2002 SDAFS Midyear Abstracts

MUSSEL SYMPOSIUM I

Freshwater Bivalves (Unionoida): Distribution, Diversity and Extinction

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The term freshwater bivalve covers a multitude of families with some representatives living in freshwater, including the six families included in the Unionoida. These six unionoid families are broken into two superfamilies Unionoidea, including the families: Hyriidae, Margaritiferidae, and Unionidae with glochidial larvae, and the Etherioidea, including the families: Etheriidae, Iridinidae, and Mycetopodidae with lasidial larvae. Representatives of this order are found in freshwaters on six of the seven continents. There are about 170 recognized genera and about 1000 species recognized today. The two major hotspots of diversity occur in the Southeastern United States and Asia, from India to the Amur Basin in Siberia. This order is unique among bivalves because it has an obligate parasitic larval stage on the gills or fins of fish as part of its reproductive cycle. The fish host linkage is the weak link in the unionoid bivalve life cycle. Unionoids are one of the most endangered groups alive today, with approximately 35 species presumed extinct in North America and 75% of the remaining North American unionoid diversity is endangered. The status of the rest of the world's fauna is less well documented

Management and Recovery of Endangered Freshwater Mussels: Lessons from the Western Fanshell, Cyprogenia aberti

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North American freshwater mussels (Unionoida) are one of the most endangered groups of organisms in the world. Within the last 50 years, both numbers of individuals and overall species diversity have been reduced. The western fanshell, *Cyprogenia aberti*, is a species of special concern by the USFWS, and is endangered in Kansas. As part of a recovery plan instituted by the Kansas Department of Wildlife and Parks, a captive-breeding program is being developed to augment existing populations and re-introduce the species into parts of its former range. This study illustrates why it is critical to evaluate genetic variability in endangered and threatened "species" of freshwater mussels prior to implementing any recovery plan. Genetic diversity was examined among populations of *C. aberti* from the Arkansas, Ouachita, White, and St. Francis river drainages in Arkansas and Kansas. Genetic analysis of two mitochondrial and one nuclear gene portions reveal *C. aberti* is comprised of at least two and possibly as many as five species (including the federally endangered *C. stegaria*). These data reveal the extraordinary value of examining genetic data prior to implementing any recovery plan in freshwater mussels and gathering data on non-imperiled taxa before populations are extirpated.

Mussel Distributions in Lower Bayou Bartholemew, Morehouse Parish, LA

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The Nature Conservancy has targeted Bayou Bartholemew, located in southeast Arkansas and northern Louisiana, as a freshwater conservation area within the Mississippi Embayment Basin. The purposes of this study were: 1) to determine the current distribution of freshwater mussels

in Bayou Bartholemew, 2) to determine the status of the pink mucket, *Lampsilis abrupta*, which was documented in Bayou Bartholemew in 1993, and 3) to compare current distribution patterns with historical records from Bayou Bartholemew. Mussel populations in Bayou Bartholemew were sampled at fifty sites located in Morehouse Parish Louisiana during the fall of 2000 and the summer of 2001. Mussel specimens were identified to species in the field and released with the exception of voucher specimens. Thirty-three native species and one introduced species (*Corbicula fluminea)* were encountered during the survey. Of the thirty-three native species, *Amblema plicata* was encountered most often followed by *Megalonaias nervosa*, *Quadrula pustulosa*, *Leptodea fragilis*, and *Plectomerus dombeyanus* respectively. No pink muckets were seen during the survey. Numerous relics were found with particularly high proportions for *Fusconaia ebena* and *L. teres*.

Reproductive Behavior and Population Dynamics of the Endangered Freshwater Mussel, *Lampsilis streckeri* (Frierson 1927), in the Middle Fork Little Red River, Arkansas

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Prior to recent examination, the status and biology of *Lampsilis streckeri* was relatively unknown. The USFWS speculated that less than 500 individuals existed within 14.5 km in the Middle Fork Little Red River, Stone and Van Buren Counties, Arkansas. The objectives of this research were to determine the distribution, population dynamics, and reproductive behaviors of *L. streckeri*. Random Catch per Unit Effort (RCPUE), transect, and quadrat methods were evaluated to determine the most productive method for determining *L. streckeri* abundance. RCPUE was the most productive method yielding 72 mussels (six species), where transect yielded two total mussels (one species), and quadrat sampling yielded 12 mussels (five species). Two sites have been documented for *L. streckeri* above its previously listed range. Reproductive behavior of *L. streckeri* was determined to be bradytictic with gravid females observed in August and overwintering with release of glochidia in late February through May. Fish host identification experiments included two testing trials of nineteen fish species representing six families. All centrarchids proved to be viable fish hosts with *Lepomis cyanellus* producing the most juveniles (650). *L. streckeri* appears stable and with a universal fish host(s), reintroduction to its original range may be the best course of action for recovery of this species.

Status of the Neosho Mucket (*Lampsilis rafinesqueana*), a Federal Candidate Species

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The Neosho mucket (*Lampsilis rafinesqueana*) is known only from the Illinois, Neosho, and Verdigris River basins in Arkansas, Kansas, Missouri, and Oklahoma. In recent years, this species has been extirpated from approximately 70 percent of its historic range, and very little evidence of recruitment has been noted. The Neosho mucket continues to survive in all four river drainages, but only two of these currently support potentially viable populations. Causes of this decline have been attributed to impoundment, mining, and pollution. Increasing development and agriculture in the watershed are causing further declines in habitat quality. These factors have resulted in naming the Neosho mucket a candidate for listing under the

Endangered Species Act. Recovery work has included the propagation and release of over 500,000 juveniles and the formation of a recovery-working group.

Reproduction and Propagation of the Neosho Mucket, *Lampsilis rafinesqueana*

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The Neosho mucket is a freshwater mussel that is endemic to the upper Arkansas River system. This species is under consideration for federal endangered status and was studied to facilitate conservation efforts. Timing of reproduction was examined at two field sites, Shoal Creek near Joplin, Missouri, and the Spring River near Carthage, Missouri. Ten or more individuals were examined monthly at each site. Gonad fluid was removed and examined microscopically for gametes and parasites. The gills of females were checked for brooded embryos. Neosho muckets at both sites produced eggs in early May and brooded until the end of July. This result contrasts with observations of other *Lampsilis* species, which produce eggs in the fall and release larvae in the following spring or summer. Approximately 5% of individuals (11/205) harbored sterilizing trematode infestations and produced no gametes. We compared transformation success of glochidia larvae on largemouth bass inoculated twice in succession. Transformation success of the first inoculation was significantly higher than the second (85% vs 48%). The reduction of transformation success was attributable to a larger proportion of glochidia detached soon after inoculation, presumably because of an immune response of the host fish.

MUSSEL SYMPOSIUM II

Electronic Key for Identifying Arkansas Freshwater Mussel Species

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Freshwater mussels are sedentary bottom dwelling inhabitants of rivers and lakes. When conditions are favorable, they occur in very dense, multi-species aggregations called mussel beds. Sometimes these beds may encompass an area of 10,000 square meters, and the mussels may occur in densities exceeding 100 individuals per square meter. Conservation and management of these aggregations requires access to historic records for location specific data. Technological advancement in database use provides access to such data provided that the field information has been assessed for accuracy and quality and organized in some useable form. One such integration of distribution and abundance field data with the ability to use location information and taxonomic expertise occurred during a recent examination of navigation maintenance practices and assessment of impacts to mussels of the White River, Arkansas. A field notebook with electronic key was deemed necessary to facilitate identification of freshwater mussels known to occur in the White River from Newport (River Mile 255) to the confluence with the Arkansas Post Canal (River Mile 10). Also, data contained within this field notebook and key provided guidance regarding (1) planning of navigation maintenance activities to minimize impacts to mussel resources and (2) procedures to implement should mussel resources be encountered during maintenance activities. The key consists of quickly accessible digital images of diagnostic features for each descriptive couplet. Linked images are provided that continually guide the user through a matrix of terminology and subtle shell shapes or features to arrive at the identification of the specimen of interest. When museum specimens can't be carried to the field, and another malacologist will only lead to more descriptive arguments, the CD is there to furnish help with a critical decision. The electronic key is currently being field tested by the US Army Corps of Engineers in Memphis, TN and CoE personnel in the field directing navigation maintenance dredging operations.

A Survey of Native Mussels in the Sac River System of Missouri

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Native freshwater mussels (Unionoida) were surveyed in the Sac River system, as part of an ongoing statewide mussel survey in Missouri. The Sac is the largest tributary of the Osage River and drains 1,981 square miles. Releases from an upstream reservoir cause extensive bank erosion and channel instability. The mussel fauna of the Sac is diverse and has not previously been surveyed. Thirty-four sites were examined from August-November 2001, using timed searches by snorkeling and diving. Sampling effort averaged 2.7 hours per site, totaled 93 man-hours, and resulted in collection of 9,077 individual mussels of 33 species. Catch per unit effort ranged from 1 to 286 individuals per man-hour with an average of 97.6 individuals per man-hour. The most abundant species (% of total) were the purple wartyback (25%), Wabash pigtoe, pimpleback (~9% each), threeridge, washboard, butterfly (~8% each), mucket, monkeyface, plain pocketbook, pistolgrip, and threehorn wartyback (~4% each). Species of conservation concern that were found include the federally endangered pink mucket, as well as salamander mussel, black sandshell, elktoe, flat floater, rock pocketbook and spectacle case. Relic shells of

ebonyshell were also found. These results indicate that the Sac is a significant but threatened habitat for T&E mussels.

Do Mussel Beds Attract Fishes in the Lower White River, Arkansas?

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The importance of freshwater mussel beds (Bivalvia: Unionidae) to fish populations has been little studied. The lower White River of Arkansas is a large river- floodplain ecosystem with extensive bottomland hardwood wetlands and diverse and well-studied mussel beds. We determined catch of fishes in hoop nets (91-cm diameter, 25-mm bar mesh) over high-density mussel beds and nearby reference areas (low mussel densities). We sampled 7 mussel beds and 7 nearby reference areas in May 2000 in two reaches of the river downstream from DeVall's Bluff and Clarendon. Catch per net night of fish was not significantly different between mussel beds and reference areas ($P > 0.05$), but significantly higher mean fish catch per net night was observed at the DeVall's Bluff reach. No significant differences were detected for catch per night night between mussel beds and reference areas for any species, but test power was generally low (< 0.10). We conclude that with the observation that further studies are needed to elaborate the importance of mussel beds to fish populations.

The Effects Of Freshwater Mussel Filter Feeding On Seston And Microbial Biomass And Diversity from A Successful Mussel Refuge

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The objectives of this study were to determine the effects of freshwater mussel filter feeding on seston mass and microbial biomass and community composition. *Amblema plicata* have been successfully maintained at the Mammoth Spring National Fish Hatchery since the fall of 1999, while little is known why this hatchery has been so successful. Two experimental groups, an unfiltered hatchery raceway water group and a pre-filtered raceway water group, were designed. Mussels were scrubbed, rinsed and placed into feeding chambers for 2 hours. Control and treatment water and mussel stomach, foot and mantle samples were plated on R2A agar plates and ECO Micro Plates™ to determine microbial biomass and community composition. Chlorophyll *a*, AFDM and nutrient analyses were conducted on control and treatment water. Microbial CFU increased significantly for each group ($p= 0.0014$ and 0.0209) after incubation and Chl *a* increased after incubation, but not significantly. Gut CFUs were lower in the filtered water group compared to whole water group. Pathogens, *E. coli* and *Yersinia* sp., were isolated from two of the 10 mussels investigated. Unassimilated microbes and phytoplankton make up a large portion of the mussel biodeposition while being flushed out during low concentrations of seston.

Longitudinal Distribution and Relative Abundance of Species within Mussel Aggregations of the White River and Ouachita River in Arkansas

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The objectives of this presentation are to determine the patterns of species distributions along selected streams from headwater to higher order stream segments and relate these distributions to stream morphology and species reproductive characteristics. Surveys were conducted between 1991-2001 to locate mussel aggregations and determine the relative abundance or estimate population numbers for mussel species in the White and Ouachita river drainages in Arkansas. The Ouachita River was surveyed from the headwaters in west central Arkansas to the Louisiana border, a distance of approximately 510 river kilometers. The White River drainage survey included the continuous headwater to larger order stream continuum of the Spring, Black, and White rivers, a distance of approximately 600 rkm. The physical location of mussel aggregations within the rivers changed from the pool to riffle transition zone in headwater reaches to the deeper bendways (i.e. lateral scour pools) in the higher stream order portions of each drainage. A generalized pattern of species dominance within aggregations is recognizable with long term brooders (bradytictic) dominant in headwater reaches and short term brooders (tachytictic) dominant in higher order segments. Preliminary analysis of longitudinal changes in species dominance correlated with stream morphological parameters indicates mussel assemblage response to hydrological factors.

Development of a Geographic Information System (GIS) Database for Native Arkansas Mussels

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In 1997, the completion of a six-year survey to determine distribution and abundance of Arkansas' freshwater mussels in 1380 km of lotic systems and 180 km of lentic systems raised new questions about how best to utilize the data in developing successful management strategies for this declining group of aquatic invertebrates. This project furnished a mussel database developed for GIS application to offer insight for best management practices and decision-making when resource sustainability and environmental protection are prioritized. Data were taken from reports of surveys conducted between 1971 and 1999 and from Arkansas State University graduate theses from 1993 to 1997. All qualitative (location, date, collector, latitude, longitude, substrate, and elevation) and quantitative (number of species and specimens at each site) data were entered and stored using Microsoft Access database files. A total of 1,800 site locations encompassing over 22 watersheds within the state of Arkansas were entered. Approximately 164,000 individual mussels representing 83 species were identified and reported from those locations. Quality Assurance was conducted on all data using ArcView® to ensure location accuracy for all collection site coordinates. This database may become a central tool in unionid management planning and decision-making, not just for analysis of the continual decline, but also for evaluation of conservation efforts into a larger framework.

STREAM/RIVER MANAGEMENT I

Evaluation of Predation by Great Blue Herons as a Source of Trout Mortality on the Upper White River

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A primary question for fishery managers is whether avian piscivory represents a large proportion of fish mortality relative to angling. Almost 2 million trout (*Oncorhynchus clarki, O. mykiss, Salmo trutta, Salvelinus fontinalis*; 23-30 cm) are stocked annually on the upper White River in Arkansas. Recent creel surveys from the Arkansas Game and Fish Commission suggest angler harvesting accounts for only 38% of trout mortality. Our primary objective is to assess the magnitude of Great Blue Heron (*Ardea herodias*) predation on these trout. Between November 2000 and August 2001, we surveyed Great Blue Herons along 500 river km on the upper White River. Heron densities ranged from 0.16 to 4.03 individuals/river km. Taxonomic and size distribution data on 458 prey captures by herons demonstrated that sculpin (*Cottus* sp.) are the most common prey (28%). Live trout represented just 46 captures (10.0%). Lengths of captured trout ranged from 3.3 to 39.1 cm, with only 59% at 'stocking size' (23-30 cm) or larger. *In situ* trout enclosure experiments suggested that herons do not show size selectivity for trout within the size range of stocked fish. We estimate annual trout biomass removal by great blue herons in this system using a bioenergetics model. To date, our data suggest that predation by Great Blue Herons is likely a minor source of trout mortality on the upper White River.

A Survey of the Macroinvertebrates and Brown Trout (*Salmo trutta*) Feeding habits, Condition and Growth Within the Little Red River

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The damming of the Little Red River in 1964 created the 33,000 acre impoundment known as Greers Ferry reservoir. Hypolimnetic releases below the dam have created the present-day coldwater fishery, world-renowned as a quality trout fishery. There has been a lack of available information as to the specific diet and food availability foe brown trout at differing stages of their life cycle within the Little Red River. This study was designed to address the availability of prey and feeding habits of several size groups for the brown trout of Beech Island and Jon's Pocket in the Little Red River. Diet of brown trout largely indicate that they are predominantly opportunistic, consistent with literature as their diet is heavily reliant upon Isopoda. The lack of available fishes for prey other than young of the year is not adversely impacting relative weights of these trout. Relative weights were consistently high; these reflect the shear numbers of available crustaceans (isopods). The confounding factor is the slow growth of these brown trout populations. Feeding and relative weights were greater for trout at Beech Island; however, trout at Jon's Pocket showed greater length and weight at age after age 3.

Rainbow Trout Stocking in an Ozark Stream: Trout Survival and Responses of Native Smallmouth Bass

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Angling groups in Oklahoma have expressed interest in stocking rainbow trout in coolwater streams of northeastern Oklahoma, but potential impacts of introduced trout on native fishes are unknown. Our objective was to evaluate the effects of rainbow trout introduction on native fish populations, particularly smallmouth bass. We characterized smallmouth bass population structure and habitat use in an Ozark stream before and after trout introduction. We stocked 500 individually marked rainbow trout monthly from November 2000 to March 2001, and evaluated movement, habitat use, and survival. Stocked trout initially showed high survival, but movement was limited by low water conditions until rain events occurred in February 2001. Following the March 2001 stocking, we estimated 891 trout remained at the stocking site, and individuals were dispersed throughout the stream. Trout relative abundance declined steadily as water temperature increased, and we located only isolated individuals by October 2001. Preliminary analyses indicate trout may decrease smallmouth bass abundance in large pools. However, our data suggest smallmouth bass returned to pre-stocking habitats as trout abundance decreased. We resumed stocking in November 2001 and will continue to evaluate effects of rainbow trout stocking on smallmouth bass.

Interaction for Food Resources between Native Fishes and Introduced Rainbow Trout in an Ozark Stream

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Angling groups have become interested in stocking rainbow trout (*Oncorhynchus mykiss*) into northeastern Oklahoma streams. The Oklahoma Department of Wildlife Conservation (ODWC) has denied stocking permits pending assessment of possible impacts of trout introductions on native fish populations, in particular, smallmouth bass *(Micropterus dolomieu),* which support an active recreational fishery in northeastern Oklahoma. One of the objectives of our study was to monitor diets of smallmouth bass, bluegill sunfish (*Lepomis macrochirus*), and shadow bass (*Ambloplites ariommus*) before and after rainbow trout stocking. We monitored diets of native fishes for one year, and beginning in November 2000, stocked rainbow trout into the stream. We continued to monitor food resource use of native fishes and stocked rainbow trout to assess possible diet overlap between native fishes and rainbow trout, as well as possible diet shifts of native species. Diets between native fishes and introduced rainbow trout did not appear to be similar, however, overlap of some important prey items suggests possible competition for food resources.

