current stocking practices to more efficiently manage the trout fishery in the Beaver Tailwater.

Effects of expanded stocking locations on striped bass survival

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We examined how recruitment of striped bass (*Morone saxatilis*) to age-1 was affected by increasing the number of stocking locations at Smith Mountain Lake, Virginia. Prior to 1996, striped bass were stocked at two sites. Four sites were stocked in 1996-1997, and ten to fourteen sites were stocked in 1998-2000. Approximately 118,000-170,000 striped bass were stocked at each site prior to 1996 but the number of striped bass stocked at each site in 1996-2000 was reduced to 17,000-78,000. Some of the new stocking sites were in areas of the lake that had greater nutrient concentrations and prey densities. Reduced stocking densities at each site increased recruitment to age-1. Reservoir managers may need to consider reservoir dynamics and density dependent relationships of stocked fish when choosing the number and location of stocking sites.

Reproduction in wreckfish (*Polyprion americanus*), an apex predator species within the Charleston Bump Complex

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The Charleston Bump is a rocky bottom feature of great topographic relief (>100 m) on the continental slope 130-160 km southeast of Charleston, South Carolina. This feature deflects the Gulf Stream offshore, which in turn creates permanent and temporary eddies, gyres, and associated upwellings. Biological productivity is notably higher throughout the water column in the "Charleston Bump Complex" of topographic features and oceanographic phenomena. The steep (>15°) rocky areas provide essential habitat for demersal adult wreckfish. The wreckfish

is a gonochoristic species that reaches sexual maturity after settling to the bottom at approximately 60 cm TL. Sex ratio data from fishery-dependent and fishery-independent sources showed that males were more abundant than females at sizes <1000 mm, whereas females outnumbered males at sizes >1000 mm. Oocyte development was prolonged, three to four months, owing to cool water temperature (<16°C) and the large size (>1.6 mm after hydration) of eggs. Females were in spawning condition during December through April, with a peak in February through April. Fecundity is determinate in wreckfish because earlier stages of yolked oocytes were not present at the beginning of the spawning season.

POSTER PRESENTATIONS

Using PHABSIM modeling to identify conservation thresholds in the North Fork Shenandoah River, Virginia

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The North Fork Shenandoah River Valley is facing many challenges concerning its freshwater supply. The Valley is a drought prone area. Since 1998, dry winters have failed to recharge groundwater supplies, resulting in severe hydrologic drought conditions. Population growth in the North Fork Corridor has averaged a 20.4%, 10-year rate of increase since 1970. With the Valley's rural setting and close proximity to the Washington D. C. Metro area, further growth is inevitable. Current projections of future population growth and water demand predict that water use will exceed supply by 2025. In 1999, a four-year instream flow study was initiated to evaluate the hydraulics, habitat, and water quality of the North Fork Shenandoah during low flow conditions. Using the Instream Flow Incremental Methodology (IFIM), Virginia Tech in cooperation with the United States Geological Survey (USGS) collected hydraulic, fish habitat, and water quality data throughout the basin. Hydraulic and fish habitat data was analyzed using Physical Habitat Simulation (PHABSIM) software. Model results will provide biologists, water managers, and county planners with baseline information to identify conservation thresholds and institute conservation flow regulations.

Immersion marking of juvenile Midas cichlids with oxytetracycline

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Laboratory experiments were conducted on the use of oxytetracycline hydrochloride (OTC) for marking juvenile Midas cichlids *Amphilophus citrinellus*. Juveniles were immersed in tris-buffered solutions of 200, 400, or 600 mg/L OTC for 4, 8, or 16 h. Marked juveniles were detected by the presence of a fluorescent mark on spines and rays when viewed under an ultraviolet light. Immersion in 600 mg/L OTC for 8 h produced the highest mark intensity. No immediate mortality occurred after the marking procedure. Duration of mark visibility and effect

of OTC treatment on long-term survival were examined by rearing both marked and unmarked juveniles for six weeks. Marks were visible for 2-7 weeks, depending on the size of the juveniles when marked. OTC marking had no effect on survival over the six-week period. The effect of OTC treatment on the vulnerability of juveniles to predation was determined by subjecting both marked and unmarked juveniles to predation by bigmouth sleeper *Gobiomorus dormitor* 72 h after OTC treatment. Vulnerability of juveniles to predation was not affected by OTC marking. The effects of light exposure on duration of mark visibility and intensity were examined by rearing marked fry under both dark and light conditions. Intensity and retention of externally visible marks were higher in juveniles held in the dark. Our results indicate that this OTC marking technique would be suitable for short-term mark-recapture, growth, and alloparental care studies of the Midas cichlid.

