ABSTRACTS

*student presenter

EFFECTS OF COPPER ON SODTUM (NA+) ION FLUX IN CHANNEL CATFISH *(ICTALURUSPUNCTATUS)* DURTNG EXPOSURE TO SUB LETHAL OR 96 H LC50 CONCENTRATrONS OF COPPER SULFATE. Melissa S. Hobbs and Billy R. Griffin, U.S. Department of Agriculture, Stuttgart National Aquaculture Research Center, Stuffgart, Arkansas; Richard S. Grippo, Department of Biological Sciences, Arkansas State University, State University, Arkansas.

Copper sulfate is a widely used in aquaculture as an herbicide and parasiticide. Previous workers have shown copper to negatively affect body ion homeostasis. Net Na+ flux was determined in juvenile channel catfish exposed to therapeutic or acutely lethal levels of copper sulfate (1.7 mg/L or 4.3 mg/L) by monitoring the change in Na+ content of the experimental water over a 24 hour period. The sub-lethal exposure of 1.7 mg/L copper sulfate was derived from a formula that uses alkalinity for calculating the application rate of copper sulfate in fish cu'ture ponds. Copper sulfate at 4.3 mg/L is the 96 h LC50 for juvenile channel catfish in the well water used in this study. Exposure to 1.7 mg/L copper sulfate resulted in a significant increase in Na+ concentration indicating a significant negativenet flux, compared to control groups. Exposure to 4.3 mg/L copper sulfate also resulted in a significant increase in water Na+ concentration although significantly less than what occurred during exposure to 1.7 mg/L copper sulfate. Sodium ion loss is a known mechanism of copper toxicity. Until a safer formula to predict an effective application rate of copper sulfate in cul.~ure ponds is derived, the apparent risk of copper toxicity should be considered when management of algae or parasites is required.

PHYSICOCETEMICAL DETERMINANTS OF FISH ABUNDANCE IN TRIBUTARY CONFLUENCES OF TEIE LOWER CHANNELIZED MISSOUR} RIVER. Patrick J. Braaten, Matthew R. Doeringsfeld, and Christopher S. Guy, Kansas Cooperative Fish and Wildlife Research Unit, Division of Biology, Kansas State University, Manhattan, Kansas 66506.

We sampled juvenile and adult fish from seven tributary confluences in the channelized Missouri River throughout the annual hydrologic cycle to deterrnine if fish use of these habitats was influenced by temporal changes in physicochemical variables in tributaries and the Missouri River. Seven sampling periods were pooled into four significantly ($P < 0.05$) distinct Missouri River water temperature groups representing periods of cold (December and January, Mean = 1.5° C), cool (March, mean = 4.4° C), warm (May and October, mean = 17.0° C), and hot (June and July, mean = 26.2° C) water temperatures. Similarly, Missouri River discharge groups were significantly ($P < 0.05$) delineated as periods of low (January, discharge = 82% of mean annual discharge), medium (October, December, March, mean = 142%), medium-high (July, mean = 164%), and high discharges (June and May, mean = 189%). Ten of 26 species composed > 90% of the fish collected. River carpsucker Carpiodes carpio, goldeye Hiodon alosoides, and sauger Stizostedion canadense `.vere the most abundant species sampled. Fish density in tributary

confluences was significantly higher (P <0.05) during the Missouri River cool and hot temperature periods than the cold period. Fish delisity was positively related to tributary surface water temperature during the cool period (r2 = 0.62, P = 0.0Jr), and positively related to tributary maximum depth (_2 = 0.48, P = 0.04), and Missouri River turbidity (r2 - 0.58, P = 0.02), during the hot period. Fish density in the tributary confluences did not differ significantly (P = 0.31) among the four Missouri River discharge group~, but density was negatively related to tributary turbidity (r2 = 0.68, P = 0.04), during the mediumhigh discharge period. Our results demonstrate that tributary confluences are used by juvenile and adult fishes native to the Missouri River, and provide ;mportant low-velocity habitat during most times of the year. The associations of fish with tributary confluences are influenced by temporal changes in physicochemical factors that VarJ throughout the annual hydrologic cycle in the Missouri River and tributaries.

EFFECTS OF PHYSICAL HABITAT, WATER REGIME, AND SEASON ON FISH ASSEMBLAGE STRUCTURE IN A SHALLOW FLOODPLAIN LAKE. William S. Chappe'l* and William L. Fisher, Oklahoma Cooperative Fish and Wildlife Research Unit, 404 LSW, Oklahoma State University, Stillwater, OK 74078.