Evaluation of a Tailwater Population of Flathead Catfish in Alabama

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Over 330,000 anglers fished for catfishes and spent more than 328 million dollars in 1996 in Alabama. However, catfishes in riverine systems are not managed; data are needed to determine if management activities are warranted. We are evaluating abundance, size structure, harvest rates, and movement of a flathead catfish population in the Coosa River below Mitchell Dam. Over 500 fish have been collected using low-pulse, low-frequency electrofishing. Floy T-bar anchor tags were attached to 157 flathead catfish (>250mm total length); spines were removed as a secondary mark. Electrofishing catch-per-unit-effort ranged from 2.3 to 70.9 fish/hr. Mean total length of fish (n = 461) was 351.9mm and ranged from 76mm to 997mm. Thirteen fish were recaptured in routine sampling; days-at-large ranged from 4 to 42 and averaged 21. Four tags have been returned by anglers, possibly indicative of low harvest rates. Initial movement data (from recaptures and tag returns) indicate limited movement with one exception. One flathead catfish was recovered dead 24.1 km downstream from the release site; it was at-large152 days. Our initial data suggest the flathead catfish population below Mitchell Dam has potential to be an excellent fishery; however, observations indicate that blue catfish may be preferred by anglers.

The Effects of Streambank Restoration and Reduction of Cattle Access as a BMP on the South Fork of the Spring River, Arkansas

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Non-point source pollution (NPS) has become a leading cause of water quality impairment in our nation. In Arkansas, agricultural activities such as livestock grazing in riparian zones are one of the major sources of non-point source pollution reducing water quality. Overgrazing alters stream morphology and increases bank erosion, reducing critical habitat for fish and benthic macroinvertebrates. Best Management Practices (BMPs) and bank restoration can be effective and practical methods for preventing and reducing water quality impacts due to erosional NPS. The objectives of this study are to determine if stream physico-chemical and biological variables change after streambank restoration and reduction of cattle access (exclusion fencing) are implemented at one cattle ranch on the South Fork of the Spring River. In a previous study pool and riffle sites above (reference) and below the ranch were evaluated before implementation (Phase I). At that time turbidity, TSS and largemouth bass abundances were higher downstream of the ranch; benthic macroinvertebrate abundance, smallmouth bass abundance and riparian diversity were higher above the ranch. Initial results approximately one and 1.3 years after implementation (Phase II) suggest a reduction in these differences that would be consistent with improvement in stream conditions from bank restoration and reduced cattle access.

STREAM/RIVER MANAGEMENT II

Effects Of Increased Minimum Flow And Stream Temperature On The Growth Of Centrarchids Of The Ouachita River, Arkansas

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Power-peaking operations at Remmel Dam on the Ouachita River have historically resulted in variable discharges (40 to 5,000 cfs) and lowered stream temperatures due to hypolimnetic releases from Lake Catherine. The Federal Energy Regulatory Commission relicensing resulted in an increased average minimum flow from 40 to 250 cfs and the installation of plates on the generation units to alter water releases into the epilimnion beginning in 2001. The Ouachita River from Remmel Dam downstream to the confluence of the Caddo River was divided into three sections based on Ecoregion. Two sites were sampled on the nearby, unregulated Saline River and were used as controls. Fish were collected by boat electrofishing before (October 2000) and after (October 2001) flow changes were implemented. All fish were identified and measured for length and weight. Otoliths were collected from seven Centrarchids (largemouth bass, smallmouth bass, spotted bass, longear sunfish, bluegill, spotted sunfish, and shadow bass). Annular incremental growth was compared among the three sections of the Ouachita River and between sampling years for each species. Results from this project will provide base-line growth rates and evaluation of short-term growth responses to flow alterations.

Turbidity and Ecological Integrity in Streams of the Mississippi Alluvial Plain Ecoregion: Is There a Relation?

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Fish community and water-quality data were collected from 36 sites on 35 streams in the Mississippi Alluvial Plain Ecoregion in 1997 as part of the U.S. Geological Survey's National Water-Quality Assessment Program in the Mississippi Embayment Study Unit. Fish were sampled in late summer. Water-quality samples were collected on three occasions--a short time after planting, midway through the growing season, and prior to harvest--and were analyzed for 23 pesticides, 10 trace elements, and 8 nutrients. Turbidity was sampled in conjunction with fish and water-quality sampling events. Multivariate analyses, t-tests, and correlations indicate that turbidity explains much of the variability in the fish community data. Mean turbidity for the northern half of the streams sampled was significantly less ($p = 0.0006$) than for the southern half of the streams sampled. Some fish metrics such as the average length for all *Lepomis spp.* and the sum of lengths for all black bass were correlated ($p < 0.05$) with turbidity. Nutrient concentrations and the number of herbicides detected also were correlated ($p < 0.05$) with turbidity. These results suggest that a relation may exist between turbidity and ecological integrity in streams of the Mississippi Alluvial Plain Ecoregion.

A Basis for Regionalizing Stream Fisheries Management in Eastern Oklahoma

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Effective management of stream fisheries requires knowledge of the regional setting. Understanding regional characteristics and conditions aids in grouping similar habitats and biotas and in identifying local variability. Our objective was to use physical and biological data to identify regions for stream fisheries management in eastern Oklahoma. We complied spatial databases of fish collections and fish populations to determine patterns of species richness and population abundance. We also developed GIS coverages for streams and reservoirs, roads, geology, soils, and land cover. These data were analyzed with univariate and multivariate procedures to determine geographic regions with similar biological and physical characteristics. We identified three major regions: the Ozark Plateau in northeastern Oklahoma, the Arkansas River Valley in east-central Oklahoma, and the Ouachita Uplift in southeastern Oklahoma. These regions will form a basis for stream fisheries management activities, such as habitat restoration projects. We intend to identify within-region variability to aid in prioritizing streams for future management activities.

East-wide Watershed Assessment Protocol (EWAP)

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Regions 8 and 9 of the USDA Forest Service have jointly developed a watershed assessment protocol. EWAP is a rapid characterization of landscape information based on 5th level watersheds (40,000 to 250,000 acres) using national GIS data layers and local information. This characterization is designed to enhance Forest Planning by allowing the incorporation of watershed assessments into the Forest Plan revision process. EWAP allows for a discussion of desired future conditions at the watershed scale, addresses the effects of forest management activities at the watershed level, and aids in the development of alternative management strategies that emphasize watershed health. EWAP establishes watershed health by describing natural and human-caused parameters that reflect watershed condition and vulnerability. Condition quantifies watershed disturbances (stressors). Vulnerability denotes values at risk that could be changed (positive or negative) as a result of Forest Service management activities. Watersheds with poor condition and high vulnerability have less integrity relative to those with better conditions and lower vulnerability. EWAP has been successfully developed for most National Forests in the eastern US.

Assessment Framework for Arkansas' Small Watersheds (< 80 Km^2) using Aquatic Macroinvertebrates

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Arkansas is a state with many diverse landforms that have been divided into six major ecoregions. This study provided the framework necessary to develop a consistent approach for collecting and interpreting aquatic macroinvertebrate data for small watersheds (< 80 km^2) of Arkansas' major ecoregions. The study had 3 objectives: 1) to evaluate the validity of aggregating reference site data into ecoregions vs. bioregions, 2) to select biological metrics that best discriminated reference sites from sites impaired by habitat disturbance and organic pollution, and 3) to combine these metrics into an index of biological integrity. Aquatic macroinvertebrate community, physical habitat and water quality data were collected in 42 streams during the spring 1998 - 2001. All sites were classified as reference and had no habitat

or water quality stresses. Historical data for aquatic macroinvertebrate communities from sixteen impaired streams, sampled by ADEQ from 1994 to 1997, was used for discriminatory power analyses. Three statistical techniques were used to classify streams: (1) an objective test of alternative classifications with multiple discriminate analysis of the metric values, (2) refinement of the selected classification with multivariate ordination of species composition (non-metric data), and (3) visual examination of box-and-whisker plots of metric values, arranged by site classes to confirm partitioning of natural variability. Geographic separation using ecoregions provided the 1st indication that reference conditions would not be homogeneous across the state. Subdividing the state into 4 bioregions reduced data variability and improved assessment accuracy. From an initial suite of 25 structural and functional aquatic macroinvertebrate metrics, 6 metrics were useful in composing the Arkansas Aquatic Macroinvertebrate Index for Small Watersheds for all 4 bioregions. Scores (6, 4, 2 or 0) were developed for these metrics to allow for aggregation into an index. Discriminatory power was strong for 2 of 4 bioregions and provided a biocriterion that improved discrimination between impaired and unimpaired sites. Discriminatory power was weak for one bioregion and could not be determined for the other using existing data. Further data collection should help to refine and improve discriminatory power in these bioregions.

An Index of Biotic Integrity for Fish Assemblages in Wadeable Ozark Highland Streams of Arkansas

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We developed an Index of Biotic Integrity (IBI) for wadeable Ozark Highland streams of Arkansas. Ninety-six fish collections, collected from 1982 to 2000, were used in IBI development procedures. All fish collections were rarified to simulate a sampling length of 51 mean stream widths (MSW). This level of effort was shown to adequately characterize fish species richness and assemblage structure in Ozark streams. We classified all fish-collection sites as reference or non-reference based on subjective and objective information. Uni- and bivariate statistics were used to examine 39 candidate IBI metrics. We determined which candidate metrics showed significant differences between reference and non-reference sites, and which metrics were redundant. Ten metrics were chosen for the IBI. Trophic metrics contributed most to IBI scores. Sampling effort affected IBI scores, mainly by affecting taxonomic-richness metric scores. Raw IBI metric values were most often correlated with nutrients, land use, road density, and sedimentation levels. IBI scores calculated for all fish collections indicate that our fish-collection data is skewed towards good quality sites, which likely represents the current distribution of Ozark Highland stream conditions. This skewed distribution may help explain why many pre-classified non-reference sites were classified as reference sites by the IBI.

RESERVOIR MANAGEMENT I

Importance of Coarse Woody Debris as Littoral Fish Habitat in Three Carolina Reservoirs

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To determine the importance of coarse woody debris (CWD) as littoral fish habitat and to assess potential impacts of its loss due to residential development on fish populations in three Carolina reservoirs, fish populations associated with CWD, residentially developed (DEV), and undeveloped (UND) habitats were sampled in the spring, summer, and fall of 1999-2000. Overall, taxa composition was similar in all habitats while fish abundance was generally similar in CWD and DEV habitats and higher than that noted in the UND habitat. In this study, fish abundance appeared related more to habitat complexity than to the specific type of habitat sampled. Even though CWD and DEV habitats provided different types of cover for fish, both were more complex and exhibited higher fish abundance than did the UND habitat. Therefore, it was doubtful that littoral fish populations in these reservoirs would be significantly impacted by the loss of CWD resulting from residential development.

Fish Populations Associated with Habitat-Enhanced Piers and Woody Debris in Piedmont Carolina Reservoirs

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One concern associated with reservoir residential development is the loss of littoral habitat complexity. A potential approach to compensate for these losses is to employ artificial habitat modules under existing piers, but the benefit of this practice on developed reservoirs has not been demonstrated. To determine the effect of pier habitat modifications, 86 piers located on 39, 100-m transects on two Piedmont Carolina reservoirs were selected for enhancement using fish hab modules augmented with brush (BHP), hab modules alone (HP), or as reference piers with no modification (RP). Fish were sampled from all transects and piers in April, July, and October 2001. Generally, during spring and summer, catch rates were higher at BHP sites than at either HP or RP sites. During spring, transect fish abundance was generally higher on transects containing woody debris (WDT) and brushed hab piers (BHT). However, this trend was less distinct during summer. On these reservoirs, fish abundance associated with developed shorelines appears to be related to the structural complexity of the habitat, even though the composition of the structure differs. This approach may serve as an effective management technique to enhance littoral habitat in residentially developed reservoirs.

Macroinvertebrate Distribution and Abundance in *Hydrilla* and *Ceratophylum* Habitats.

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Assessment of aquatic macroinvertebrate abundance and species composition can be useful for understanding aquatic system structure, water quality variation, and the forage base available to fishes. Vegetation-dwelling invertebrates are important food organisms for juvenile and adult fishes, particularly in lakes with few benthic organisms. Epiphytic invertebrate densities are typically tied to the quality and quantity of habitat available, which can be strongly influenced by the species composition of the resident macrophyte community. Many lentic habitats in the southern U.S. have been invaded by exotic hydrilla *Hydrilla verticillata*, but the consequences of these invasions to native macroinvertebrate communities have not been determined. The goal of this study was to assess the impacts of hydrilla infestations on the littoral macroinvertebrate community in the Atchafalaya River Basin located in south central Louisiana. Our objectives were to determine the abundance and community composition of hydrilla-dwelling aquatic macroinvertebrates, evaluate the effects of macrophyte-induced reductions in water quality on macroinvertebrate densities, and compare macroinvertebrate densities between hydrilla and native coontail (*Ceratophylum demersum*) beds. Collections were made with a trap that consisted of a 60 x 45 cm suitcase constructed of 0.5-cm thick angle aluminum with 600-μ stainless steel mesh walls. Preliminary results indicate that water quality not only affects macroinvertebrate abundance, but also influences macroinvertebrate diversity in these macrophyte beds.

Effects of Hydrilla Infestation and Management on the Food Habits of Age-0 Largemouth Bass *Micropterus salmoides* in the Atchafalaya Basin, Louisiana

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Major changes in the ecology of the Atchafalaya Basin have undoubtedly occurred since the submerged macrophyte hydrilla *Hydrilla verticillata* invaded in the early 1970's. To determine the effects of hydrilla on age-0 largemouth bass, we identified stomach contents of 690 individuals to compare current bass food habits with bass food habits from 1973-1976, before hydrilla infestation. Age-0 bass were also collected from an area of the basin managed with drawdown to control hydrilla abundance. A minimum of 20 fish were collected bi-weekly with a boat electrofisher from four different areas in the lower Atchafalaya Basin. Two areas had moderate to high densities of hydrilla, one area was a deep man-made canal free of submerged macrophytes, which was sampled to determine if age-0 bass diets in non-hydrilla areas were similar to those in 1973-1976 samples, and one was from the managed area, drawn down for 90 days in the winter to kill hydrilla. Preliminary results indicate that dense hydrilla may hinder age-0 largemouth bass ability to forage on fish, thereby inhibiting a vital growth phase in the life history of this important sportfish.

A Comparative Evaluation of Striped Bass Egg Production in the Major Tributaries of Lake Texoma

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The striped bass (*Morone saxatilis*) has been stocked in numerous reservoirs in the southeastern U.S. both as a sport fish and a biological control for gizzard shad (*Dorosoma cepedianum*). Lake Texoma is one of only about 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 number of striped bass eggs produced in the Red and Washita rivers and to locate spawning sites on the Red River. We netted striped bass eggs using 500 μ plankton nets in the two major tributaries on alternate days at three sample sites per river in order to determine the relative abundance of eggs in both systems. Water temperature, flow, conductivity, and salinity were also measured at each sample site. We intend to stage eggs to determine age and back-calculate approximate spawning areas according to water velocity. The Red River has a considerably higher concentration of total dissolved solids (TDS) than the Washita River. The swelling of striped bass eggs during the period following spawning until water-hardening is affected by TDS. We found that striped bass underwent minimal swelling after spawning in both rivers with most eggs less than 2 mm in diameter. Data continue to be analyzed and results will be presented at the Southern Division mid-year meeting.

Striped Bass Summer Daily Use Areas and Movements in a Southeastern Impoundment

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We searched the lower embayment of Lake Murray every 2-h for 48-h. Striped bass moved an average of 234 m/h, but individual movements varied from 0 to as much as 1,978 m/h. Striped bass were associated to a greater extent with the main river channel at night, and were associated more closely with a shelf and two tributary channels during the day. There was no significant relationship between, temperature, dissolved oxygen, or habitat suitability index value and time of day. Daily use areas averaged 0.83 km^2, and ranged from 0.29 to 1.73 km^2. Striped bass were observed to use the same areas on a seasonal basis as they did on a diel basis in Lake Murray. However, mean hourly rates of movement were greater than movement rates calculated for the normal two-week interval between samples. Studies of a similar nature may greatly underestimate the total movement of fish when tracking is only conducted on a biweekly or monthly basis. Further, changes in location between biweekly samples may not indicate displacement, but may only represent random locations in normal use areas. It is quite likely that striped bass are much more active than has previously been reported.

RESERVOIR MANAGEMENT II

Relations Between Zooplankton Availability and Age-0 Black Crappie *Pomoxis nigromaculatus* Abundance in Three Florida Lakes

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We investigated relations between larval black crappie *Pomoxis nigromaculatus* abundance, prey availability, and abundance of juvenile black crappie at three Florida lakes. Age-0 black crappie were collected at Lakes Wauberg, Lochloosa, and Tarpon using surface and bottom trawls during summer-fall 2000 and 2001. Zooplankton abundance was measured concurrent with trawl sampling. Both larval and juvenile black crappie abundance were higher in Lake Wauberg than Lakes Lochloosa and Tarpon in 2000. Larval abundances were higher at Lake Lochloosa than Lakes Wauberg and Tarpon in 2001, but juvenile abundance in 2001 was highest at Lake Wauberg. Juvenile size in fall 2000 was largest in Lake Tarpon and smallest in Lake Lochloosa. Differences in juvenile black crappie abundance and size among study lakes may be related to food abundance and size of food available. Future studies will assess diet selection of age-0 black crappie among lakes.

Age, Growth and Food Habits of Blue Catfish in Lake Norman, North Carolina.

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An assessment of the blue catfish *Ictalurus furcatus* population in Lake Norman, North Carolina was conducted to improve the current state of knowledge regarding the ecology of this introduced blue catfish population. Length, weight, and age data from incidental catches of blue catfish by Duke Power Company during spring 1999 and 2000 are being used to describe age-and-growth characteristics. Comparisons between Lake Norman, Lake Texoma, OK, and Kentucky Lake, TN, indicated mean lengths-at-age of blue catfish in Lake Norman were smaller than the other lakes. Stomach contents were identified seasonally to describe the diet of blue catfish in Lake Norman. The diet composition of blue catfish in winter consisted primarily of aquatic plants (Charaphytin) and fish; however, during the spring and summer Asiatic clams *Corbicula fluminea* were the dominant food item while fish decreased in overall occurrence. Fall diet composition analysis indicated a decrease in Asiatic clam intake from the summer, while fish and aquatic plants amounts increased. Blue catfish in Lake Norman are in good condition, with slow growth rates, and have a diverse and seasonally variant diet composition of primarily Asiatic clams, fish, and aquatic plants.