Assessing Florida largemouth bass introgression in Texas reservoirs: efficient sampling from observing spatial heterogeneity

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We determined the spatial pattern of introgression of Florida largemouth bass *Micropterus salmoides floridanus* within three embayments of Toledo Bend Reservoir, Texas and assessed the ability of various simulated sampling strategies to yield accurate and precise estimates of genetic composition. Introgression (percent of fish exhibiting one or more *M. s. floridanus* alleles at two diagnostic loci) was spatially heterogeneous. Sampling simulations suggested 60 to 90 fish were necessary for relatively unbiased estimates of genetic composition. Systematic sampling was the most efficient means of estimating genetic composition. Precise and accurate estimates of genetic composition are needed to improve the efficiency and effectiveness of Texas' large stocking program. By considering heterogeneity of genetic composition, we could prescribe an efficient sampling protocol addressing sample size and distribution of sampling effort.

Specialized electrofishing boats for sampling trout in Arkansas

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Arkansas' trout waters provide a diverse and difficult challenge for fisheries biologists to conduct fisheries population samples. These rivers are white-water/float streams and/or tailwaters below dams and vary in conductivity. Physical injuries to trout and personnel safety have also become prevalent issues with electrofishing boat usage. Traditional aluminum boats

with propeller driven outboard motors were not adequate to sample all habitats in these rivers. In 2002, two electrofishing boats were built to achieve the following goals: 1. Increase our ability to sample in all habitats – shallow riffles, pools, white-water, etc., 2. Decrease the chance for electrofishing injury to fish based on information from recent literature, 3. Establish standardized sampling protocols, and 4. Increase personnel safety. For white-water shoals, an 18-foot twin-tube cataraft was built for approximately \$13,000. The raft was powered by a 15 hp outboard, propeller driven motor, with console steering. The electrofisher was powered by a Smith-Root 3.0 GPP package. For all other habitats, a 20.5 foot fiberglass, flat-bottom john boat was built and powered by a 40 hp jet outboard with console steering, for approximately \$17,000. The electrofisher was powered by a Smith-Root 5.0 GPP package. Both boats incorporate combinations of features not used before in Arkansas and have proven extremely useful.

Statistical properties of the relative weight (Wr) index and an alternative procedure for testing Wr differences between groups

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Fishery managers commonly test for differences in relative weight Wr between groups using traditional statistical procedures. However, the statistical properties of the Wr index have not been studied; consequently, we cannot be certain that Wr data satisfy the assumptions upon which many traditional statistical procedures are based. We derived the approximate statistical properties of the Wr index using the Delta method and estimated these parameters for several fish samples. Additionally, we devised a likelihood ratio test (R test) that tests for differences in Wr between groups and which does not assume independent and identically distributed data. We applied the R test to the sample data and compared the results to those obtained using traditional statistical tests. We determined that the statistical properties of the Wr index were conditionally dependent on fish length and that Wr data are correlated. For the sample data, parameter estimates increased with fish length and typically were inflated above realistic Wr values due to variability in sample length-weight data. Traditional statistical tests were more liberal than the R test in declaring statistical significance. In order to protect the Type-I error rate, we recommend that the R test be used when testing Wr data.

Determining effective and efficient stocking rates for largemouth bass

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Texas Parks and Wildlife Department (TPWD) has stocked Florida largemouth bass (FLMB) since 1972. Because most stocked fingerling largemouth bass remain within 1 km of their stocking site, TPWD's standard stocking rates of 10-41 fish/surface ha typically yield 10,000-100,000 fish/stocked site. Effectiveness and cost efficiency of these stocking rates are unknown. We determined the percent contribution of stocked fingerling largemouth bass in Toledo Bend Reservoir when stocked at three rates (1,000, 10,000, and 100,000 fish/site) and calculated associated production and stocking costs. About 5 months after stocking, stocked fish continued to contribute to the cohort at the 10,000- and 100,000-fish treatments. Average contribution of stocked fish was 5.4% and 14.9% in sites stocked with 10,000 and 100,000 fish, respectively. However, it cost 250% more for every 1% contribution of stocked fish when sites were stocked with 100,000 fish compared to 10,000 fish. In Texas, a single stocking truck can transport and stock 200,000 fish. Applying our results, those fish would contribute to the cohort along 40 km of shoreline using a rate of 10,000 fish/site or 4 km at a rate of 100,000 fish/site. Our findings suggest that stocking largemouth bass fingerlings at a rate of 10,000 fish/site was both effective and efficient.