The Cumberland Pool is a broad and shallow lake along the Washita arm of Lake Texoma, OK/TX that is rapidly changing due to sedimentation from the Washita River. The objective was to relate fish assemblage structure to changing environmental factors. Stratified random sampling with trapnets, gill nets, seines, and an electrofishing boat was used to collect fish over a two year period. The strata consisted of habitat type and season. Water regime was integrated with habitat type. Preliminary observations revealed greater variation in abundance of white crappie *(Pomoxis annularis)* caught in heterogeneous habitats and less variation in abundance of white crappie caught in homogeneous habitats. We also observed summer habitat segregation of catfish species, with blue catfish Ictalurus furcatus inhabiting the open water and channel catfish *Ictalurus punctatus* inhabiting the nearshore. Rising water inundating large areas of vegetation tended to concentrate Catostomid species, common carp *Cyprinus carpio, Lepisosteus* species, and white crappie.

EVALUATION OF TROPHY BASS REGULATIONS USING AN ANGLER CREEL SURVEY ON UPPER AND LOWER WHITE OAK LAKES, ARKANSAS. D. Colton Dennis, Don Turman, and Mike Bivin, Arkansas Game & Fish Commission, Fisheries Division, #2 Natural Resources Drive, Little Rock, AR 72205.

Upper and Lower White Oak Lakes are 324 and 486 hectare reservoirs located in South-central Arkansas and owned by the Arkansas Garne and Fish Commission. A four year, daytime creel survey was conducted on both lakes between December 1992 and November 1996 to determine angler pressure and success and evaluate the effects of Trophy Bass Regulations on the Lower lake. A 400-525 mm (16-21 in) protected slot limit with 3 fish under 400 mm (16 in) and 1 fish over 525 mm (21 in) or a total of 4 fish below 400 mm (16 in) was imposed as the creel limit on the Lower lake in January 1994 as required by the Arkansas Largemouth Bass Management Plan for a Trophy Bass Lake. The Upper lake bass population remained regulated by the statewide bass creel limit of 10 fish/angler/day throughout the 4-year study. This allowed for the opportunity to have a side by side evaluation of trophy regulated and non-regulated lakes, since

both lakes are similar in size, had almost identical bass population structures, and were fertilized. A stratified, random, three stage probability sampling scheme was used to conduct pressure counts and interview anglers by boat 120 days/year/lake. Upper White Oak lake bass angler harvest of bass > 400 mm (16 in) was prevalent from 1993-95; however, in 1996 the idea of catch-and-release became popular among bass anglers as the numbers of bass > 400 mm (16 in) released on the Upper and Lower lakes were the highest recorded during the creel study. Lower lake bass angler-hours were lower in 1996 than in previous years, but bass anglers on the Lower lake were more successful at catching and releasing bass 400-525 mm (16-21 in) per hour than for any other year during the creel survey. Bass anglers also experienced a 0.583 total catch per hour on the Lower lake in 1996. Bass angler-hours decreased 60% from 1993-96 on the Lower lake, but 59% of the total bass angler-hours for both lakes in 1996 were spent on the Lower lake. Electrofishing and creel survey data reflect the success of the Trophy Bass Management Plan in generating a good bass population above 400 mm (16 in) and participat on of bass anglers in the catch-and-release philosophy, which together are building a quality trophy bass f~shery in Lower White Oak Lake.

CHARACTERISTICS OF LARGEMOUTH BASS TOURNAMENTS IN FELSENTHAL NATIONAL WILDLIFE REFUGE, AR. Colton Dennis* and Steve Lochmann, Arkansas Game and Fish Commission, 2320 Chidester Road, Camden, AR 71701.

The biases and benefits of angler-supplied data have demonstrated the utility of angler diaries. We wanted to examine the utility of data supplied voluntarily from largemouth bass tournaments in addressing management concerns regarding bass populations. Nine years of permitting and reporting data (1988-96) collected by the Felsenthal National Wildlife Refuge (Crossett, AR) were examined. The number of angler-hours did not change significantly, but the number of tournaments increased suggesting a trend toward shorter tournaments. The number of tournaments reporting catch and the number of fish caught per angler-hour increased between 1988 and 1996. The average weight of a bass from the tournaments also increased during the time period. The average percent of tournament fish dead or kept decreased from approximately 93% in 1989 to approximately 25% in 1994, where it has remained steady in recent years. The percent of tournaments with the biggest bass over five pounds increased and then decreased during the time period. Based on electrofishing data, RSD values between 1988 and 1996 increased. It may be possible to use voluntary angler-supplied data from bass tournaments to supplement typical collections and provide useful information for management decisions.

GETTNG CITIZENS INVOLVED WITH AQUATIC HABITAT CONSERVATION. Steve Filipek, Stream Team Coordinator, Arkansas Game and Fish Commission, 102 NE 2nd Street, Brgant, AR 72022.