Development of Mechanistic Models for Description of Larval Yellow Perch Predation Vulnerability in an Ecosystem-Specific Context

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Annual variation in larval mortality is a major source of recruitment variability in fishes. Research shows predation is often an important component of larval mortality, and may occur in a relatively narrow size window. The ratio of predator size to larval size is a good description of this predation window for larval fish. Mechanistic predation models are often based on general relationships between size ratio and capture probability for a non-specific predator. However, these general models may not adequately describe predator-prey relationships when applied in a system-specific context. We investigated how larval yellow perch, *Perca flavescens*, size-dependent vulnerability to predation differed among several potential predators in the southern Lake Michigan system. We conducted behavioral experiments with yellow perch larvae (5-20 mm TL); and adult yellow perch (100-150 mm TL), white perch, *Morone americana*, (80-100 mm TL) and alewife, *Alosa pseudoharengus*, (100-200 mm TL) as predators. These data were used to build several structurally different models of the size ratio-capture probability relationship. These models were compared to each other, and to more generalized models described in the literature, for optimal fit within predator taxa and consistency of fit between taxa. Our results show that the size ratio-vulnerability relationship differs among predator species and that the predictive power of mechanistic models used to describe predation vulnerability in specific systems will be enhanced when these differences ware taken into account.

Diet Analyses Of Double-Crested Cormorants and Largemouth Bass in Lake Chicot

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Interactions among piscivorous animals, such as double-crested cormorants (*Phalacrocorax auritus*) and largemouth bass (*Micropterus salmoides*), and economically important fish species are unclear. Diets were examined from approximately 400 cormorants and 300 bass. Greater than 90% of cormorant prey was composed of shad (*Dorosoma spp.*) and yellow bass (*Morone mississippienis*). Other cormorant prey species included channel catfish (*Ictalurus punctatus*), and sunfish (*Lepomis spp.*) with a frequency equal to 3.49% for each group. Minimum prey size was 64 mm and the maximum was 300 mm. Mean prey length was 192 mm. Shad also appear to be the most frequent fish species found in largemouth bass diet. Other prey species found in bass were silversides (Atherinidae), minnows (Cyprinidae), and sunfish. Minimum prey size was less than 10 mm and maximum prey size was 152 mm. Mean prey size was 54 mm. A diet overlap index of 0.40 suggested that sport fish and cormorants were not in direct competition for prey. Neither piscivore was having an observable impact by predation on sport fish populations in Lake Chicot. However, bioenergetic models are being used to determine which of these factors has a greater impact on the mortality of other sport fish.

Identification Of Piscivore Prey Species Using Dichotomous Key Based On Prey Saggital Otoliths

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Most diet analyses are based on whole and partially digested prey items from the guts of piscivorous animals. Much information might be lost if partially digested prey items are unidentifiable. Hard parts, such as otoliths or spines, can be used to identify prey items.

However, we could find no otolith key to identify prey species of double crested cormorants. We collected species preyed on by double-crested cormorants during a population sample on Lake Chicot, AR. Approximately ten samples from each inch group were collected. Fish were weighed and measured. Both saggital otoliths were extracted. Morphological characteristics of these otoliths are being described in order to develop a dichotomous key. Otolith characteristics used to identify species include the ratio of otolith length to otolith width, rostrum and antirostrum length to width, presence or absence of collum, and sulcus structure. Otoliths from some species, such as freshwater drum are unique. Other groups, such as the Lepomids, are more difficult to distinguish. This key should simplify similar work and allow more comprehensive predation studies.

Feeding Behavior of Two Size Groups of Naïve (Pellet-Reared) and Wild Largemouth Bass (*Micropterus salmoides*) in a Laboratory Experiment

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Previous field studies indicated reduced feeding efficiency of pellet-reared largemouth bass during their transition from artificial feed to live prey, or a failure to transition, after being stocked into Florida lakes. We designed a laboratory experiment to compare the feeding efficiency of two size groups (mean = 300 mm and 100 mm total length) of naïve (pellet-reared) and wild largemouth bass (*Micropterus salmoides*). Fish were fed small live prey, bluegill (*Lepomis macrochirus*) and Seminole killifish (*Fundulus seminolus*) in the case of the larger size group of largemouth bass, and mosquito fish (*Gambusia affinis*) in the case of smaller fish. Laboratory feeding experiments were run for 48 hours with largemouth bass as a solitary predator for both size groups, and the larger pellet-reared largemouth bass were also tested as a group predator. Larger pellet-reared fish were not able to catch live prey as a solitary predator, but they fed regularly in a group. Small pellet-reared fish fed on live prey significantly better than larger pellet-reared fish but significantly less than wild fish about the same size. Behavioral differences in predator-prey interactions were observed in tanks with naïve largemouth bass compared to tanks with wild fish. Our results show that the ability of pellet-reared fish to learn to feed on live prey decreases with age (or length of time on feed), and seem to be influenced by interaction with other fish present in the tank.

ANGLING AND ANGLERS I

Recreational Specialization, Preferences and Management Attitudes of Tennessee Tailwater Trout Anglers

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Segmenting angler populations into subgroups using data on fishing behavior, preferences, and avidity can help fisheries managers understand the wants and desires of recreational anglers. A study of trout anglers on eight tailwaters in middle and eastern Tennessee was conducted for this purpose. A 10-page mail survey was sent to 1,082 trout anglers who agreed to receive the survey after being interviewed on-site for an affiliated study. Response rate was 77% (excluding surveys that were undeliverable). Angler subgroups were formed using four hierarchical cluster analyses of fourteen variables related to angling experience, resource use, investment, and centrality to lifestyle. Five groups of anglers were identified, and nonhierarchical cluster analysis was used to determine the size of each group, which ranged from 118 to 263 individuals. Groups varied widely in their angling experience and investment in fishing equipment. Anglers ranged from novices new to the sport to highly specialized anglers that had many years of experience pursuing trout. Group attitudes differed significantly in regards to the importance of harvesting trout; higher-specialization anglers supported more stringent regulations.

Angler Demographics, Participation and Attitudes Towards Recreational Fishing at Community-Fishing Ponds in Little Rock and Pine Bluff, Arkansas

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We conducted surveys (May through September 1999-2000) to assess angler demographics, participation, and attitudes towards recreational fishing at community-fishing ponds in Little Rock and Pine Bluff, Arkansas. A total of 192 and 155 interviews were completed at two Pine Bluff ponds and at five Little Rock ponds, respectively. Children < 16 years old comprised 40% of anglers in both communities. In Pine Bluff, 15% of anglers were senior citizens and in Little Rock 9%. African-Americans represented 69% of the anglers in Pine Bluff and 78% in Little Rock. Approximately 20% of anglers in both communities traveled < 1 mile to fishing locations and 46% traveled between 1 and 5 miles. Although variable between locations, the majority of anglers preferred to catch channel catfish followed by bluegill, largemouth bass, and crappie. Overall, satisfaction with fishing success was poor but most anglers rated their fishing-trip experience as good. Angler groups were categorized based on race, frequency of participation (frequent, moderate, and infrequent), and distance traveled to fishing locations (<1 mile, 1-10 miles, and >10 miles). These groups were cross-tabulated with question responses related to participation at fishing locations, motivations for fishing at these locations, species preference, and satisfaction ratings.

Effects of Young Anglers on Hybrid Bluegill

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Hybrid bluegill are becoming increasingly popular for stocking at youth fishing clinics and urban recreational fisheries. However, no data has been published to suggest the impacts of young anglers (ages 12 and under on hybrid bluegill. The objective of our study was to quantify catch rate and short-term angling mortality associated with young anglers. We held two fishing clinics to estimate catch rates of stocked hybrid bluegill. Anglers were observed for 10-minutes intervals throughout the clinic. We also conducted catch and release mortality trials to estimate short-term mortality of fish captured by young anglers. Fish were held in net pens and observed for 36 hours following capture. Mean catch rates for hybrid bluegill at the two fishing clinics were 7.1 and 4.3 fish/hour. We estimated that 66% of stocked hybrid bluegill was captured during a two-hour fishing period. We observed only one death from a total of 80 captured fish during our mortality trials. These data indicate that hybrid bluegill are suitable candidates for catch and release management.

Angling Susceptibility of Spotted Bass in the Buttahatchee River, Mississippi

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In the summer and fall of 2000, we estimated susceptibility of stock-length (≥180-mm) spotted bass, *Micropterus punctulatus*, to angling in the Buttahatchee River, Mississippi. Population estimates for two segments of the river (an unaltered upstream site and a downstream site altered from gravel mining) were made from a multi-census mark and recapture effort using pulsed-DC boat mounted electrofishing equipment. Controlled angling was conducted to estimate angling susceptibility. Shallow riffles bordering the study areas were presumed to block fish movement into and out of the study areas. Population estimates and density between the sites varied greatly with the unaltered site having 2.6 spotted bass/100m of stream and 11.2 spotted bass/ha, while the altered site contained 8.3 spotted bass/100m of stream and 34.8 spotted bass/ha. Angling catch per effort for the unaltered site was 0.95fish/h with a potential harvest of 7.1 fish/ha, and the altered site had a catch per effort of 1.1 fish/h and a potential harvest of 7.9 fish/ha. Based on these harvest rates approximately 23% and 68% of the spotted bass populations could have been removed from the altered and unaltered sites in 40 angler hours. Results indicate that spotted bass populations in the Buttahatchee River can be highly vulnerable to angling exploitation.

Populations Characteristics of Riverine Smallmouth Bass in Tennessee and Simulated Effects of Length Limits

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We described population characteristics of riverine smallmouth bass (*Micropterus dolomieu*) in Tennessee and used F.A.S.T. modeling software to identify harvest restrictions that would maximize PSD and RSD14, and secondarily, maximize yield. From 1995 through 2000, we collected 3,185 smallmouth bass from 72 locations and determined age using otoliths. For the

average population the predicted total length at age was 106, 166, 218, 261, 298, 329, 356, 379, 398, and 415 mm for ages 1 to10. We used von Bertalanffy growth parameters estimated for the statewide population, a range of conditional fishing mortality (*cf*) rates (5 to 50%), and a range of conditional natural mortality (*cm*) rates (10 to 50%) to simulate the effects of 256-, 305-, 356-, and 406-mm minimum length limits and protected length ranges (slot limits) from 305-356, 305-381, and 356-432 mm. Under the circumstances where regulations were effective (*cm* ≤ 30 %, *cf* ≥20 %), the 356-mm minimum length limit appeared to be the best regulation for the average smallmouth bass fishery in Tennessee's streams and rivers.

A Case History of Salmonid Fishing Regulations in Great Smoky Mountains National Park: 1934-2001

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Since the establishment of Great Smoky Mountains National Park (GRSM) in 1934, fisheries managers have utilized about every regulation in the fishery managers toolbox to manage salmonids. Our objectives were to summarize the regulation history of GRSM, determine if regulations met management objectives, and determine if regulations effected the age structure, growth, and population dynamics of wild salmonid populations within GRSM. Initial data comparisons were made difficult due to an absence of data, lack of continuity, and inconsistencies in collection procedures. Rainbow trout length frequency data varied very little among regulation periods. In addition, there was no significant difference in mean numbers of sub-legal (< 7-inch) or legal (> 7-inch) rainbow trout per stream mile among various regulation periods. Rainbow trout mean lengths at age data indicate no significant differences among similar populations for age-0 to age-4 rainbow trout. There were also no significant differences in annual mortality rates (age-2+ to age-4+) among fished and unfished populations throughout the study period. In summary, regulations had little effect on wild rainbow trout populations in GRSM. Abiotic events, such as droughts and floods, have a much greater effect on salmonid dynamics in GRSM than regulations or fishing pressure.

ANGLING AND ANGLERS II

Net Value of Trout Fishing Opportunities in the Clinch River, Tennessee

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A roving angler survey was conducted between March and November 2001 to collect visitation data from trout anglers fishing the Clinch River below Norris Reservoir, Tennessee. The contingent valuation method (CVM) was used to estimate the net value of trout angling opportunities in the Clinch River. The contingent valuation questions examined the value of a trout fishing trip under present conditions and several management scenarios. These scenarios included the increased chance of catching more trout, the increased chance of catching a large trout (>406 mm TL), and changes in the discharge regime from Norris Dam. The net value of

trout fishing in the Clinch River under current conditions was estimated to be $52.14 per trip. Estimates of consumer surplus were $56.32 per trip for the increased chance of catching twice the number of trout and $46.97 per trip for doubling the chance of catching a large trout. Current travel cost and visitation information will be paired with 1996 Clinch River trout angling effort data to determine net value using the travel cost method (TCM). Consumer surplus estimates obtained from the two methods will then be compared.

Evaluating Fishing Effort and Harvest of Flathead Catfish in Lake Carl Blackwell, OK

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The objective of our study was to estimate the effects of noodling and other fishing techniques on a population of flathead catfish in Lake Carl Blackwell, Oklahoma. We used creel and telephone surveys, tagging, and fishery independent sampling to estimate fishing effort, harvest, and population size and age structure. We completed 1001 telephone interviews that were used to estimate fishing effort. Fishing effort is highest for trotlines but more fish are harvested with juglines. We obtained 90 flathead catfish from the fishery that were used to estimate the size distribution of the catch. Thirty-two of these were harvested with trotlines and 56 were harvested by noodlers; the size distribution of these harvested fish was similar between fishing methods. We independently sampled 1,015 flathead catfish with gillnetting and electrofishing, and the size structure of the population was similar to the size distribution of anglers' catches for fish > 510 mm TL (the minimum legal length for flathead catfish in Oklahoma).

Angler Exploitation and Size Preferences of Flathead Catfish in the Missouri River: Initial Steps at Beginning to Manage for High Quality Fisheries

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We marked 2,946 flathead catfish (12.0-44.0 inches TL) with Carlin dangler tags within a fifty mile portion of the Missouri River near St. Joseph, Missouri to estimate angler exploitation and size preferences. All fish were marked during a two week period in early June from 1999-2001. To encourage tag returns, monetary rewards ($5-$100) were given. During the first two years of the study, uncorrected return rates were 10.0% and 7.2%, and uncorrected annual exploitation rates were 6.2% and 4.1%. Based on a surrogate post card return rate of 16%, corrected annual exploitation was 38.8% and 25.6% for the first two years, respectively. Both catch and harvest of flathead catfish varied by size. Tagged fish 12.0-14.9 inches TL were caught and harvested in lower proportions than expected ($P<0.01$), and fish 15.0-19.9 inches were caught and harvested in higher proportions than expected ($P<0.001$) when each was compared with the number of fish tagged within their respective size groups. No difference existed between the proportion of tagged fish greater than 20 inches TL that was either caught ($P>0.1$) or harvested ($P>0.5$) by anglers compared with the proportion of fish tagged within this size group. Results of this study will assist in developing regulations to provide high quality fisheries for flathead catfish in Missouri's large riverine systems.

An Evaluation of the Hooked On Fishing – Not On Drugs Program in Arkansas

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The Hooked On Fishing – Not On Drugs Program (HOFNOD) was introduced into Arkansas schools in 1977 to provide positive and fun alternative educational experiences for youth. The HOFNOD program was evaluated using teacher and student questionnaires. In 2000, 611 students and 54 teachers from 17 participating schools completed questionnaires. Twenty schools in 2001 completed 521 student and 36 teacher questionnaires. As a control, questionnaires were completed by 173 students from 4 schools that were not in the HOFNOD program. Most students in HOFNOD were in the 6th and 7th grades and Caucasian. Gender was evenly distributed. Most of the participating teachers were female, Caucasian, and had at least 10 years of experience. Teachers' responses revealed that participation in HOFNOD increased students' academic performance, learning motivation, school attendance, homework completion rate, and participation in fishing activities. Similarly, students' responses indicated that the program helped them become involved in productive activities such as fishing that were positively associated with increased learning motivation and academic performance.

Evaluating the Success of Youth Fishing Outreach Events at Recruiting License Buyers using a Point-of-Sale System in Texas

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Texas Parks and Wildlife (TPW) Inland Fisheries Division supports KIDFISH, a private outreach program designed to educate and provide hands on fishing experiences to children. An especially important part of these efforts has been introducing Texas youth to fishing so that they might become licensed anglers in the future. No estimate of the success that events have at recruiting participants into the licensed angling population of Texas has been made. We obtained entry forms for 6,554 KIDFISH participants from 1994 to 1999. The children's names, addresses and age were entered into a Microsoft Access database. We retained 388 records from the database retaining only the participants who had complete information and would have been 17 years old or older (ages when a fishing license is required) in FY 1999. We matched the names, zip codes and age for these participants with the TPW point-of-sale (POS) licensing system records for FY 1999 for resident fishing, special resident fishing, combination hunting and fishing and super combination hunting and fishing licenses. We determined that 28 participants purchased a recreational fishing license, 1 participant purchased a special recreational fishing license, 5 participants purchased combination hunting and fishing licenses, and 8 participants purchased super combination hunting and fishing licenses for a total of 42 (10.8%) of the 388 participants. We also obtained 800 records from the Texas Department of Public Safety to use as a control group. These names were randomly selected from similar age ranges as the 388 outreach participants. None (0%) of the 800 DPS records matched with TPW FY 1999 point of sale records. We are currently administering unique mail surveys to four groups: 1) outreach participants who purchased a fishing license, 2) outreach participants who did not purchase a fishing license, 3) non-outreach participants who purchased a fishing license, and 4) non-outreach participants who did not purchase a fishing license. The surveys will

measure such things as socio-demographic characteristics, family history of fishing and motivations for participating in extracurricular activities.

HABITAT AND LAND USE

Relationship Between Land Use and Stream Fish Assemblage Structure at Multiple Spatial Scales in Two Ecoregions of Arkansas

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Recently many studies have looked at how land use practices alter physical habitat, water quality, flow regime and ultimately aquatic faunas in streams. These attributes have also been found to differ between ecoregions. We looked at two different ecoregions in Northern Arkansas (Ozark Highlands and Boston Mountains), at four spatial scales (reach, stream, watershed, and ecoregion) to determine possible effects of land use on habitat and fish assemblage structure. We sampled fish and physical habitat annually, and water quality quarterly. Most of the Ozark Highland streams had high percent agricultural land use in the watershed, and most of the Boston Mountains streams had low agricultural land use. At the reach scale, there was no significant relationship between fish species richness and pool depth or riparian canopy angle for either ecoregion. At the watershed scale, fish species richness increased asymptotically with drainage area in the Boston Mountains, whereas there was no significant relationship between fish species richness and drainage area in Ozark Highland streams. Overall, species richness showed a non-linear relationship to percent agriculture within the drainage basin, peaking at 20-30% agriculture and decreasing at lower and higher levels of agriculture. This evidence supports the hypotheses that land use, as well as ecoregion, can affect fish assemblage structure in streams.