Assessment of the flathead catfish fishery in the Yadkin-Pee Dee River system in North Carolina using an angler diary

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An angler diary survey of the flathead catfish *Pylodictis olivaris* sport fishery in the Yadkin-Pee Dee River system, North Carolina was conducted (1999-2001) to determine if changes in catch rates and length frequency distributions have occurred since a similar survey of the same waters was conducted during 1989-1991. Study participants submitted data for 204 fishing trips that included reservoir, tailrace, and river habitat types. A total of 400 flathead catfish were caught during 1,514 hours of fishing. Because of differences in reporting procedures between the two studies, to allow for statistical comparisons among habitats and between years we compared catch/hour/trip data. The overall catch rate (0.38 fish/hour/trip) in this study was significantly higher ($P < 0.0007$) than found in the earlier study (0.30 fish/hour/trip). Total lengths ($N = 228$) ranged from 178 to 1,245 mm compared to 152 – 1,219 mm in the earlier study. The length frequency distributions of flathead catfish captured in the two studies were significantly different ($P < 0.0001$) and there is evidence ($P = 0.0677$) the mean length in the recent study (633 mm) was smaller than in the initial study (670 mm). However, there is nothing in the catch rate or

length frequency distribution data to suggest important changes have occurred in the quality of the flathead catfish fishery in the intervening decade.

A molecular genetic marker for the taxonomic identification of kingfishes, *Menticirrhus* spp. (Perciformes: Sciaenidae)

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Kingfishes (*Menticirrhus* spp.) are important resource species harvested along much of the U.S. Atlantic coast. Three species are harvested in North Carolina: southern kingfish *Menticirrhus americanus*, northern kingfish *M. saxatilis*, and gulf kingfish *M. littoralis*. Statewide landings of kingfishes declined from 1.2 million pounds in 1993 to less than 200,000 pounds in 1998. Landings have increased slightly since 1998, but remain well below the ten year average. Because landings data for North Carolina are pooled across the three sympatrically occurring species, trends for individual species are difficult to ascertain. Effective management of kingfishes will require species-level fisheries and biological data. Morphological variation among kingfishes is subtle. Although meristic counts and coloration can be diagnostic, these features are often damaged or obscured by harvesting practices. We developed an unambiguous molecular marker to distinguish among sympatric kingfishes. A 450-base pair fragment of the mitochondrial cytochrome b gene was amplified from reference specimens using polymerase chain reaction (PCR). Automated DNA sequencing of the fragment revealed substantial genetic variation among species with nucleotide sequence divergence estimates ranging from 9.5% (*M. americanus* vs. *M. saxatilis*) to 16% (*M. saxatilis* vs. *M. littoralis*). Accurate taxonomic identifications using this marker can facilitate fisheries investigations as well as species-level biological studies of recruitment, age and growth, reproduction, and habitat ecology.

Use of propagated shortnose sturgeon as surrogates for wild fish in development of field techniques

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Developing and testing techniques for studying imperiled species are necessary for population restoration, but acquisition of experimental subjects is problematic due to their scarcity or special status. The South Carolina Department of Natural Resources and U.S. Fish and Wildlife Service have cooperatively developed propagation techniques for the endangered shortnose sturgeon *Acipenser brevirostrum*. Original offspring of wild broodfish were used in a stock enhancement study. Subsequent generations of hatchery-reared fish have been used as surrogates for wild fish in a variety of studies, including: (1) salinity/temperature/dissolved oxygen bioassays to provide critical water quality parameters for use in searches for wild juvenile habitats; (2) tag retention studies to determine the optimal tag types for use in mark/recapture studies; (3) transmitter attachment/implantation studies to identify methodology that minimizes impacts and maximizes retention; (4) surgical procedures trials to identify appropriate techniques and suture materials; (5) effects of removing a barbel for genetics testing and pectoral fin spine for ageing; and, (6) effects of large explosive charges on juveniles. The results of these and other studies have been applied to field studies of wild fish. Thus, use of captively propagated sturgeon as experimental subjects has enhanced management capabilities for wild shortnose sturgeon, and the establishment of captive broodstock for other imperiled species is recommended.