The Arkansas Stream Team Committee was formed by several state and federal agencies, and private citizens in an effort to counteract the degradation of Arkansas streams. The objectives of this group are to involve Arkansas citizens in the conservation, rehabilitation, and wise management of Arkansas' invaluable stream resources. Included in this involvement are aspects of education, stewardship, and advocacy. The Arkansas Stream Team is a hands-on effort to maintain the excellent quality streams still found in many areas of the state and rehabilitate those

that have been degraded by a wide variety of impacts (gravel mining, point source pollution, non-pt. pollution, etc.). Volunteers work to take care of a mile or so of stream, wetland, spring, or any waterbody. They may keep it clean, monitor the water quality in that section, work with the landowner (who can be a stream team member too) to help stabilize an eroding stream bank, learn about how streams function, write or talk to elected off~cials to help them realize what is happening to streams, or all of the above. The volunteers pick the stream to work on and what they want to do on that stream. To date, approximately 80 Stream Teams have signed up. The long term goal is to have various Stream Teams working on an entire watershed and utilizing their contacts and networking to have landscape scale impacts as a larger group. The founding agencies were the Arkansas Game and Fish Commission and the Natural Resources Conservation Service, however current membership includes the Arkansas Department of Pollution Control and Ecology, Arkansas Soil and Water Conservation Commission, USDA Forest Service, National Biological Service, US Geological Survey, Arkansas Scenic Rivers Commission, Arkansas Department of Parks and Tourism, and Arkansas Division of Volunteerism. ~

GROWTH AND GLUCOSE TOLERANCE OF GOLDEN SHINERS FED DIETS DIFFERING IN CARBOHYDRATE SOURCE. Andrea Humphrey* and Rebecca Lochmann, University of Arkansas at Pine Bluff, Dept.of Aquaculture/Fisheries, Pine Bluff, AR, 71611.

Utilization of carbohydrates among fish species is more variable than utilization of protein or lipid. Carbohydrates are desirable as inexpensive energy sources in feeds, but no research has been conducted to determine the relative use OT :'ifferent types of carbohydrates in golden shiners. Therefore, four isocaloric isoenergetic semipurified diets containing 30% carbohydrate as dextrin, starch, glucose or sucrose were fed to triplicate groups of golden shiners for 8 weeks to determine their response to carbohydrates of different levels of complexity. Fish fed the diet with starch had significantly higher weight gain than fish fed diets with other carbohydrates. Fish fed the diet with dextrin produced the next highest gain, while fish fed diets with sucrose or glucose gained the least weight. Weight gain was positively correlated with carbohydrate complexity (starch > dextrin > sucrose 3D glucose) which is typical of carp and many warmwater fish. Following the feeding experiment, a different (larger) group of fish was acclimated to test diets or two weeks, then fasted for 36 h and subjected to a glucose tolerance test to investigate carbohydrate utilization further. Fasting glucose levels in whole blood of individual anaesthetized fish (n 3D4) were measured with a glucometer initially. The remaining fish were divided into two groups and fed either a diet containing glucose or starch to satiation. After feeding, glucose levels in blood from 3-5 fish per treatment were determined at 0.5 - 2-hour intervals. Due to differences in complexity of glucose versus starch the latter is digested more slowly, which can be manifested as a delayed increase in blood glucose of fish fed starch versus glucose. However, blood glucose of fish fed diets with glucose was highly variable compared to that of fish fed diets with starch, and no significant differences in response were observed at any of the sampling periods. Although blood glucose data was adjusted for differences in fish weight, differences in fish size or feed intake might have contributed to the variability of the data.

THE TEMPORAL COMPOSITION OF ZOOPLANKTON IN FRY CULTURE PONDS IN THE FALL. Maurice Jackson*, Gerald Ludwig, and Steve Lochmann, *Aquaculture/Fisheries Center, UAPB, P.O. Box 4912, Pine Bluff, AR 71611

Technology now allows spawning of goldfish to be extended to at least September. The success of feeder goldfish production depends heavily on appropriate zooplankton in fry culture ponds. Until now, no detailed study has been conducted on production of feeder goldfish or zooplankton succession in culture ponds during the fall. Comparing the zooplankton abundances in culture ponds with and without fry will enable us to determine if fall production of feeder goldfish is feasible. Fry culture ponds were filled, fertilized, and sampled daily for zooplankton, temperature, and dissolved oxygen for approximately eight weeks from September 20 - November 9. Fry were stocked in ponds five days after filling. Four taxonomic groups of zooplankton (rotifers, copepod nauplii, copepod adults and cladocerans) were identified and enumerated from plankton samples. Survival rates for the study were determined. Our results suggest that zooplankton dynamics would not be a limiting factor in fall production of feeder goldfish.