A Comparison of the Effects of Historical and Current Land Use on Fish Populations and Habitat

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With the increasing modification of rivers and streams by urban and agricultural development, it is necessary to determine to what extent human disturbances are reversible and how long recovery takes. In recent years, considerable emphasis has been placed on the protection and reestablishment of riparian zones as a method for improving overall stream quality. However, current efforts to mitigate lands immediately adjacent to streams may not be successful. Previous studies indicate that historical land use is a better predictor of present day fish abundance and diversity than current use. To better understand the relationship between historical and current land use as indicators of overall integrity of fish populations, this study examined 71 stream sites in Carroll and Heard counties within the upper piedmont ecoregion of western Georgia. Streams were sampled from May through November 2001 in both the Tallapoosa and Chattahoochee drainage basins. GIS data for present day land use and historical information from soils maps (1940-1960) will be correlated with IBI scores and habitat assessments. Analysis of data generated may enable land managers to better direct future stream restoration efforts.

Fish and Habitat Diversity in the Bayou DeLoutre Watershed

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Bayou DeLoutre is a relatively unimpacted stream in southern Arkansas and northern Louisiana that has become the focus of a conservation partnership of The Nature Conservancy and Plum Creek. Baseline information on the flora and fauna of the watershed are being collected to aid the Conservancy in selecting portions of the watershed for preservation. The objectives of this study were: 1) to examine current fish distributions in the Bayou DeLoutre watershed, 2) to compare current distribution patterns with historical records, and 3) to describe fish assemblage habitat associations. Fish populations in Bayou DeLoutre were sampled during the late summer and fall of 2000. Preliminary data analysis distinguishes Bayou DeLoutre samples from its confluence with the Ouachita River through Phillips Lake from those taken above Phillips Lake. Severe degradation of headwater streams with a concomitant loss of species richness in the vicinity of El Dorado, Arkansas was noted. It is recommended that conservation activities recognize the importance of both upper and lower portions of the watershed to fishes of the region**.**

Habitat Associations and Demographics of the Endangered Roanoke Logperch in Three Virginia Rivers: Implications for Conservation

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The ability to predict spatial distributions and understand factors that limit persistence in certain habitats is important for conservation of imperiled fishes. The endangered Roanoke logperch (*Percina rex*) has populations in four rivers in Virginia, yet, prior to this study, habitat use and demographics of three populations were poorly understood. Regional variation in geomorphology, community composition, and habitat availability can impact habitat use by fishes. We analyze habitat associations and demographics of logperch populations in the Roanoke, Pigg, and Nottoway rivers. The Roanoke and Pigg rivers are clear, coolwater, and high-gradient; while the Nottoway River is tannin-stained, warmwater, and lowland. Logperch in the Pigg and Roanoke rivers use deep, high-velocity riffles and runs, while logperch in the Nottoway River use deeper pools and runs with low water velocities. Logperch in all three rivers consistently use loosely embedded, silt-free gravel. The highest densities of logperch and increased numbers of the sub-adult age class were observed in the Nottoway River. Results indicate the danger of extrapolating microhabitat use patterns across systems. In addition, this comparison gives insight to limiting factors in the three systems, particularly the impact of silt loads on logperch demographics and habitat use.

Distributions of Fishes of the New River National Gorge, West Virginia, Following Major Flood Events

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During September and October 2001, we inventoried fishes of New River tributaries within the New River Gorge National River (Appalachian Plateau Province in southern West Virginia). Initially, our main objectives were to examine the influence of watershed and stream characteristics and nonnative species on the distribution and composition of fish species. Before the project, two major flood events occurred within our study area, and we have modified our

objectives to address flood impacts on fish distributions. Thirty-nine species were collected from thirty sites on tributaries within the New River National Park, including 19 cyprinids, 7 centrarchids, 6 percids, 3 salmonids, 2 catostomids, 1 cottid, and 1 ictalurid. Flood impacts in tributaries of the lower section of the New River Gorge National Park were greater than those that occurred in the upper section, and tributaries in the lower section had fewer fish species and lower population densities.

Longitudinal Patterns of Community Structure for Stream Fishes in a Virginia Tailwater

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Artificial disturbances in flow impose changes outside the natural range experienced by most stream fishes, limiting their distribution and abundance. Such high environmental variability provides an opportunity to understand mechanisms shaping fish community structure in a regulated river. Philpott Dam located on the Smith River, VA is a peaking, hydropower facility with hypolimnetic releases that create flows fluctuating from 30 to 1400 cfs. A primary objective of our research is to describe nongame species distribution, abundance, and diversity and to relate these patterns to environmental conditions. Preliminary results indicate that temperature regimes and tributaries influence nongame fish community patterns. Species distributions show a general trend of increasing abundance as distance increases from the dam and as temperature increases along the longitudinal gradient. However, peaks in fish abundance and diversity occur at tributary junctions. Tributary junctions may provide localized benefits to mainstem biotic communities, thereby increasing the likelihood that nongame species will persist in the Smith River tailwater. Understanding such mechanisms behind fish community structure in regulated rivers will improve efforts to manage streamflow and preserve aquatic life.

NONGAME FISH AND AMPHIBIAN SESSION

Local Movements of American Eels in Shenandoah River, West Virginia

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The Atlantic States Marine Fisheries Commission recently listed research needs, including the analysis of movements, to address management and conservation issues concerning the apparent population decline of American eel, *Anguilla rostrata*. To determine local movements, 13 eels (518-810mm TL) were captured in the Shenandoah River below Millville Dam, West Virginia, and surgically implanted with radio tags. The eels were relocated once weekly for nine weeks using triangulation techniques. Four of the 13 eels initially moved downstream, then upstream. Four initially moved upstream, then down. Two moved upstream and remained (one at the base of the dam), while one moved downstream and remained. One stayed at the release site, and one was not re-located. Only one eel returned and stayed near the capture site. Stream flow was relatively constant throughout the relocation period, but radio tagging effects, surgical healing time, and lunar phase may have played a role in the initial movement variability and patterns.

Preliminary Characterization of the Genetic Population Structure of the Tallapoosa Shiner

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The Tallapoosa shiner (*Cyprinella gibbsi*), listed as "rare" by the Georgia Department of Natural Resources, is endemic to the Tallapoosa drainage. This species is found in the Tallapoosa River system above the Fall Line in both Alabama and Georgia. Population samples were obtained from the lower Tallapoosa River in Alabama, the upper Tallapoosa River in Georgia, and the Little Tallapoosa River in Georgia. Genetic characterization of these populations was carried out by sequence analysis of the mitochondrial genes ND4L and ND4 (partial), and by RAPD-PCR. Comparisons of the data indicate genetically distinct populations at the extremes of the Tallapoosa River range and a mixing of these populations in the Little Tallapoosa River. These populations can be characterized by the distribution of four unique ND4L haplotypes. PCR primers were designed to specifically amplify the ND4L gene and all four of the ND4L haplotypes can be distinguished by SSCP. A thorough characterization of the genetic population structure of the Tallapoosa shiner throughout its range will be carried out this spring using SSCP analysis of the distribution of the ND4L haplotypes.

Distribution and Occurrence of Northern Cricket Frog (*Acris crepitans*) Abnormalities in Arkansas Based on 43 Years of Museum Collection Data

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The northern cricket frog (*Acris crepitans*) is a resident of streams, rivers, and wetlands of eastern North America. This species may be declining throughout its range and may be a water quality indicator. We documented abnormalities in cricket frogs from the Arkansas State

University Museum of Zoology Herpetology Collection. Abnormality frequency increased linearly from 1957 to 2000 (r^2 = 93.1%, P = 0.035). From 1957 through 1979 only 3.33% of specimens were unusual. This rate was 6.87% during the 1990's and in 2000 it was 8.48%. Hot spots were identified in Sharp, Lawrence, and Randolph Counties. We observed 106 abnormalities among 1,442 frogs (7.35%). Differential abnormality frequencies between agronomic regions and the Ozarks need study. Potential reasons for distributions include: 1) Acris might possess naturally high abnormality levels and land use practices may reduce this variability, 2) agronomic fields might act as reproductive sinks reducing numbers of abnormal individuals, 3) an unknown xenobiotic may be in Ozark streams, 4) the museum's collection effort may be skewed, 5) Extraordinary populations of green tree frogs (*Hyla cinera*) suggest agronomic habitat might be favorable for this species. It may compete with *Acris* and selectively prey on less mobile abnormal cricket frogs.

The Status of Rare Fishes in Carroll and Heard Counties, Georgia

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In conjunction with a watershed assessment of the streams in Carroll and Heard counties conducted during the summer of 2001, the objective of this study was to delineate the presence of rare fishes within the Tallapoosa and Chattahoochee river drainages. Six rare species of fish where identified within these two counties. Thirty-eight sample sites on twenty-one streams in the Chattahoochee drainage yielded four rare species: *Noturus funebris, notropis hypsilepsis, Fundulus bifax*, and *Cyprinells gibbsi*. Thirty-four sample sites on twenty streams in the Tallapoosa drainage were sampled with four rare species collected: *Noturus funebris, Fundulus bifax*, *Etheostoma tallapoosae*, and *Cyprinella gibbsi*. The distributions of these species juxtaposed with their historical ranges, habitat and physiochemical stream parameters including sedimentation, siltation, stream impoundments and IBI scores will be addressed. The increased demand for water due to the growth and development in both Heard and Carroll counties, as well as the ongoing drought conditions may have already impacted the distribution of these fishes. The current distribution of rare fishes within these two developing rural counties will be an important consideration when planning for future growth.

Morphological Comparisons of Hatchery-Reared Specimens of *Scaphirhynchus albus*, *S. platorynchus*, and *S. albus* x *S. platorynchus* Hybrids

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Habitat modifications within the Mississippi and Missouri rivers have lead to presumed hybridization between the endangered pallid sturgeon, *Scaphirhynchus albus*, and the sympatric shovelnose sturgeon, *S. platorynchus*. Several character indices have been developed to identifying specimens of *Scaphirhynchus*, but these indices have numerous assumptions. To test these indices, we examined progeny (60 specimens, 78-600 mm SL) of "known" pallid, shovelnose, and hybrid sturgeon that were propagated, raised, and preserved at hatcheries from brood stock captured in the upper Missouri River Drainage. Results indicate that current indices

do not correctly identify small (< 250 mm SL) or combined sizes of *Scaphirhynchus*, and fail to differentiate large *S. albus* from hybrids. A standard principal components analysis (PCA) was employed on 13 meristic characters and a sheared PCA on 51 morphometric variables; a PCA requires no a prior knowledge of the identity of the specimens. These analyses provided complete separation between these sturgeon species and their hybrids. PCA with a reduced character set of 6 meristic and 12 morphometric variables also lead to accurate and reliable specimen identification. It is essential for researchers to collect appropriate data and photograph released specimens for positive identification for genetic or any other studies to be valid.

Combining Inferences from Models of Capture Efficiency, Detectability, and Suitable Habitat to Classify Landscapes for Conservation of Threatened Bull Trout, *Salvelinus confluentus*

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Effective conservation efforts for at-risk species require knowledge of the locations of existing populations. Species presence is typically estimated by conducting field sampling surveys or alternatively, by developing predictive models. Direct surveys can be expensive and inefficient particularly for rare and difficult to sample species, and models of species presence may produce biased predictions. Here we present an empirical Bayesian approach that combines sampling and model-based inference for estimating species presence. The accuracy and cost-effectiveness of this approach was compared to that of direct surveys and predictive models for estimating the presence of the threatened bull trout (*Salvelinus confluentus*) via simulation with existing models and empirical sampling data. Simulations indicated that a direct sampling approach would be the most effective and would result in the lowest presence and absence misclassification error rates for three detection probability thresholds. However when sampling effort is considered, the combined approach would result in the lowest error rates per unit of sampling effort. Hence, lower probability of detection thresholds can be specified with the combined approach, resulting in lower misclassification error rates and improved cost-effectiveness.

HABITAT ASSOCIATION I

Assessment of Short-Term Impacts to Stream Fish Communities and Habitat Associated with Culvert and Bridge Construction in Tennessee

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Stream fish communities, habitat, and water quality were evaluated in seven Tennessee streams designated for culvert/bridge construction. Surveys were conducted through spring 2000 to 2001, covering different sampling phases: pre-construction, during construction, and post-construction. Each stream was sampled approximately every 6-8 weeks, with four 100-m sampling reaches per stream; two above the anticipated culvert/bridge (control sites) and two below the construction site (impact sites). Fish were sampled using single pass backpack electrofishing to determine fish community similarity, diversity, and species richness. Stream habitats were evaluated using a habitat unit approach, where each unit's width, depth, length, substrate, and percent composition of fines were determined. Two stream cross-sections (one impact station and one control station) were temporarily benchmarked to examine potential stream channel morphology, flow, and discharge changes resulting from construction activities. Water quality parameters measured included: turbidity, dissolved oxygen, temperature, conductivity, pH, alkalinity, acidity, and select metals. Analysis of fish community data was performed using ANOSIM (Analysis of Similarity), and Two Factor ANOVA analyses for metric diversity indices and water quality parameters. Preliminary data suggest possible extirpation of sensitive species, proliferation of tolerant and pioneering species, temporary increases of turbidity and fines, decrease in pool depth, and elimination of some spawning habitat with possible impacts to sensitive non-game fishes.

Habitat Associations with Upland Stream Fish Communities in Bankhead National Forest, Alabama

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Fishes were semi-quantitatively sampled at nine sites in the Sipsey Fork River drainage in Bankhead National Forest, Alabama to examine associations between habitat variables and stream fish communities. A total of 20 physical and chemical habitat variables were measured at each site and their relationships with fish community were explored by examining correlations, regressions and principal components analyses. Regression models indicated that high richness, diversity and numbers of fishes were correlated with high stream banks, greater mean water depth, and standard deviation of velocity. Principal components analyses indicated that stream size was strongly associated with species richness, total number of fishes collected, and percid relative abundance. Relative abundance of centrarchid species was also associated with lower velocity, undercut banks and large woody debris (LWD). Cyprinid relative abundance was associated with higher velocity and negatively associated with LWD.

Fish Habitat Associations in a Southern Prairie Stream: Implications for Instream Flow Studies

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Information on fishes and habitats was collected in the Sulphur River, a highly modified system in northeast Texas, as part of an instream flow study. Classification and ordination analyses were used to describe relationships between fish assemblages and habitats at coarse, intermediate, and fine resolutions of physical habitat structure. For all resolutions, there was a significant ($P = 0.005$) relationship between variation in species and variation in habitat. As the resolution of habitat broadened from fine to coarse, there was a corresponding decrease in the amount of species variation explained from 35.8% to 23.8%. Variance decomposition revealed that depth, velocity, reach, and discharge variables explained 16.6% of the variance across all resolutions whereas structural habitat variables explained 19.3% for the fine resolution, 13.3% for the intermediate resolution, and 7.2% for the coarse resolution. At the intermediate level of resolution, microhabitat structural variables explained more variance (5.8%) than did mesohabitat (3.6%) or location (2.4%) variables. Scale must be considered in fish-habitat studies. If managers wish to base instream flow decisions on an appropriate ecological scale, they will need to weigh the costs and benefits, both logistical and ecological, of what it takes to collect data on increasingly finer resolutions of habitat.

Effects of Low-Water Bridges on Fish Community Structure and Population Density in Streams of the Ouachita Mountains

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Low-water bridges have been shown to inhibit fish passage; however, few studies have investigated effects of reduced movement on fish communities in warm-water streams. In the summer of 2001, we sampled fish communities in 21 streams on the Ouachita National Forest, Arkansas to assess the influence of road-crossings on fish community structure and population density. Each low-water bridge consisted a concrete slab with 1-4 concrete or corrugated steel culverts. Fish were collected by 2-pass electrofishing from four, 50-m, reaches (two upstream and two downstream of each crossing) that were each separated by a 50-m, non-sampled, buffer reach. Physical characteristics of the crossings such as culvert velocity, apron height, and plunge pool depth were measured for all streams within a span of two days. Species richness was significantly lower in the upstream reaches (upstream mean=7.14, downstream mean=9.38, $p \leq 0.01$) indicating that reduced re-colonization from downstream reaches affects the structure of fish communities. Furthermore, abundance of certain families and species was also significantly lower upstream of the road crossings (e.g. sunfish, sucker, minnow families, Ouachita madtom and orangebelly darter species, $p \leq 0.1$). Spring baseflow culvert-velocities exceeding 0.6 m/s were consistently associated with lower upstream richness. These findings may assist efforts to prioritize management and replacement of low-water bridges in forested ecosystems.

Movement and Passage of American Shad at the New Savannah Bluff Lock and Dam

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Dams have served as substantial obstacles to anadromous fish migrations. However, the effectiveness of locks in facilitating up-stream passage has not been fully evaluated. We implanted 50 migrating adult American shad *Alosa sapidissima* with radio transmitters in the vicinity of the New Savannah Bluff Lock and Dam, a low-head regulator facility on the Savannah River, and monitored movement and passage during the period of annual upstream spawning migration. After transmitter implantation, 46 % exhibited fall back behavior but resumed upstream migrations within 21 d, 14% exhibited fall back behavior and did not later resume upstream migration, 16% exhibited fall back behavior and either died or expelled their transmitter, and 24% remained in the vicinity of dam. In order to facilitate fish passage, the lock was operated continuously for 8 hours one day per week. One lock cycle consisted of a one-half hour period of attraction flow with the lock doors open, followed by a normal lock event, followed by a one-half hour period when the upstream lock door were left open. Of those fish remaining or returning to the dam after transmitter implantation, 49% passed upstream through the lock. We conclude that an aggressive locking schedule with an attraction flow may be an effective method of facilitating upstream passage of American shad in some situations.

HABITAT ASSOCIATION II

Spawning Activity of Migrating Adult Shortnose Sturgeon in the Pinopolis Lock and Dam Tailrace: Preliminary Results

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The reductions in numbers of shortnose sturgeon *Acipenser brevirostrum* has been largely attributed to reduced recruitment, resulting form the construction of dams that block passage to important spawning areas. The use of alternative spawning areas by dam-impaired migrating sturgeon has not been fully investigated. We deployed an array of 50 stationary egg collectors in the tailrace downstream of the Pinopolis Dam on the Cooper River, South Carolina in an area where shortnose sturgeon have reportedly spawned in previous years. Egg collectors were examined daily throughout the spawning season. Eggs were removed, preserved, and identified in the laboratory. Spawning activity was evaluated in relation to river stage, discharge, and substrate. Preliminary results will be discussed.