Annual patterns of length-frequency distributions of the Yazoo shiner *Notropis rafinesquei* in three streams in northern Mississippi

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We studied demographics of the Yazoo shiner *Notropis rafinesquei*, a species endemic to the upper Yazoo River system, in three northern Mississippi streams. We sampled each population approximately monthly from March 1993 to October 1994. Preliminary analysis of length-frequency distributions suggests several life history features. Spawning, as evidenced by appearance of young-of-year in samples, occurred twice each year (late spring-summer and fall) in all streams. Recruits from spring spawning reached 10-20 mm standard length by July-August, and by October, are large enough to potentially participate in fall spawning. Length-frequency distributions were similar at all sites in both years. However, animals appeared to live 2-3 years in Buckhorn and Cypress creeks, but only 1.5-2 years in Hotopha Creek. Maximum adult size was lower in Hotopha Creek. Our results show that the Yazoo shiner shares life

history traits with related species, particularly the orangefin shiner *Notropis ammophilus*. Further analysis of life history strategies of the Yazoo shiner and comparisons among close relatives will allow discriminations of ancestral characteristics from species-specific adaptations.

Temporal and spatial distribution of two introduced aquatic predators in mid-atlantic coastal rivers

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Between 1965 and 1989, approximately 245,000 juvenile blue catfish *Ictalurus furcatus* and 200 flathead catfish *Pylodictus olivaris* were introduced into ten locations on the Rappahannock, Mattaponi, and James Rivers, Virginia, and into at least 12 impoundments within the Potomac basin. Both species are currently distributed throughout Virginia coastal rivers, and a blue catfish population is established in the Potomac River, Maryland. Few comparable predators existed historically in Atlantic slope rivers, and evidence suggests that introduced ictalurids may impact native fish assemblages. This study used GIS to compare dispersal rates documented for blue and flathead catfishes in their native range (“predicted” distributions in mid-Atlantic coastal rivers) with their “observed” distributions in several mid-Atlantic coastal rivers ($n \geq 40,000$ records). Preliminary findings indicate that blue catfish expanded less rapidly than predicted, while flathead catfish dispersed at faster rates than predicted. Data on water quality ($n \geq 74,000$ records) and physical impediments will be used to explain variations in predicted and observed distributions of blue and flathead catfishes, and to highlight opportunities or limitations for expansion into adjacent water bodies. Findings will increase our understanding of the factors influencing the establishment and dispersal of nonindigenous fishes in coastal river systems.

Methodology for using otoliths to age mooneye *Hiodon tergisus*.

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Our objective was to develop methods for using otoliths to age mooneye *Hiodon tergisus*. Twenty-nine mooneye (238 – 300 mm total length, 110 – 241 g) were collected from the Tallapoosa River (AL). Otoliths were extracted with forceps after cutting into the dorsal surface of the head posterior to the eye. Otoliths were burned on a hotplate and mounted on a slide in

crystal bond, ventral side down. After the crystal bond hardened, otoliths were ground to the nucleus with wet sand paper (600 grit). During grinding, otoliths were frequently viewed under a dissecting microscope (5 – 25x) to determine when the nucleus was visible. After reaching the nucleus, a fiber optic light source was used to illuminate the sectioned otolith to facilitate the discrimination of annuli. Mineral oil was applied to enhance the visibility of annuli. Two workers, without reference to fish length, recorded the number of annuli, and any discrepancies were reconciled with a concert read. Ages of mooneye ranged from two to eight years. Annuli were relatively clear, with 83% agreement between readers. All reconciled differences between readers were separated by one year. Our method to age mooneye may be applied to understand basic population ecology of this rarely studied species.

Further evidence of the invasion of the Indo-Pacific lionfish *Pterois volitans* along shelf-edge reefs of the southeastern United States

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The natural habitat of the lionfish *Pterois volitans* ranges from southern Japan, south to the east coast of Australia, and throughout Indonesia, Micronesia, and French Polynesia. In recent years, *P. volitans* have been documented in the coastal waters of several states bordering the western Atlantic Ocean, including Florida, Georgia, North Carolina, and New York as well as the island of Bermuda. Our observations of adult *P. volitans* inhabiting the temperate reefs off the North and South Carolina coasts continue to document this species invasive habitat expansion. Fifteen sightings from a submersible were video-documented in August of 2002 in depths from 45-65 m. All sightings occurred during daylight hours on live-bottom habitat in water temperatures between 20-22° C.