Movement of Migrating Adult Shortnose Sturgeon Artificially Passed above a Lock and Dam into a Large Southeastern Reservoir: Preliminary Results

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Fish passage facilities have been used successfully to allow anadromous species to access historic spawning grounds when associated with run-of-the-river type dams. However, the effectiveness of fish passage facilities when associated with dams impounding large reservoirs as are common in the southeast has not been previously evaluated. In this study, we document the behavior of migrating adult shortnose sturgeon *Acipenser brevirostrum* artificially passed above a dam into a large reservoir in the area of a proposed fish passage facility. Shortnose sturgeons will be captured downstream of the Pinopolis Dam, implanted with radio transmitters, and released above the dam into a large reservoir. Telemetry methods will be used to follow the sturgeon throughout the reservoir and associated river system. In addition to movement patterns, water quality and substrate composition will be monitored in areas that shortnose sturgeons are found to utilize.

A Behavioral Comparison of Wild and Hatchery-Reared Adult Shortnose Sturgeon in the Savannah River: Preliminary Results

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Wild adult shortnose sturgeon *Acipenser brevirostrum* exhibit a high degree of fidelity for their natal riverine or estuarine system. However, wandering of a small proportion of stocked hatchery-reared juvenile sturgeon into other river systems has been observed. Although homing may be reduced in hatchery-reared fish, migratory patterns may be similar. As spawning migrations only occur in adult, sexually mature fish, migrations may be correlated with hormonal

changes associated with sexual maturation. Few studies have been published regarding the behavior of sterile fish. In this study, we compare the migratory behavior of adult sterile and non-sterile hatchery reared shortnose sturgeon with that of wild shortnose sturgeon in the Savannah River. Ten wild fish and ten fish from each of four hatchery-reared treatments (diploid, triploid, sterilized by complete gonad removal, and sterilized by partial gonad removal and duct ligation) were implanted with combined radio and acoustic transmitters and released in the Savannah River in the spring of 2002. Fish were located several times each week during the spawning migration and twice monthly during the remainder of the life of the transmitters. Differences in migration behavior and habitat selection will be discussed.

Fish Habitat Associations within the Kisatchie National Forest, Louisiana, USA

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The U.S. Department of Agriculture Forest Service has an ongoing commitment to monitoring and protecting fauna native to National Forest streams. This study was designed to establish baseline fish abundance and environmental data for streams of the Kisatchie National Forest (KNF). The data will be incorporated into a model to better predict cumulative effects of forest-related activities on aquatic resources throughout the KNF. The KNF is made up of six districts, Caney, Winn, Evangeline, Catahoula, Kisatchie, and Vernon, which are part of five different watersheds (Red River, Ouachita River, Calcasieu River, Little River, and Atchafalaya Basin). Fifty-seven sites were sampled by electrofishing throughout the six KNF districts during the summers of 2000 and 2001. 11,603 specimens of 54 species were collected. Canonical correspondence analysis detected strong fish-habitat associations due to a small subset of the 27 physicochemical parameters evaluated at each site.

STREAM/RIVER MANAGEMENT III

Texas Water: Will There be Enough for Fish by the Year 2030?

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The objective of this study was to spatially analyze the supply and demand for water in Texas today and make projections for the year 2030. Data analyzed in a geographical information system (GIS) include the 100-year average precipitation for the state, the historical and projected human population, the areas of the land devoted to crops, urban development and roadways, and an analysis of habitat fragmentation. The Texas population of 21 million today is expected to be 32 million by 2030. Croplands, urban areas, and roadways are rapidly fragmenting habitat and placing uneven demands on local water supplies. With 85% of Texans residing in urban areas, the demand for water, both quality and quantity, is stressing the supply. Today, based on the average 100-year precipitation, residents of West Texas have more water available per capita than do residents of East Texas. With the pressures to move water from rural areas to urban areas, will there be adequate water to maintain in-stream flows by the year 2030? There will not be adequate water unless we adopt a system to recycle and reuse freshwater today.

Assessment of Electrofishing Removal Sampling in Small Streams

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Knowledge of stream fish assemblage structure is necessary to meet a variety of objectives, but little work has been done to assess sampling methods for fish in small streams. I used six-pass electrofishing at six sites in two Ozark Mountain streams to determine the effect of number of electrofishing passes on estimates of fish abundance, relative abundance, and species richness, and to determine capture probabilities for small stream fish. Two-pass sampling averaged 91.0% (SD=12.9) of species and 65.3% (SD=7.2) of individuals collected in six passes. Based on six-pass removal sampling, capture probabilities averaged 0.31 and 0.42 in the two streams, but differed among fish species. Some species were not effectively sampled with removal electrofishing (i.e., removal failed for whitetail shiners and slender madtoms at some sites), whereas central stonerollers had relatively high capture probabilities (>0.5) and darters showed higher capture probabilities (0.3-0.5) than previously reported. The equal capture probability model was most often selected as the best fit to the data. Two- and three-pass removal sampling usually underestimated population abundance with decreased precision compared to six-pass sampling. Removal sampling should be tailored to the goals of a particular study. For example, fewer passes may be necessary to adequately determine species richness and relative abundance, whereas greater sampling effort may be required to provide adequate population density estimates.

Periphyton Communities of Ozark Streams and Their Relations to Selected Environmental Factors

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Periphyton samples were collected at 51 stream sites in the Ozarks of Arkansas, Missouri, and Oklahoma. Water quality and other environmental factors also were measured at the sites. These sites were categorized into land-use categories. Statistically significant ($p<0.05$) differences in periphyton metrics (measures of diatom, blue-green, oligotrophic, and tolerant algae dominance) were identified among sites assigned to agriculture, forest, and mining categories and results suggest that periphyton communities of Ozark stream riffles are affected by natural and land-use related factors. These factors include nutrients, organic carbon, alkalinity, shading, suspended sediment, embeddedness, stream morphometry, and grazer abundance. Although few factors were correlated with total or blue-green algae biovolume, several factors were significantly correlated with biovolume of diatoms. Biovolume of diatoms was correlated with orthophosphorus, total phosphorus, alkalinity, and dissolved organic carbon concentrations and embeddedness. Diatom relative biovolume was much higher at mining sites than at forest or agriculture sites and was correlated with several factors, including many land-use related factors. Snails and stoneroller abundance are related to periphyton biovolume and community composition. Total periphyton and diatom biovolume typically were highest at sites where snail density was lowest. Lower relative abundances of diatoms usually occurred at sites with higher snail densities and stoneroller relative abundances.

Looking at All the Angles in Stream Rehabilitation

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A new era relative to stream rehabilitation, habitat improvement, and streambank erosion control has occurred throughout the Southeast and the nation. Utilizing various "bioengineering" techniques, the emphasis has been on using trees, cedar revetments, rootwads, vegetation, erosion control matting, and boulders in sculpting a renovated and more natural channel in damaged systems. Riprap has been a four-letter word in this new paradigm, probably due to its overuse by agencies with the responsibility to stop streambank erosion or keep rivers navigable. A new chapter is being written, however, due to the increased use of rock vanes for erosion control by engineers, hydrologists, and yes, even biologists. Rock dikes have been used since the times of the Caesers in Rome to "push" rivers where man wanted. The Army Corps of Engineers have utilized rock barbs and dikes to move the current of rivers to scour deeper thalwegs for navigation. Later, the Corps used bendway weirs to decrease erosion on low gradient floodplain rivers. Hydrologists are working with fisheries biologists now to show how the use of upstream angled rock vanes, along with topical use of boulders, can be a significant tool in slowing bank erosion while providing instream fish habitat. Much less rock (aka. riprap) is used than in traditional stabilization efforts, streambanks are stabilized, currents can be redirected when necessary, while streambank cover and diversity are maintained and velocity refugia and feeding stations are established. Several of these upstream angled rock vanes have been used in Arkansas on various sized rivers with good results. Some examples are given from various ecoregions around the state.

Fish Assemblages from 1972-2001 on Vache Grasse Creek at Hwy 22 in Sebastian County, AR, with Comparisons in 1992 to Streams of Nearby Fort Chaffee Military Base and the Arkansas River

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Students at University of Arkansas Fort Smith have helped to survey fishes in Vache Grasse Creek at Hwy 22, Sebastian Co AR since 1972. In 1992, this site, nearby sites on Fort Chaffee, and the Arkansas River were sampled during a biodiversity survey. Expected species richness and dominance among collections were calculated using simulation models and rarefaction to control for abundance. In 1992, expected species richness ranged from 4.5 to 10.6, and dominance from 0.70 to 0.22. At the Hwy 22 site, expected species richness across years ranged from 4.7 to 11.1 and dominance from 0.46 to 0.20. Similarity among sites in 1992 ranged from 0.97 to less than 0.14, but mean similarity was higher (0.49) than expected by chance (0.12). At the Hwy 22 site, similarity also was higher (0.43) than expected by chance (0.14) and ranged from 0.10 to 0.89. Differences among assemblages in 1992 were primarily related to drainage location and species' life history characteristics. Summer-fall collections at Hwy 22 and headwater sites in 1992 had more species with opportunistic and equilibrium-periodic strategies, whereas periodic and opportunistic-periodic strategies were common in mainstem sites in 1992 and winter-spring collections at Hwy 22.

STREAM/RIVER MANAGEMENT IV

Target Fish Assemblages for Aquatic Restoration: An Example from the Lower Little Tennessee River Basin

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Natural resource managers face many difficulties in assessing impacts of existing projects, including hydroelectric facilities built in the early 1900's in areas where pre-project fish assemblages were not sampled. Assessing impacts of flow regulation and reservoir-induced habitat fragmentation without pre-project information requires managers to define objectives for restoration based on indirect evidence of the pre-project status of the system and knowledge of modern constraints which may extend beyond the boundaries of a given project. We summarize the challenges we encountered and strategies used to develop restoration targets for the fish assemblage of the Cheoah River, a tributary to the lower Little Tennessee River in North Carolina, and Calderwood bypass, a remnant of the Little Tennessee River between two mainstem reservoirs in eastern Tennessee. We used detail fish distributional information from the literature, sampling records, and museum collections, as well as comparisons of physiographic and other characteristics of sister drainages in the area to derive a list of known and possibly occurring species from the two regulated rivers which are currently bypassed. We attempted to infer this natural fish assemblage, along with relicensing studies for the Tapoco Project, a system of four dams between TVA's Fontana and Tellico projects, to form a basis for recommending changes in flow and temperature regimes to restore systems to a more natural state, and judge the potential impact of operational changes proposed for other reasons. For example, thermal regimes of flows restored to bypassed reaches will significantly influence how fish assemblages respond. Flow delivery to the Cheoah River (e.g, cold-deep or warm-shallow reservoir outlets) and thermal alterations of the Little Tennessee River by hypolimnetic Fontana discharge are thus important considerations for managing these systems. Other flow-related questions involve provision and scheduling of flows for whitewater recreation in the Cheoah River, and dominance of the Little Tennessee River hydrograph by TVA operations. Natural resource agencies may request flow regimes with seasonal variation and periodic (annual and multi-annual) disturbance events in order to improve aquatic and riparian conditions and restore functions of more natural patterns of flow regime variability. Following habitat restoration with natural-like flow releases, some species, excluded by these projects for many decades, may still be unable to recolonize target areas due to migration barriers or lack of nearby source populations. We expect that reconstruction of a target assemblage will require translocation of Little Tennessee genetic stock. These restoration targets should be regarded as scientific hypotheses, and the means used to approach them viewed as large-scale experiments amenable to verification, and where feasible, adaptive management.

Brook Trout Restoration, Great Smoky Mountains National Park: History and Future

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In 1976, the Park initiated efforts to restore stream segments upstream of natural barriers to native brook trout but backpack electrofishing was the only method approved for this work. Initial results indicated that five to seven years of annual removals were required to eliminate non-native rainbow trout from a stream. However, in 1996 we initiated the use of multiple removals in a summer and were successful in restoring streams in two years. We also initiated the process to evaluate the use of antimycin to restore stream segments in 1996. Antimycin was used in October 2000 to eliminate rainbow trout from 4.8 km (3.0 miles) of Sams Creek. Aquatic insect surveys were collected within one to four days after the cessation of treatment to evaluate impacts. Visual surveys conducted during and after treatment found numerous species of aquatic insects and indicate that salamander and crayfish populations were not impacted. However, follow-up surveys demonstrated that mayfly populations downstream of the potassium permanganate station were severely impacted. Post treatment fish population surveys conducted in this area showed that fish were virtually eliminated from the potassium permanganate station downstream to the confluence with Thunderhead Prong, but were not impacted below that point.

Contribution of Stocked Fingerling Brown Trout in the Lake James Tailrace, North Carolina

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The Lake James tailrace extends for 29 km in western North Carolina. Hypolimnetic releases provide suitable temperatures for trout, but seasonally low dissolved oxygen levels and a heavy bedload of sand were seen as potential limiting factors to a quality trout resource. The North Carolina Wildlife Resources Commission (NCWRC) has managed the upper 1 km of the tailrace as a put-and-take trout fishery for over 30 years. The NCWRC began annual stockings of 25,000 brown trout *Salmo trutta* fingerlings into the upper 18-km of the tailrace in 1996. This study was conducted to determine if stocking fingerling brown trout is a suitable management strategy for maintaining a brown trout population in the tailrace. Twenty-five thousand brown trout fingerlings were coded wire tagged and stocked in May 2000 (mean, 90 mm) and 2001 (mean, 86 mm). Twenty-three sites were boat electrofished in September 2000 and 2001. Overall, 88% of age-0 brown trout in 2000 (N=81) and 75% in 2001 (N=109) were tagged. Tagged age-0 brown trout growth varied little between 2000 (18.2 mm/month) and 2001 (16.6 mm/month). In addition, 36 tagged age-1 brown trout (mean, 291 mm) were captured in 2001, indicating growth past age-0 is good. Preliminary results of this study indicate that spring stocking fingerling brown trout is maintaining a quality brown trout population in the tailrace.

Trout Population Changes Following Habitat Modification in Dry Run Creek

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Dry Run Creek is located in Baxter County, Arkansas and is fed by the discharge from Norfork National Fish Hatchery. The creek is managed as a catch and release stream for handicapped anglers and youths under the age of 16. Dry Run is a very popular location to take young anglers

due to its dense trout population. Fish in the creek often reach five to ten pounds. The stream is relatively narrow and short, flowing less than ½ mile before entering the Norfork River. Prior to the modifications, the upper 64 meters of Dry Run were under utilized by anglers. The streambed is bedrock and water depths were typically only a few centimeters. Two wedge dams and one double wing deflector were installed in this section of the creek during the spring of 2000. This created three pools whose depths reached approximately ½ meter. Trout population estimates were made on November 5th, 1999 and on November 14th, 2000, following the modifications. All species of trout had higher mean lengths following modifications, however only brown trout were significantly longer. Trout densities increased by a factor of 3.25, from 7,042 per kilometer prior to the modifications to 22,926 per kilometer after the modifications.

RESERVOIR MANAGEMENT III

Three Decades of Cove Rotenone Sampling in Tennessee Valley Reservoirs: Implications for Reservoir Aging

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A paradigm held by fisheries scientists is that over time, reservoirs undergo a successional process that has been termed "reservoir aging". This process is characterized by a period of high productivity in the years immediately following impoundment (trophic upsurge), followed by a period of decreasing productivity (trophic depression) which leads to a state of relatively stable productivity over time (trophic equilibrium). The Reservoir Committee has undertaken an effort to examine historical changes in fish densities and standing crops in reservoirs to gather empirical evidence of how the reservoir aging process has affected fish populations in Southeastern reservoirs. In conjunction with this effort, we examined densities and standing crops of fishes collected during cove rotenone sampling in over 40 Tennessee Valley reservoirs. Only Three reservoirs had long-term, reliable data from fixed stations. Wheeler and Chickamauga, mainstream Tennessee River impoundments, and Cherokee, a tributary impoundment, each had only two coves, which met the data criteria. Total densities of fish did not change significantly in the three reservoirs, but one cove each in Chickamauga and Cherokee had increased standing crops. Regression analyses indicated that forage fish densities and standing crops changed very little through time, game fish increased somewhat, and rough fish tended to decrease.

An Historical Perspective of Age and Size Structure of Flathead Catfish in Lake Carl Blackwell, OK

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We studied a flathead catfish population in Lake Carl Blackwell, Oklahoma from 1998-2001. The population was also studied from 1968-1972 and this provides a unique opportunity to compare life history traits and population characteristics over time. In 1968, Turner estimated that there were 532 fish greater than 575 mm in the population. We estimate the current population size of fish greater than 575 mm to be 1,647 individuals. The current exploitable population (>510 mm) of flathead catfish has shifted to larger sizes. Our modal size was 725 mm, compared to Turner's estimate of 625 mm. It also appears that the size at maturity of females has declined. Fifty percent of our females were reproductively mature at approximately 300 mm and 100 % were mature by the time they reached 500 mm. Turner's smallest reproductively active fish was in the range of 450-475 mm. Population size estimates and the size distribution of fish >510 mm indicate that the population has grown. Increasing population size may be due to decreased exploitation but may also reflect differences in study design. Conversely, declining size at maturity is usually an indication of high exploitation on larger individuals.

Estimating Fish Age: Valid Methods Are Not Enough

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Past authors have stressed the importance of validating methods to estimate fish age. However, individual differences in interpretation ensure an element of subjectivity will be retained. As a result, an individual reader's age estimates can be highly erroneous, even when valid methods are used. To demonstrate, I validated a method using sagittal otoliths for estimating ages of largemouth bass *Micropterus salmoides* to 16 years. Thirty-six biologists and technicians experienced at estimating fish age were then trained and asked to independently assign ages to 50 known-age largemouth bass (ages 0-14) using the validated method. Individual accuracy was highly variable (54-100%). Thirty of the readers were then divided into 15 pairs. Within each pair, readers compared age estimates and resolved disagreements by mutually examining the otoliths in question. Accuracy increased greatly with the paired reads, about 93% of the reader pairs correctly estimated ages of $\geq$ 90% of the fish. These results suggest reader experience may not be a good indicator of accuracy, and that individuals need to verify they are correctly identifying annuli. In addition, the results demonstrate that the use of multiple readers can reduce individual subjectivity and improve accuracy.

Comparing Gill-Net Mesh Complements for Sampling Shad in Oklahoma Reservoirs

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The Oklahoma Department of Wildlife Conservation (ODWC) experimented with Standard Sampling Procedures (SSP) during the fall of 2000 in an effort to better assess forage populations, namely shad species (*Dorosoma* spp.). The objective of this study was to develop sampling procedures for including a forage component in ODWC's criteria for stocking fish in Oklahoma reservoirs. Three different gill-net sampling methods were used to evaluate shad populations in 18 Oklahoma reservoirs. Catches from small mesh (12.7 to 76.2 mm) bottom-set nets were compared to bottom-set nets currently prescribed by SSP (19.0 to 101.6 mm) on 18 reservoirs. Catches from surface set, small mesh nets (9.5 to 25.4 mm bar mesh) were compared to small mesh bottom-set nets (12.7 to 76.2 mm) on three reservoirs. Catches of shad on 17 of 18 reservoirs were higher in small mesh sinking gill nets than in nets currently being used. Floating gill nets caught more shad than the small mesh sinking gill net sets on all three reservoirs. Number of shad collected per net varied greatly among lakes. Fewer samples were needed to detect a 50% change in catch rates with smaller mesh sinking nets than the nets currently in use on 12 of 18 reservoirs sampled. Given the means and variance encountered in this study, approximately 20 net sets would be needed to detect a 50% change in catch rates using small mesh sinking nets. Less than 10 net sets would be required to detect a 50% change in shad abundance using the floating nets. The results of this study indicate the need for ODWC to make changes in SSP to incorporate forage estimates in routine sampling. Both the small mesh sinking nets and the floating nets could be used to obtain forage estimates to be used in the stocking criteria with a reasonable amount of sampling effort. Even though floating nets would require less effort to obtain these estimates, use of small mesh sinking nets was recommended because of the inability of the floating nets to catch other target species, namely channel catfish (*Ictalurus punctatus*).

RESERVOIR MANAGEMENT IV

Use of Satellite Imagery and GIS to Identify Factors Affecting Plant Re-Establishment in Lake Kissimmee, Florida

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We used satellite imagery and Geographic Information Systems (GIS) to investigate the relationship between wave action factors (potential wave exposure and effective fetch) and plant re-establishment in enhanced areas of Lake Kissimmee, Florida, USA. In all cases, wave action factors were positively correlated with the probability of no increase in plants. This corresponded with our expectation that more exposed areas would experience less plant re-establishment than areas protected from wind. However, when we tried to correlate these wave action factors with percent area coverage of aquatic macrophytes (PAC) in enhanced sites, we were unable to detect a significant relationship. Other factors aside from wave action, including littoral slope and the presence of offshore vegetation, may have influenced plant re-establishment in these sites and so need to be explored. Potential sources of error associated with each of the techniques may also have contributed to the discrepancy.

Relation of Age-0 Largemouth Bass Abundance and Size to Vegetation Coverage and Water Level in Two Florida Lakes.

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Changes in electrofishing catch per hour (CPH) and mean total length of age-0 largemouth bass Micropterus salmoides were examined in relation to aquatic macrophytes and seasonal water elevation at Lakes Lochloosa and Orange, Florida during the 1990's. At Lochloosa Lake, stepwise multiple regression revealed a significant positive relationship ($P<0.10$) between mean CPH of age-0 largemouth bass and percent areal coverage of hydrilla. Mean total length was positively related to winter water elevation at this lake. At Orange Lake, mean CPH was directly associated with percent areal coverage by hydrilla but inversely related to summer water levels. No relationships were determined between mean total length and any of the dependent variables at Orange Lake. We found percent areal coverage of hydrilla influenced age-0 largemouth bass abundance in both lakes but not growth. The influence of water levels on age-0 largemouth bass was not consistent between lakes. We suggest that there may be an optimal level of vegetation coverage for largemouth bass recruitment, but experimental studies should be conducted. Further investigation into the effects of water level fluctuation on age-0 largemouth bass in natural lakes is also merited.

Trophy Largemouth Bass Abundance and Harvest in a Central Virginia Impoundment: Implications for Restrictive Slot Limits

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Briery Creek Lake is a 342-ha impoundment in central Virginia that has become widely recognized as having Virginia's premier trophy largemouth bass *Micropterus salmoides* fishery. We estimated largemouth bass density (fish/ha) using a multiple census mark-recapture technique along a 3.2-km section of shoreline and by using the Leslie catch-depletion technique in a 4.1-ha cove. An access point creel survey was conducted in 1999 and 2000 to estimate angler catch and harvest. We used a dynamic pool model to simulate the effects of a newly imposed 356 – 610 mm protected slot limit with respect to size structure, harvest, yield, and abundance of trophy (≥ 560 mm) largemouth bass. The mark-recapture study estimated largemouth bass density to be 44 fish/ha and the number of trophy largemouth bass in the lake to be 333. The Leslie catch-depletion technique estimated the density of largemouth bass to be 43 fish/ha and the number of trophy fish to be 412. The number of largemouth bass harvested in 1999 and 2000 was 2,698 and 2,353 fish, respectively. For both years combined, the time required to catch a trophy largemouth bass averaged 142 hours. Anglers harvested 139 and 122 trophy largemouth bass in 1999 and 2000, respectively. Modeling indicated that a 356 – 610 mm slot limit would result in two-three times more trophy largemouth bass in the population, decreased yield and no change in the number of fish harvested.

AQUACULTURE AND FISH HEALTH

Characterization of Baitfish Pond Effluents and Receiving Stream Water Quality in Central Arkansas

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Over 10,000 hectares are devoted to baitfish culture in central Arkansas. Effluent characterization is necessary to determine if baitfish culture has problematic nutrient discharge. Effluents from ten commercial baitfish ponds were sampled and characterized. Pond drainpipes, drainage ditch discharge points, and streams were sampled during the first and last 10 % of pond volumes and analyzed for total nitrogen (TN), total phosphorus (TP), biochemical oxygen demand (BOD), total suspended solids (TSS), and volatile suspended solids (VSS). Drainpipe samples were serially fractionated through 41, 30, 20, 10, 8, and 5 µm meshes to determine particle size and nutrient composition. No significant differences in measured parameters were found between first and last 10 % of pond volumes. Ditch-ends significantly differed from drainpipe samples in BOD concentrations only ($P < 0.05$). Upstream TP concentrations were significantly lower than drainpipe samples ($P < 0.05$), but upstream was not significantly different from downstream TP concentrations. Serial fractionation of drainpipe samples resulted in small significant decreases in TSS concentrations at the 10, 8, and 5-µm mesh levels ($P < 0.05$). Baitfish effluents in this study contained similar or lower levels of nutrient concentrations than those found in receiving streams and in effluent concentrations reported for commercial catfish farms.

Stocker Channel Catfish (*Ictalurus Punctatus*) Production At Three Different Stocking Sizes

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Stocker-size channel catfish stocked in multiple-batch production ponds are thought to survive better, grow faster, and reach market size sooner. However, little is known about the cost of producing stocker catfish. A pond production study was conducted to analyze the effect of fingerling size stocked on net yield, growth, feed conversion ratio, and size variability of stockers at harvest. Later, enterprise budgets were developed, based on the results of the pond study, to compare costs of producing catfish stockers from different fingerling sizes. In March, small and large vat-graded catfish fingerlings (mean weight of 9 and 24 g respectively) were stocked in eight 0.1 ha earthen ponds at 100,000 fingerlings/ha. Fish were fed once daily to satiation and ponds were aerated nightly with a 0.37-kW electric paddle-wheel aerator. Ponds were harvested in October 2001. In the small-fingerling treatment, fish reached a mean weight of 255 g and the net yield averaged 8,400 kg/ha. In the large-fingerling treatment, fish reached a mean weight of 360 g and the net yield averaged 6,300 kg/ha. The results will be integrated in a multi-period linear programming model to identify optimal management strategies for a whole catfish farm.

Golden Shiner Egg Production over the Spawning Season

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This study documented daily egg production by golden shiners over a 111-day spawning season. Four, 5.9 m^2 (0.6-0.8 m deep) plastic-lined pools were stocked March 15, 2000, with 50 golden shiners each (average weight per fish = 9.8 g). Fish were fed once daily at 5% body weight per day with a 40% protein, 9% fat, extruded (pelleted) feed. A spawning mat on a floating rack in each pool was replaced and checked daily for eggs. Eggs were removed with 1.5 % sodium sulfite solution and measured volumetrically. Periodically, egg samples of known volumes were counted to provide estimates of the number of eggs per unit volume. Eggs were found in at least one of the four pools every day, with four exceptions. On average, slightly over 1 million eggs were produced per kg of broodfish. Egg production per female was estimated to be 231 $\pm$ 28 (mean $\pm$ SD) per day. Broodstock condition (Wr, K) was significantly better at the end of spawning season than it was at stocking. In addition, by harvest (July 5-7), broodfish had nearly doubled in weight, averaging 17.6 g, despite having spawned for more than 3 months.

Fluctuating Asymmetry as a Measure of Developmental Stability in Golden Shiner (*Notemigonus crysoleucas)* Developing under Three Different Conditions

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Developmental stability is an organism's ability to accomplish bilateral symmetry by proper expression of the genotype, leading to an expressed phenotype. Stress or perturbations during development can result in deviations from perfect bilateral symmetry. Fluctuating asymmetry is the term given to small random differences in left and right sides of a bilateral trait. The degree of asymmetry has been proposed as a measure of the degree of stress during embryological development. In this study, we compared symmetry in morphological characters between three groups of golden shiners (*Notemigonus crysoleucas*) representing different spawning habitats or methods. Sample groups included shiners from a 500-acre impoundment and a 0.1-acre earthen culture pond. The third group of fish originated from spawning on artificial mats in indoor tanks, with the eggs hatching out under controlled conditions. Viable young from the third group were moved to outdoor pools five days post hatch. Measurements for seventeen morphological characters were obtained to accurately assess degree of asymmetry present in the three groups. This study will highlight differences that might arise from developmental stress due to differences in spawning methods.

Variability in Lipid Class Composition and Size of Golden Shiner Eggs during an Extended Spawning Season

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Golden shiners (*Notemigonus crysoleucas*) are an important component of baitfish production in Arkansas. Golden shiners are fractional spawners with a spawning season that runs from mid-April through June. To our knowledge, changes in egg quality over a spawning season have not been previously examined. Such changes would be of significance to progressive farmers

spawning fish in indoor tanks instead of ponds. Changes in egg quality would effect decisions such as rotation of brood stock. In this preliminary study we looked at eggs collected from a single group of 50 fish (1 ♂: 2.5 ♀) which spawned periodically in a 6 m^2 outdoor pool over a 111-day period. Lipid class composition was evaluated in batches of eggs from each day of collection. Measurements of individual egg diameter were also taken. Triacylglycerols averaged 6.82 (±1.82) μg/egg, sterols averaged 2.26 (±0.51) μg/egg, and polar lipids averaged 5.75 (±2.43) μg/egg. No temporal trends were noted for these three major lipid classes. Egg diameter averaged 1.08 (±0.04) mm. There were also no trends in egg diameter over the study period. Initial evaluations indicate that for golden shiners spawning in indoor tanks there is no significant degradation of egg quality over the spawning season.

THE STUDENTS' DARTER SYMPOSIUM

Influences of Instream Features on the Dispersal Patterns of Darters

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Understanding the dispersal dynamics of stream fishes will aid in the management of populations and in the designation of critical habitats for threatened species. Movement studies to date have determined species- and stream-specific movement rates and home ranges, failing to elucidate the biotic and abiotic variables that could cause these parameters to vary. To determine the influence of instream features on dispersal patterns, we studied the movements of three darter species throughout an upland Virginia watershed during the summer of 2001. In early summer, we marked fishes at 24 sites using batch elastomer tags. We chose sites that differed in land-use, stream size, and predator abundance. In late summer, we recaptured fishes and tested for relations between dispersal patterns and measured instream features. Of 589 recaptured individuals, only 26 (4%) dispersed from the riffle in which they were marked. Emigration rate was highest at sites where considerable riffle shrinkage occurred during the summer, whereas predator abundance and stream size had no measurable effects. Median dispersal distance was 92.4m (range 39.6 - 248.8m). These data indicate that darters are relatively sedentary during the summer, but are capable of long-distance movement through inhospitable habitats when conditions become less favorable.

Roanoke Logperch (*Percina rex*) Age and Growth: A Comparison Between Three Populations

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Roanoke logperch (*Percina rex*) is a federally endangered species endemic to Virginia and restricted to four isolated populations. The objective of this study is to analyze age profiles and growth rates of three of these isolated populations inhabiting the Roanoke, Pigg, and Nottoway rivers. This analysis offers a unique opportunity to examine key demographic differences among these populations. The Roanoke and Pigg rivers in western Virginia are coolwater, high gradient, mountaine streams, while the Nottoway River in eastern Virginia is warmwater, tannin-stained, and lowland. Logperch were captured from these rivers during the summers of 2000-2001, and scales were collected and preserved for further analysis. Results will be discussed in light of conservation of this species.

Dominant to Endangered? Historical Changes in Yellowcheek Darter and Associated Fish in the Little Red River Headwaters

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The Yellowcheek Darter (*Etheostoma moorei*) is an endemic species of north-central Arkansas, found only in four headwater streams of the Little Red River above Greers Ferry Lake. Headwater inundation as the result of the formation of Greer's Ferry Lake in 1962 has lead to isolation of Yellowcheek populations. A study of Yellowcheek darters from 1978-1981 showed that the Middle and South Forks sustained the largest numbers of Yellowcheek darters, with populations of 36,000 and 13,500 respectively. The Yellowcheek was the most abundant riffle fish during this earlier study. During 1999-2000, we used kick seining and electroshocking to determine current Yellowcheek abundances in the Middle, South, Archey and Turkey Forks. In stark contrast to the earlier study, Yellowcheek were estimated to be a distant fifth in abundance compared to associated riffle fish with populations on three forks totaling 10,000 individuals. No individuals were detected on the Turkey Fork or in the upper sites of any of the study streams. Thus, current data indicate an alarming decline in population sizes.

Tag Retention in Reintroduced Species of Selected Darters in the Pigeon River, TN

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The Pigeon River has historically suffered from the cumulative effects of years of pollution and hydrological alteration. In recent years, water quality improvements in the river have led state, federal, and private agencies to reintroduce several species into the Pigeon River. To assess the survival of the relocated species, a fluorescent visible implant elastomer (VIE) tagging technique was employed using a surrogate darter species (*Etheostoma rufilineatum*) in a laboratory setting. Fish were tagged with one of three colors of VIE and observed in aquaria for approximately 90 days to evaluate tag retention. Two anesthetics (tricaine methanesulfonate and clove oil) were evaluated during the tagging procedures to compare lowest effective concentrations and their effects on survivability. The first reintroductions were 133 blueside darters (*E. jessiae*), 121 bluebreast darters (*E. camurum*), and 293 gilt darter (*Percina evides*). All fish were collected from area streams with similar habitat and tagged before release with various colors of VIE. Snorkeling surveys after the blueside and gilt reintroductions revealed several (3) healthy gilt darters. No bluebreast darters were observed but the habitat was considered marginal; a new introduction site has been identified. Subsequent surveys are planned to determine the survivability of bluebreast darters.

Examination of Morphological Variation Among Populations of the Fantail Darter, *Etheostoma* (*Catonotus*) *flabellare* (Percidae) from River Drainages of North Carolina, South Carolina, Tennessee, and Virginia

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Etheostoma flabellare has long been recognized as a single, geographically variable species, but numerous researchers have suggested that this taxon may represent a species complex. As phase one of a long-term study, morphological comparisons were made on one currently recognized subspecies, *E. f. brevispina*, to examine variation in this taxon and determine its distribution and taxonomic status within the fantail darter complex. Examination and analyses of 20 meristic variables on 1250 specimens and 20 pigmentation variables on 209 nuptial males from nine river

drainages (Atlantic Slope and Mississippi River Basin) revealed that *E. f. brevispina* is restricted to the Savannah, Santee, and upper Pee Dee River drainages of North Carolina, South Carolina, and Virginia. Specimens from these drainages were distinguished from other populations based on a combination of meristic and pigmentation characteristics. Additional data collection is ongoing, including analyses of morphometric data, and a closer examination of populations from a contact zone, which possibly represents an area of introgression. Initial results indicated that *E. f. brevispina* may warrant species level recognition.

NONGAME FISH SESSION

Monitoring and Managing the Endangered Boulder Darter, *Etheostoma wapiti*

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The critically rare and federally endangered boulder darter, *Etheostoma wapiti*, is known only from an approximately 100 km section of the lower Elk River and the lower ends of a few larger tributaries in southern Tennessee and northern Alabama. Historic collections exist from Shoal Creek in northern Alabama, but the species has not been seen there since the late 1800s. Since 1994, Conservation Fisheries, Inc. (CFI) has monitored boulder darter populations. CFI has designed a captive propagation program to augment existing boulder darter populations in the Elk River, and ultimately provide fish for reintroduction into Shoal Creek. The success of a multi-agency effort to improve spawning habitat for boulder darters in the Elk River by adding slab-rocks was evaluated. Direct observation with mask and snorkel has been the most effective monitoring technique for documenting presence or absence of boulder darters or assessing potential boulder darter habitat. Marking captively-propagated individuals released into the wild is an effective tool for tracking survivorship and movement of introduced fish.

Physical Habitat Parameters and Population Characteristics of a Spawning Aggregation of the Paleback Darter, *Etheostoma pallididorsum*, in the Caddo River Drainage, Arkansas

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The paleback darter, *Etheostoma pallididorsum*, like other members of the Subgenus *Ozarka*, utilizes small tributaries or spring/seeps in open pastures and wooded areas as spawning habitat that is different from the non-breeding habitat in creeks or small rivers. One known spawning site occurs in a spring-fed tributary to Collier Creek, which flows into the Caddo River. This seep/spring tributary flows down a highway drainage ditch adjacent to Arkansas Highway 8 directly in front of Caddo Hills High School. Concerns that access road and highway drainage maintenance practices might be affecting spawning movements, or access to spawning sites provided impetus for monitoring fish ingress and egress during the fall-winter spawning seasons of 1990-91, 1991-92, 1992-93, and again in 2001-02. Fish movements were monitored daily utilizing a series of wire mesh funnel traps completely spanning the effective tributary width. Paleback darter population data collected included enumeration of sex, length (in 10mm cohorts), and direction of movement for each specimen captured. Physical parameters measured or obtained included air and water temperature, discharge, water depth, rainfall, day length, barometric pressure, and lunar period. Comparisons are made of paleback darter individuals making the spawning migration, periodicity of the spawning migration, and correlations with physical variables during the spawning migration for each of the monitored spawning seasons.