Evaluation of summer macrohabitat availability (temperature and water quality) for aquatic organisms in the North Fork Shenandoah River, Virginia

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Water quality greatly affects the aquatic life a river can sustain. Ideally, flow rates, water temperature, dissolved oxygen, and nutrients remain within acceptable limits for survival and growth even in anthropogenically influenced streams. North Fork Shenandoah River (NFSR) has been experiencing declining flow due to drought conditions and human population expansion requiring increased water withdrawals. The United States Geological Survey sampled 52 NFSR sites in July 1999. Eleven percent of the sites exceeded Virginia's water quality standard for a maximum temperature of 31°C, 35% were near the upper thermal limit for smallmouth bass, 25% exceeded the state standard for pH of 9.0, 37% fell below the minimum dissolved oxygen standard of 4 mg/L, and a high proportion of samples contained unionized ammonia (NH₃) levels above the estimated environmental threshold for mussels. To determine which areas are potentially inadequate for fish assemblages during low flow conditions, current habitat availability will be delineated, followed by modeling fourteen reaches using SNTMP (Stream Network Temperature Model) and QUAL2E (Enhanced Stream Water Quality Model).

Post-stocking survival of phase-I striped bass fingerlings

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Striped bass fisheries within inland reservoirs are primarily sustained with annual stockings of juvenile fish. In order to better develop management objectives and transport techniques, we evaluated the 24-h post-stocking survival of phase-I striped bass fingerlings in three upper Catawba River reservoirs. Prior to transport, 100 randomly selected fingerlings were placed into 3 survival cages at the Watha State fish hatchery. At the time of stocking, 100 randomly selected fingerlings (mean total length 62 mm) were placed into 3 survival cages at each reservoir. Water quality parameters were analyzed within the hauling tanks at arrival, within the hauling tanks post-acclimation, and within each reservoir. Survival within the control group averaged 98.3 %. Survival between reservoirs ranged from 94.3 % to 71.2 % and was inversely related to hauling time. Water quality analysis indicated significant differences between transport and reservoir

conditions. Results of this study indicate decreased survival of stocked fingerling striped bass with increased hauling time.

A model to predict landscape scale variation in brook trout spawning intensity and reproductive success in a central Appalachian watershed

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Restoration of brook trout populations in acid impacted waters requires an understanding of how geology, geography, and water chemistry interact to influence the recruitment dynamics of brook trout at a landscape scale. To facilitate restoration efforts in this region, we constructed a model to predict spatial variation in brook trout spawning intensity and overall reproductive success in the upper Shavers Fork watershed in eastern West Virginia. Two hundred thirty-five km of stream segments within the upper Shavers Fork basin were categorized as acidic ($\text{Ca:H} < 10$), softwater ($10 \leq \text{Ca:H} < 100$) or hardwater ($\text{Ca:H} \geq 100$) habitats. Stream segments were then classified into four size classes based on drainage area: headwater ($0.25 - 2 \text{ km}^2$), small ($2 - 5 \text{ km}^2$), intermediate ($5 - 12 \text{ km}^2$), and large ($> 12 \text{ km}^2$). Trout spawning intensity and reproductive success were then modeled for all stream segments within the watershed. Results indicate that brook trout populations in this watershed are most threatened in softwater streams with drainage area less than five km^2 . Streams of this size are the most important areas for spawning, yet they are likely to experience episodic acidification events and suffer complete reproductive failure. Our results stress the importance of considering drainage area when designing and prioritizing water quality monitoring and treatment programs in acid impacted watersheds.

Discerning the difference between slim and none: design considerations for creel surveys of lightly-fished reservoirs

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In anticipation of upcoming Federal relicensing of hydropower reservoirs in the western region of the state, the North Carolina Wildlife Resources Commission needed information on the characteristics of associated recreational fisheries. Because extremely low levels of fishing activity were anticipated on many of these systems, the required data could not be collected efficiently using traditional roving or access point creel survey designs. A roving-access design was employed to survey anglers on ten reservoirs in the Little Tennessee River basin from 1998 through 2001. Roving counts of boating parties were used to expand effort, catch, and harvest information obtained from access point interviews of exiting boaters. A spreadsheet-based expansion model was developed to stratify estimates by month and type of day (weekday or

weekend/holiday), allowing substitution of missing values on low-use days when no interviews could be obtained. Where possible, multiple reservoirs were surveyed by a single creel clerk, either by allocating sample days (1998-1999) or by using multi-reservoir count circuits (1999-2001). During the second and third years, survey efficiency was further improved by weighting sampling probabilities toward later periods of the fishing day, when the majority of fishing parties exited. Refinements in survey design led to improved precision of estimates; during the last two survey years, proportional standard errors (PSEs) ≤ 0.15 were consistently achieved on estimates for reservoirs with annual fishing effort levels as low as 19,000 angler-hours. Similar roving-access designs may provide reliable estimates of fishing effort on other lightly-used recreational fisheries where angler access is confined to a small number of access points.