Ensuring the Viability of the Strawberry River Orange Throat Darter *(Etheostoma fragi*): The Nature Conservancy's Strategy

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As part of the Arkansas Field Office of The Nature Conservancy's commitment to the protect biodiversity, a strategy has been developed for the preservation of the endemic Strawberry River orangethroat darter. As it's name implies, this species is found no where else in the world except the Strawberry River and some of its tributaries. Although the Strawberry has a reputation as a relatively pristine system, water quality deterioration and increased rates of sedimentation have been documented as substantial threats to this very narrow endemic, as well as the other sensitive aquatics found there. The Nature Conservancy's broad strategy for ensuring a viable population of this species consists of the establishment of an anchor preserve and the development and implementation of a watershed conservation plan within the context of a community based conservation effort. Details of the preserve and watershed plan formation will be presented.

Natural Hybrids of the Madtoms *Noturus flavus* and *Noturus insignis* from the Monongahela River Drainage, West Virginia

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Natural hybridization is rare in the family Ictaluridae. Putative hybrids of the madtoms *Noturus flavus* and *N. insignis* were collected from the Blackwater River, Monongahela drainage, West Virginia. Sheared principal components analysis of morphometric characters and principal components analysis of meristic characters were used to quantify morphological differences among *N. flavus*, *N. insignis*, and putative hybrids. Putative hybrids were intermediate in tooth patch dimensions, caudal fin pigmentation, length of the dorsal fin base, width between pelvic bases, distance between the adipose/caudal notch and base of caudal fin, and position of anal fin. Although not confirmed by genetic analyses, hybridization between *N. flavus* and *N. insignis* is supported by morphological intermediacy, and may be linked to higher abundances of *N. insignis* or degraded habitat in the Blackwater River.

Development And Refinement Of Propagation And Culture Protocols For The Cahaba Shiner, (*Notropis cahabae),* and the Goldline Darter, (*Percina aurolineata)*

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The goal of this work was to develop methods for captive reproduction and rearing of two rare fish, the Cahaba shiner, *Notropis cahabae,* and the goldline darter, *Percina aurolineata*, to supply larval and juvenile individuals for toxicity research by EPA as part of an effort to evaluate the protectiveness of water quality criteria for the Cahaba River in Alabama. Because habitat requirements and early life history of these species are poorly known, observations of aquarium-held fish, particularly behaviors associated with reproduction and early life history, could also provide information critical for future conservation and management. Propagation success for both species was variable and limited in the first year's effort, but improved significantly in the

two subsequent years of work. Techniques were developed and refined to deal with egg recovery and incubation, and problems presented by the extremely small size of both species' larvae as well as the pelagic behaviors and food and microhabitat requirements of the darter larvae. Additional potential refinements were suggested by the work, to be tested next year with the goldline darter.

TECHNICAL POSTER SESSION

Characteristics, Preferences, and Motivations of First-Time Recreational License Holders in Arkansas

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Fishing is an important and traditional recreational activity for millions of Americans. However, an overall decline in fishing license sales exists nationally as well as in Arkansas. Family issues and values play a critical role in fishing initiation, satisfaction and continued participation. Furthermore, anglers are more likely to participate in an activity if positive reinforcing memories exist from earlier experiences. Therefore, information regarding the characteristics, preferences and motivations of youth first-time license holders may be a viable management tool for fisheries agencies such as the Arkansas Game and Fish Commission (AGFC). In early 2002, we will mail a questionnaire to 1,500 randomly selected first-time Arkansas license holders ages 16 to 18. Our study will determine characteristics and angling preferences as well as determine factors that contribute to participation in recreational fishing. We will examine age, gender, race, residence, fishing locations, targeted species, and preferred fishing techniques. This project will be conducted in three steps: 1) pre-test questionnaire (50); 2) mail questionnaire (1,500); and 3) non-respondent telephone survey. The information from this research will be used to assist management agencies recruit new anglers and set priorities for improved and more diverse recreational fishing experiences.

Effectiveness of Reclamation on the Recovery of Aquatic Fauna in Black Branch and Cane Creek

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Streams impacted by acid mine drainage (AMD) exhibit low pH, increased concentrations of toxic metals and reduced biological integrity. Reclamation of AMD contaminated systems has been conducted; however, little information exists to document recovery of aquatic ecosystems and to evaluate the effectiveness of reclamation. Black Branch and Cane creek watersheds (Walker County, Alabama) were extensively mined for coal in the late 1800's until the mid-1900's and were then abandoned. A large gob pile containing waste minerals is a prominent feature of the landscape, and combined with numerous pit mines in the watershed, contributed low pH AMD to Black Branch. From July 1997 to April 1998, remediation of AMD impacted Black Branch was conducted as part of the Appalachian Clean Streams Initiative Program. Multiple limestone drainages, a settling pond, and wetland cells were constructed. Water, and invertebrate samples were collected before, during, and after remediation to evaluate the effectiveness of reclamation. Immediately following remediation water quality and invertebrate communities increased, however monthly sampling has indicated levels have returned to those

recorded prior to remediation. AMD projects that do not monitor chemical and biological responses to reclamation may be deemed successful, yet in reality may have failed.

The Use of External Radio Transmitters on Blue Catfish

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Previous studies have indicated that the attachment or implantation of internal radio transmitters on Ictalurids face many difficult challenges. These range from the regurgitation of gastric-attached transmitters to transintestinal expulsion of transmitters implanted within the body cavity. In an attempt to improve transmitter retention, we examined attaching radio transmitters externally to the dorsal musculature of blue catfish *Ictalurus furcatus*. This procedure eliminated the need for difficult surgical procedures and decreased the overall handling time for fish in the field. We first tested and refined techniques on captive fish within our aquaculture facility for 4 months. Overall survival rate on eight blue catfish during the initial lab tests was greater than 80%. During an eight week period in the winter of 2001, we attached radio-transmitters externally to 29 blue catfish throughout Lake Norman, North Carolina. During the first 3 months of the field study, initial survival rates were near 80%, but survival rates dropped to 40% over the summer and fall 2001. Long term survival rates will determine if this method is an overall improvement for movement and habitat use studies in comparison to the more commonly practiced internal transmitter attachment procedures.

Suitcase Sampler for Vegetation-Dwelling Aquatic Macroinvertebrates.

Chec Colon-Gaud*, William E. Kelso and Adam Piehler. School of Forestry, Wildlife, and Fisheries. Louisiana State University. Baton Rouge, Louisiana, 70803.

Aquatic macrophytes play an important role in aquatic systems, providing shelter, breeding habitat, and food for fishes and aquatic macroinvertebrates, and serving as indicators of water and habitat quality. Quantitative sampling macrophytes and their associated macrofauna, however, is often difficult due to high plant densities and differences in macrophyte morphology. Since 1960, many lentic habitats in the southern U.S. have been invaded by hydrilla Hydrilla verticillata, an aggressive submerged macrophyte native to Asia. Hydrilla has become the dominant submerged macrophyte in the Atchafalaya Basin in southcentral Louisiana, and we are currently assessing the impacts of dense, virtually mono-specific hydrilla stands on water quality and macroinvertebrate distribution and abundance. As part of this study, we needed to develop an efficient, quantitative method of sampling macroinvertebrates in the dense canopy and understory habitats in littoral hydrilla beds. We devised a 60 x 45 cm suitcase trap constructed of 0.5-mm thick angle aluminum with 600-μ stainless steel mesh walls, and used it to collect vegetation-dwelling macroinvertebrates from May to September 2001. Results indicate the sampler is easy to deploy and retrieve, effective in all plant densities, permits estimation of macroinvertebrate densities by plant volume or dry weight, and is more effective than traditional net sweeps in describing the structure of the macroinvertebrate community.

Habitat Use and Exploitation of Striped Bass and Hybrid Striped Bass in Claytor Lake, Virginia; Preliminary Findings

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We investigated the habitat use, movements, and exploitation of striped bass *Morone saxatilis* and hybrid striped bass *M. saxatilis* x *M. chrysops* in Claytor Lake Virginia. The following is preliminary data collected during 2001. Striped bass (SB) (n = 9) and hybrid striped bass (n = 11) (HSB) were fitted with temperature sensitive radio tags and located bi-weekly. In addition, SB (n = 19) and HSB (n = 136) were fitted with internal anchor reward tags to determine angler exploitation. Vertical profiles of temperature and dissolved oxygen were taken periodically to determine available summertime habitat. There were 10 reported recaptured HSB and 3 recaptured SB, for respective 7.4% and 15.8% exploitation rates. We found an insignificant difference ($p = 0.011$) in temperature use and a significant difference ($p = 0.004$) in dissolved oxygen use over the time periods sampled for SB and HSB. There is significant evidence ($p = 0.001$) that a difference exists for the interaction by species and month for temperature and dissolved oxygen use. The dam intakes are positioned so that available SB and HSB habitat is lost, and fish are susceptible to summertime emigration. Home range and movement calculations will be determined following collection of a full year of data. These results are meant as preliminary findings only and are based on only a partial year of data and small sample size. Therefore, extreme caution should be used when interpreting statistical results.

Population Trends of Double-Crested Cormorants within the Catfish Production Areas of Arkansas: 1999-2001

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Abstract: Double-crested Cormorants (*Phalacrocorax auritus*) wintering in the southeast delta of Arkansas were monitored via aerial surveys to determine numbers and distribution for the past 2 winters. A minimum of two surveys per month (December 1999–April 2001) was conducted along a fixed flight route during the last 3 hours of sunlight and encompassed catfish production areas. Survey flights were conducted on consecutive days to reduce possible movement of cormorants between the two flight routes. Only one observer was use during the first winter (1999-2000), whereas a double-observer count followed by a next morning ground-truth count was established during the second winter (2000-2001). For both winters, December through February surveys exceeded 15,000 individuals. The only exception was during early January, when an appreciable drop in numbers occurred during both years. Cormorant numbers peaked in early February 2000 and 2001 to exceed 26,000 individuals. Cormorants utilized a total of 10 and 12 night roosts during 1999-2000 and 2000-2001, respectively. The fidelity to night roosts and seasonal fluctuations in cormorant numbers between and within the 2 wintering seasons are of interest because of the extrinsic variables, such as water and forage availability, may differ across spatial and temporal scales. Also, baseline population trend data are important in conducting field research within the catfish industry to compare between years, to measure density-dependent variables, and to provide a valuable tool in assessing cormorant population changes that may occur with future management strategies adopted by the United States Fish and Wildlife Service.

Simulated Impacts of Juvenile Mortality on Gulf of Mexico Sturgeon Populations

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We used an age-structured computer model to assess the impact of changes in juvenile mortality on the Gulf of Mexico sturgeon population in the Suwannee River, Florida. We simulated population trends under four levels of annual juvenile mortality (20, 25, 30, and 35%). As the rate of mortality increased, population size decreased and rates of population growth shifted from positive to negative. Our models indicated that juvenile survival is important to the success of gulf sturgeon populations and mortality estimates are needed to predict population viability. We suggest that life history studies in estuaries should be conducted and bycatch rates for commercial fisheries should be quantified to aid in the management and conservation of gulf sturgeon.

Movement of Flathead Catfish in the Missouri River: Examining Opportunities for Managing River Segments for Different Fishery Goals

Travnichek, Vincent H. Missouri Department of Conservation, 1110 South College, Columbia, MO 65201

As part of an angler exploitation study on flathead catfish (Pylodictis olivaris) from the Missouri River we marked 2,939 flathead catfish, 12.0-44.0 inches total length (TL), with Carlin dangler tags. Fish were marked within a fifty-mile section of the Missouri River near St. Joseph, Missouri. All fish were tagged in early June from 1999 through 2001. Based on tag returns by anglers and marked fish recaptured by the Missouri Department of Conservation (N=300), we determined movement patterns of flathead catfish in the Missouri River. Minimal movement by flathead catfish was detected. Over half (52%) of the tag returns were within one mile of tagging location, and 94% were within ten miles of tagging location. Maximum movement was 70 miles, and it occurred within a two-month period after the fish was tagged. To examine differences in movement patterns of various sized fish, flathead catfish were placed into one of three size groups (12.0"-14.9", 15.0"-19.9", or $\geq$20.0"). While no significant difference (P=0.098) was detected in movement among the three size groups, there was an upward trend in movement for larger-sized flathead catfish. Movements averaged 2.3, 3.4, and 4.2 miles for small, medium, and large size classes, respectively. Results suggest that discrete populations of flathead catfish exist in the Missouri River, and thus, sections of the Missouri River could possibly be managed for different fishery goals for flathead catfish.

Arkansas Fish Database

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Through a cooperative effort a statewide database of fish collections has been established. The database is in Microsoft Access® as well as ESRI ArcView®. This flexible platform allows the user to query collections in a spatial and temporal manner for individual species or fish communities. Cooperators include Dr. Henry Robison, the Arkansas Game and Fish Commission, Arkansas Natural Heritage Commission, The Nature Conservancy, and the Southern Research Station and Ouachita National Forest of the USDA Forest Service.

Community Structure Variability in Sunfishes of the Genus *Lepomis* in Streams of the Upper Piedmont Ecoregion of West Georgia.

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The objective of this study was to characterize the community structure of sunfishes of the genus *Lepomis* in light of stream habitat and physicochemical parameters. Fishes were sampled and habitat assessments were conducted at 94 sample sites on 38 streams in Carroll, Heard and Paulding counties, Georgia. Seven species of sunfish where identified with *L. auritus* and *L. macrochirus* the most common. A negative correlation between the relative abundance of *L. auritus* and *L. macrochirus* and *L. marginatus* and between *L. macrochirus* and *L. marginatus* was observed. There is a positive correlation between the extensiveness and diversity of epifaunal substrate, channel alteration and the frequency of riffles and the relative abundance of red the redbreast sunfish. With an increase in channelization, and a decrease of in-stream habitat diversity, the redbreast sunfish is replaced by the bluegill and the dollar sunfish. The relative abundance of sunfish species of the genus *Lepomis* may be a quick and inexpensive indicator of the ecological status of warm water piedmont streams.

Socioreproductive Behavior of the Bloodfin Darter, *Etheostoma sanguifluum*

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The bloodfin darter, of the upper Cumberland River drainage, exhibits socioreproductive behavior typical of the *E. maculatum* species group of the subgenus *Nothonotus*, species of which are behaviorally distinguished from the *E. camurum* group by a pronounced reversal of sexual roles. Males select spawning shelters under overhanging cobbles above stone slabs at the heads of riffles. Male shelter holders are courted by sexually ready females, who are admitted only when exhibiting a pattern of snout markings that to some degree resembles an egg clutch. Once admitted, the female engages in an extended session of "foreplay," nudging, nuzzling, crawling over and under the male. She then rolls to her side and wedges herself into the horizontal crevice formed by the two slabs, where she is joined, belly to back, by the male. Jostled several times by the male, the female begins to vibrate rapidly and is followed in this by the male. During each of one or more vibratory bouts, the female gushes a clump of 10-20 eggs. Interrupted between spawning events, the female may join the male in repelling intruders. When she is spent, the female departs and the male remains to guard the eggs. He may accumulate egg batches from several females in succession.

Socioreproductive Behavior of the Yellowcheek Darter, Etheostoma *moorei*.

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The yellowcheek darter is a riffle dwelling inhabitant of the little Red River above Greer's Ferry Lake in Arkansas. Socioreproductive behavior is generally typical of species of the *E. camurum* species group of the subgenus *Nothonotus*. In early May, females occupy and defend spawning shelters over fine gravel in the lee of cobbles or other current obstructions in the swiftest parts of large riffles. Rampages involving forays in to adjoining territories and sorties to meet conspecific intruders of both sexes effectively provide a preemptive defense of subsequently deposited egg clutches. Males compete for access to receptive females. In the presence of the prevailing male,

the female burrows in to the gravel until all but her head and caudal fin are exposed. Mounted by a male, she vibrates with him and expels a batch of 20-30 eggs in a tight clump. Other females who bury in the vicinity are often jerked out of the substrate by the attending male. Following spawning, neither parent provides protection or care of the eggs.

HISTORY POSTERS OF STATE AND SUBUNIT CHAPTERS

Historical and Current Aspects of the Texas A&M Chapter

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The Texas A&M University Chapter of the American Fisheries Society was chartered in 1969 and has the distinction of being the first chapter in the state of Texas. The Chapter became inactive for several years but was reactivated in the fall of 1973 due to increased student and faculty interest. The primary objective of the Chapter was to promote interaction and information exchange among undergraduate students, graduate students, and faculty. To accomplish this objective, activities have historically included monthly meetings, an annual fish fry, and, the Chapter's cornerstone event, an annual technical session. The technical session in early years was comprised of presentations by both students and faculty from departments across campus as well as agency and other fisheries professionals throughout Texas. More recently, in 1997, the annual technical session was transformed into a student-only symposium featuring a variety of natural resource topics in addition to fisheries. Building on previous accomplishments, current aspects include: community outreach, a web page, student achievement awards, a listserve, field experience, and travel assistance to state, division, and national meetings. With an increase in member recruitment and participation, the Texas A&M University Chapter will continue to evolve.

History of the Texas Chapter of the American Fisheries Society- Silver Anniversary

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The **Texas Chapter AFS** celebrated it's **Silver Anniversary** this year. Special efforts were made to contact the original 83 charter members to personally invite them to attend this celebration. Nineteen charter members attended and were recognized during the banquet. **Membership** has ranged from 83 charter members to nearly 250. Presently, the Texas Chapter has **eleven standing committees**, which include Awards, Continuing Education, Editorial, Endowments, Internet, Issues, Membership, Nominating, Pond Management, Publicity/Exhibits, and Student Outreach. An **Archives Ad Hoc Committee** was added following the Silver Anniversary meeting. This committee was charged with the task of organizing and maintaining the Chapter's files, assimilating historical information, and documenting the history of the Chapter. Each year the Chapter hosts an **annual meeting**, which typically includes about twenty scientific papers, which are published in a Proceedings (became non-gray literature in 1991). Fundraising auctions and raffles have also been an important element of the annual meetings, with proceeds going toward the funding of **student scholarships**. The Chapter has provided nearly 100 scholarships. Awards may also be given annually to **"The Outstanding Texas Fisheries Worker of the Year"** in eight categories.

A History of the Tennessee Tech Student Fisheries Association: Education through Service

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The Tennessee Tech Student Fisheries Association (TTUSFA) was founded in 1988 when the Tennessee Chapter of the American Fisheries Society decided to support the establishment of student chapters at universities in the Volunteer state. The SFA is dedicated to the advancement of the education of TTU students interested in fisheries science through local and regional service activities. Among these activities have been the Southern Division Student Colloquium, an annual Kid's Fishing Derby, a Save-Our-Streams Project, and a pond management project at the Boxwell Boy Scout Reservation near Galatin, TN. The Student Colloquium was first held in 1982, and was hosted by the TTUSFA from 1989 until 1997. The Colloquium provided a forum for fisheries students to present their research, and attracted students from all over the southeast. The annual Kid's Fishing Derby has been held at Cane Creek Park in Cookeville, TN, for the last thirteen years, and now regularly attracts over 100 children each year. The Save-Our-Streams and Boxwell pond management projects have provided members with valuable hands on experience with sampling techniques. In addition to being beneficial to fisheries students at TTU, these activities have also been greatly beneficial to the local and regional fisheries community.

History of the Virginia Tech American Fisheries Society

Anne Hunter

The Virginia Tech Chapter of the American Fisheries Society has been an active chapter for 29 years. How have we developed over time? What did our academic program look like when VTAFS first started and what does it look like now? Who was involved along the way? We are excited about the history of our chapter and the prospects for the future. VTAFS traditions are still strong and we want to thank those who have been involved along the way.

Auburn University's Department of Fisheries and Allied Aquacultures: From Farm Ponds to Supercats.

Jeff Jolley and the Auburn University Chapter of the American Fisheries Society, 203 Swingle Hall, Auburn University, Auburn, Alabama 36849 334-844-9318.

Research in inland fisheries and aquaculture at Auburn University began in 1933 by a team of three scientists headed by Dr. H.S. Swingle. Their program focused on the construction and management of Alabama farm ponds for recreation and for food production. When the first formal courses were offered in 1946, a "hands-on" approach was adopted for teaching. This practice has continued to the present. Over the years, world-renowned programs have been developed in the areas of aquaculture, fish diseases, fish ecology and management, fish genetics and fish nutrition. The Department and associated International Center for Aquaculture and Aquatic Environments have grown since their inception in 1970; their mission includes teaching, extension, and research functions. Today, the Department has one of the largest graduate programs on campus. In 1973, a Chapter of the American Fisheries Society was chartered. The Auburn University Chapter has had a fantastic history that has included hosting SDAFS Student Colloquiums and Mid-year meetings. Locally, the Chapter has an active outreach program and members contribute time to educate K-12 students on fisheries related topics. The Department

of Fisheries and Allied Aquacultures is making plans to celebrate the 100th anniversary of Dr. H. S. Swingle's birth in 2002.

Evolution and History of the Mississippi Chapter's Student Subunit of the American Fisheries Society

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In May 1983, the Fisheries Club was first recognized as an official student organization by the Student Faculty Organization Committee of Mississippi State University (MSU). The goal at that time for the club, as stated in original by-laws was: "to provide a vehicle for social and professional interaction among fisheries students and professionals at MSU and to promote communication and professionalism among fisheries students and faculty at MSU." Since its beginnings, the Fisheries Club was involved with the Mississippi Chapter of the American Fisheries Society (MS Chapter-AFS). In cooperation between the Fisheries Club and the MS Chapter-AFS, the Fisheries Club was accepted as an official subunit by the MS Chapter-AFS in February 1999. Currently, the MSU membership represents the only formal student subunit within the MS Chapter-AFS and consists of undergraduate students, graduate students and faculty interested in fisheries, aquaculture, and aquatic ecology. The Student Subunit seeks to provide its members with opportunities for professional development, promote interaction among fisheries students and faculty at MSU, as well as increase student involvement with the MS Chapter-AFS. Our past and current activities involve guest speakers, educational workshops, participation with the annual meeting of the Mississippi Chapter-American Fisheries Society, and community service projects.

History of Georgia American Fisheries Society Subunit

Tom Reinert

The UGA Fisheries Society was formed in 1994, as a Student Organization of the Daniel B. Warnell School of Forest Resources and the University of Georgia. We are composed of University students, staff, and faculty members who have an interest in fisheries, ecology, limnology and other disciplines involving aquatic resources. We have an active schedule that includes informative seminars, community service projects, and fun activities. In the spring of 2000, we were recognized as an official Student Sub-Unit of the Georgia Chapter of the American Fisheries Society.

A History of the Arkansas Chapter of the American Fisheries Society

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The Parent Society officially recognized the Arkansas Chapter of the American Fisheries Society on October 1, 1986. The goal of the Chapter is to promote the wise management, conservation, and use of the fishery and aquatic resources of Arkansas. The Chapter's first president was Danny Ebert. The Joe Hogan Award, first presented in 1993, is the Chapter's way of recognizing individual achievement in the Fisheries field. The first recipient was Steve Filipek. Since 1997, the Chapter has also presented an annual award to conservation groups that further the cause of

aquatic resource stewardship in Arkansas. Recipients of the Conservation Group Award include the Arkansas Chapter of Trout Unlimited, the Bayou Bartholomew Alliance and the Mountain Home Sportsman's Club. The Chapter officially recognizes student subchapters at Arkansas Technical University in Russellville, the University of Arkansas at Fayetteville, and the University of Arkansas at Pine Bluff. Current membership for the chapter stands at more than 100 professionals, academics and students.

Tennessee Chapter AFS Poster – 50th Anniversary Celebration in Little Rock.

John Taylor, Larry Wilson and Doug Peterson

The Chapter was originally chartered in 1977 as the East Tennessee Chapter. In the early years the Chapter held three evening meetings per year. The meetings consisted of a discussion of business matters, a fisheries presentation, discussion of environmental issues, and a tour of the site facilities.

By 1978 the Chapter had expanded its boundaries to include Tennessee Technological University. In 1982, the Chapter joined the National Resource Conservation Societies (NRCS) of Tennessee and met with them in the Fall for several years. As interest and participation grew, the Chapter continued to expand its boundaries and in 1983 changed its name to the Tennessee Chapter.

Although the three meetings per year format continued for several years, the spring meeting was designated as the "Annual Meeting" beginning in 1984. During the Winter 1985 meeting, a motion was passed that the annual meeting include scientific presentations and be held at various locations throughout the state to maximize participation. The annual meeting has been held in February or March each year, and has grown to span concurrent days.

During the Fall 1988 meeting, the Chapter voted to form "sub-units" or "Student Fisheries Associations" at the University of Tennessee – Knoxville and at Tennessee Technological University. The Chapter also issued its first newsletter in 1988.

Joint annual meetings were held with the Kentucky Chapter in 1992, the Georgia Chapter in 1993 and the Mississippi Chapter in 1996. The 1993 meeting, held in Chattanooga, also co-hosted the first annual Southern Division Mid-year Technical Meeting. In 1998 we, again hosted the Southern Division Mid-year conference.

From its inception, the Chapter has been the major vehicle of information exchange, interagency cooperation, environmental action, and professionalism in the state. The Chapter presents annual awards including the Lifetime Achievement Award, Outstanding Fisheries Scientist, and Outstanding Student Presentation Award. The Chapter also has presented special service awards and Friends of Fisheries Awards.

A History of the Georgia Chapter of the American Fisheries Society

Ronnie J. Gilbert and Thomas R. Reinert

Dr. Al Fox (University of Georgia) convened the first meeting of the group that would become the Georgia Chapter of the American Fisheries Society (GA-AFS) at the University of Georgia (UGA), February 9-10, 1970. At an additional organizational meeting in Atlanta, Georgia, on September 28, 1970, Bylaws were approved and the name Georgia Fisheries Workers Association (GFWA) was chosen. The objective of GFWA was "to provide a means of

communication concerning fisheries and other related aquatic resources in Georgia." The Bylaws directed the Chairman to appoint an Executive Committee that included representatives of at least five fisheries-related organizations. A major responsibility of the Executive Committee was planning and conducting an annual meeting. The first Annual Meeting was held January 25-26, 1971 at UGA. During 1970's and 1980's GFWA rejected affiliation with The American Fisheries Society (AFS) because "it would entail the loss of members, raising of fees, loss of identity, loss of informality and expansion of the program to other states." There was also concern that many Georgia Department of Natural Resources (GA-DNR) employees, especially technicians, who were not AFS members, could not be considered for elected offices. At the 1985 GFWA annual meeting, Dr. Ronnie J. Gilbert obtained 20 signatures of AFS members interested in forming a Georgia Chapter. Dr. Gilbert was elected as the first President of the Georgia Chapter (GA-AFS) at the 1986 Business Meeting held during the GFWA Annual Meeting. GA-AFS was approved by AFS in 1990. GFWA and GA-AFS voted to consolidate on February 11, 1992, and Spud Woodward was selected as the first President of the expanded GA-AFS. Since consolidation, GA-AFS has co-hosted the 1993 and 2000 Mid-year Technical Meetings of the Southern Division and formed an official AFS student subunit, the UGA Fisheries Society. The success enjoyed by GFWA and GA-AFS has been due to the hard work of their leaderships. Members recognized for outstanding service during the first 30 years include: Beverly Clement, E. H. Armor, Sue Anthony, Dr. Ronnie J. Gilbert, Dr. Mike Van Den Avyle, Dr. Bob Reinert, Mike Spencer, Dr. Bruce Saul, and Matt Thomas. The complete history of GA-AFS can be found on our website: www.uga.edu/ugafish/ga-afs.

HISTORY POSTERS SDAFS, RESEARCH AND COMMITTEES

Southern Division History - People, Events, and Accomplishments for Its First 50 Years

Submitted by Mike Van Den Avyle on behalf of the "SDAFS Anniversary Committee" for the History poster session.

This year (2002), the Southern Division AFS celebrates its 50th anniversary. This poster presents highlights of Division organization, officers, evolution of Technical Committees and Chapters, meetings, and significant events and accomplishments. The presentation includes numerous pictures featuring people, fisheries, and Division projects and chronicles Division records that date back to the years when the organization was in its formative stage.

History and Role of the Cooperative Research Units Program in the Southern Division American Fisheries Society

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In line with the historic perspective of this meeting, the authors propose a multimedia poster presentation on the history and role of the Cooperative Research Units in the Southern Division American Fisheries Society. Many of the southern division members have worked for or received their graduate degree through a Cooperative Research Unit. Thus, the primary objectives of this presentation are to: provide an enjoyable photo-heavy retrospective highlighting members of the division throughout their careers; and to convey the active role that Cooperative Research Units Scientists plan in the Southern Division AFS. As proposed, the presentation will be a continuously looping powerpoint presentation presenting the histories of the individual Southern Division units, as well as, many photographs of some of Southern Division's "gray-beards" before they were gray-beards.

Developments in Hatcheries and Aquaculture in the Southeast Over the Past 50 Years

Presented by Ron Southwick and the Aquaculture Technical Committee

For the past 50 years all the states throughout the southeast U.S. have successfully integrated fisheries management stocking requirements with the operation of public fish hatcheries. These facilities produce fish that must meet specific needs including species, numbers, size, genetics integrity, disease-free status, and proper timing for stocking. The committee's poster depicts some of the dramatic changes in fish culture techniques through the years, and the dedicated hatchery workers who work tirelessly to ensure that fisheries managers are provided with the fish they need to continue the research, restoration, and sport fishing programs in the southeast.

Historical Overview and Future Emphasis of the U.S. Fish and Wildlife Service Program

Linda Kelsey. Assistant Regional Director, Fisheries Program, U.S. Fish and Wildlife Service's Southeast Region.

The U.S. Fish and Wildlife Service will provide a display/poster depicting an overview of the history of the Service's Fisheries Program 1872 - 2002, 130 years of fisheries conservation. It will also highlight new areas of emphasis for the Fisheries program for the future such as culture

and propagation of threatened, endangered, and imperiled fishes and other aquatic species, cryopreservation and genetics research, and habitat restoration activities. Examples of activities from the Service's Southeast Region National Fish Hatcheries and Fisheries Management Assistance Offices will be focused.

The Aquaculture/Fisheries Center of the University of Arkansas at Pine Bluff: A Recent History of Growth and Development

Carole Engle

The Aquaculture/Fisheries Center (AFC) of the University of Arkansas at Pine Bluff provides an example of rapid institutional growth and development during a period that has been characterized more by retrenchment and cutbacks for many universities. The UAPB program began in 1974 with the construction of the first research ponds. This was followed by a B.S. degree program in Fisheries Biology in 1980. The AFC as an institutional unit was created in 1988 and was followed in 1996 by the creation of a separate academic Department of Aquaculture and Fisheries. An Agriculture Research Unit (USDA) was co-located with the AFC at UAPB in 1994. Final approvals for the M.S. degree program in Aquaculture/Fisheries were obtained in 1997, and the first graduate students were enrolled that same year. Current AFC personnel include: 16 Ph.D. scientists, 11 M.S. scientists, and 10 B.S.-level support staff. The aquaculture research and extension program has been supplemented in recent years by an expanded natural fisheries effort. The rapid growth of the UAPB AFC is due to its emphasis on strategic research and extension programs that solve problems identified by stakeholder groups, holding true to its land-grant mission,.

The Oklahoma Fishery Research Laboratory

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In 1947, the Cooperative Fisheries Experiment Station was established as a result of an agreement between the Oklahoma Game and Fish Department and the University of Oklahoma. The Experiment Station was the forerunner of the Oklahoma Fishery Research Laboratory (OFRL), which was established in 1950 by a Memorandum of Understanding. Under this Memorandum, the operation of the OFRL was to be administered jointly by the Oklahoma Department of Wildlife Comservation and the University. Within the University, OFRL activities are coordinated through the Oklahoma Biological Survey. Originally located in a WWII navel training facility building on the University’s North Campus, a new facility was constructed on South Campus in 1989. The OFRL has had a distinguished history of fisheries research beginning with some of the first work done on catfish age and growth, and continuing to the present with outstanding research on crappie population dynamics and Florida largemouth bass introductions. Additionally, the OFRL has provided three Southern Division AFS presidents over the past several decades.

Kentucky Department of Fish and Wildlife Resources: A Historical Perspective

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In 1910, J. Quincy Ward appeared before the Kentucky Legislature with the sportsmen's request for a game and fish commission supported by license fees. Two years later, after much

wrangling, the agency was formed with the duty to "propagate the game and fish of Kentucky". In it's first five months, the division took in $31,000 from license sales. With Ward as director, the new game and fish division had four governor-appointed commissioners.

In 1944, the fish and wildlife agency, as it functions today, was born. The General Assembly placed the division under civil service and made it a separate agency of state government. This is also the time at which the fisheries division began. In 1947 the fisheries biology and farm pond sections were established. The General Assembly rewrote the game and fish laws in 1952 and changed the division to Kentucky Department of Fish and Wildlife. The following year, Kentucky Afield-TV and the Happy Hunting Ground magazine were born.

By 1955, 21 public lakes had been completed or had land purchased for construction. Minor Clark Fish Hatchery began operations in 1973 and the Wolf Creek National Fish Hatchery opened in 1975. The Aquatic resource education program began in 1990 and provides educational programs, materials and learning experiences for every aspect of Kentucky's population. The addition of the Water Patrol section of law enforcement occurred in 1994.

Fisheries management, conservation and culture methods have been refined and improved throughout the history of the Kentucky Fish and Wildlife Department. A historical perspective of these changes is presented in poster format.

The Reservoir Committee History Poster

Dr. L. E. Miranda and Mark Oliver.

The Reservoir Committee of the Southern Division AFS was originally appointed in 1957 and had its first meeting in 1958. The objective of the early committee was to provide a coordinated approach to addressing reservoir fisheries management concerns such as water level management , 0pre-reservoir clearing, assessing recreational and commercial fisheries, shad control, and exotic species introduction. The Reservoir Committee continues to provide a forum for biologist to discuss problems, expose hypotheses to critical review, summarize data, and management. The Committee has had an extremely active history beginning with an in-depth focus report on investigation needs on large reservoirs, and continuing with assessments and standardization of fish sampling methods; the multi-state Predator Stocking Evaluation; three reservoir symposia; developing several regional and national reservoir databases; the Lake Texoma Shad-a-Thon (shad sampling evaluation); the Robert M. Jenkins Memorial Reservoir Research Scholarshi0ps (2 annually); and creating 2 on-line fisheries habitat manuals. The Reservoir Committee has also been a generous financial support of many other division and parent society research and information sharing activities.

Pollution Committee Poster

Ken Shirley and the Pollution Committee.

The Pollution Committee was formed in 1958 as the “Water Pollution Sub-Committee of the Reservoir Committee”. It was established “to review legislation of member states, assess the nature and extent of pollution of major streams and impoundments and ascertain the probable effects of large-scale pesticide programs”. In 1963 it became the “Pollution Committee” with its major goal to develop “a defensible basis for the assessment of damages in cases of pollution caused fish kills”. In 1970, the committee published companion booklets Monetary Values of Fish and Fish-Kill Counting Guidelines. The techniques and values provided by these booklets

and their subsequent revisions have been successfully used in court cases throughout the nation to collect damages from fish kills. The monetary values book was revised in 1975 due to inflation and the guideline book was revised in 1976. In 1982, the committee collaborated with other American Fisheries Society divisional committees to revise and combine the two booklets as AFS Special Publication # 13 - Monetary values of Freshwater Fish and Fish Kill Counting Guidelines. In 1992, the committee collaborated with the AFS Socio-economics Section to publish AFS Special Publication #24 – Investigation and Valuation of Fish Kills. On-going and future projects include updating the publication to address price changes for fish, developing standardized computer software for entry of fish kill data and report generation and adding fish kills and pollution events into GIS.

A History of the SDAFS Striped Bass Technical Committee

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The origins of the SDAFS Striped Bass Committee are found in a Reservoir Committee subcommittee created in 1967 to deal with reservoir striped bass issues. The Southern Division elevated the group to full technical committee status as the Striped Bass Committee in 1970. The Committee was "interested in all phases of hatching, rearing, stocking, and management of striped bass in suitable habitats." The Committee produced the *Guidelines for Striped Bass Culture* in 1976 and *Culture and Propagation of Striped Bass and Its Hybrids* in 1990. The group promoted cooperation in striped bass production among southeastern fisheries management agencies. The Committee also investigated the effectiveness of stocking phase I and phase II striped bass fingerlings in southeastern reservoirs. The Committee's focus has changed from primarily striped bass aquaculture in its early years its current interest in reservoir striped bass management.

Small Impoundments Committee History Poster Abstract

Diana L. Andrews.

The Small Impoundments Committee of the Southern Division of the American Fisheries Society was established in 1987. Ed Steinkoenig was the first Chairman of the committee and the driving force behind it's establishment. The Committee was formed to enhance ongoing small impoundment management programs then being conducted by most Southeastern states, and to further small impoundment research programs. Committee members represent various organizations including state, federal, university and private entities. The purpose of the committee is to foster information exchange among state, federal, university and private entities; and to promote the proper scientific management and use of public and private impoundments less than 500 acres. Since it's formation the committee has conducted survey's on the importance and valuation of small impoundments in Southeastern states, co-sponsored a continuing education course on Aquatic Plant Management with the reservoir committee and held an Urban Fishing Program Techniques workshop.