EFFECTS OF TURBIDITY ON PREDATION OF YOUNG RAZORBACK SUCKER. James E. Johnson, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701

Razorback sucker is an endangered species native to the Colorado River. Numbers have declined dramatically during the Twentieth Century, believed due to altered habitat and introduced predatory fishes. The few remaining razorback sucker populations are known to spawn in mainstream rivers (Colorado, Green) with high turbidities and in Lake Mohave with low turbidity, but young fish fail to survive in either habitat. In order to test turbidity preferences, 30 young razorback suckers 47-48 days of age were placed into a gradient chamber containing three isolated turbidities: 0, 250, and 2000 ppm; bentonite was used to create the different turbidity levels. Overall, 67% of the young fish chose the clear water chamber, 23% chose the 250 ppm chamber, and 10% the 2000 ppm chamber. In predation tests under those same turbidities, at 0 turbidity young razorback sucker were unable to avoid green sunfish, with the non-native predator consuming 99.7% of available prey. Suckers were significantl, more efficient at avoiding the native Colorado squawfish under clear water conditions, but still 90. 1% of the young fish were consumed. At 250 ppm turbidity, green sunfish consumed 51.6% of razorback sucker young and Colorado squawfish 56.5%. Avoidance was significantly greater than at 0 ppm, but not significant between predators. At 2000 ppm turbidity, green sunfish consuming 31.2% of the young suckers and Colorado squawfish 40.2%. Again, turbidity significantly reduced predation, but differences were not significant between predators. Thus, turbidity acts as cover for young razorback sucker, but they select for clear water habitats where they are more vulnerable to predation. This suggests it will be difficult to recover this species in habitats containing large numbers of predators.

MODELLING THE EFFECTS OF LAND USE AND CLIMATE CHANGE ON A LARGE-RIVER SMALLMOUTH BASS POPULATION. Thomas J. Kwak and James T. Peterson, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701 and U.S. Forest Service Rocky Mountain Research Station Boise, Idaho 83702

Anthropogenic changes in temperature and stream flow, associated with watershed land use and climate change, are critical influences on the distribution and abundance of riverine fishes. To project the effects of changing land use and climate, we modeled a smallmouth bass *(Micropterus dolomieu)* population in the Kankakee River, a midwestern, large river-floodplain ecosystem, under historic (1915-1925), present (1977-1990), and future (2060, influenced by climate change) temperature and flow regimes. The age-structured model included parameters for river discharge during critical seasonal periods, fish population dynamics, and angler harvest. Model relationships were developed from empirical field data collected over a 13-year period. Sensitivity analyses indicated that discharge during the spawning/rearing period had a greater effect on adult density and harvest than did winter discharge. Simulations for 100 years projected a 127% greater mean fish density under a historic flow regime (70.1 fish/ha) than that estimated for the present (30.8 fish/ha) with a sustainable harvest under both flow regimes. Simulations under a future climate-change induced flow regime with present land use projected an 80% decrease in mean fish density (6.1 fish/ha) from present and an unstable population that went extinct in 88% of simulations. However, when simulated under a future climate-altered flow regime with historic land use, the population increased by 46% (45.0 fish/ha) from present and sustained a harvest. Our findings suggest that land use changes may be a greater detriment to riverine fishes than projected climate change and that the negative effects of increased precipitation associated with future global warming could be mitigated by river channel, floodplain, and watershed restoration.

RESOURCE PARTITIONING AMONG ADULTS OF THREE BLACK BASS SPECIES IN SKIATOOK LAKE, OKLAHOMA. James M. Long and William L Fisher, Oklahoma Cooperative Fish and Wildlife Research Unit, 404 LSw, Oklahoma State University, Stillwater, OK 74078.

In an attempt to control an increasing spotted bass population, a differential harvest regulation was imposed on three black bass species in Skialook Eake, Oklahoma. Spatial abundance and prey use patterns of adult largemouth, smallmouth, and spotted bass were determined. In Spring 1997, fish were sampled by nighttime elecircfishing to assess resource partitioning arnong these species. Skiatook Lake exhibited a longitudinal trophic state gradation from eutrophy in the upper end to oligotrophy in the lower end, based on chlorophyll-a concentrations. Largernouth bass catch per unit effort (CPUE) was similar among strata ($P = 0.453$). Smallmouth bass CPUE was significantly greater in the lower lake ($P < 0.001$) and was highly correlated with secchi depth ($P < 0.001$, $r = 0.70$). Spotted bass CPUE was significantly lower in Hominey Creek ($P = 0.013$), an uplake stratum, but was greater than both largemouth and smallmouth bass CPUE in most areas of the lake. Spotted bass and largemouth bass CPUE was negatively correlated with each other in the mid lake stratum and was not correlated with dissolved oxygen, temperature, conductivity, chlorophyll-a, or secchi depth. Largemouth and smallmouth bass consumed more fish whereas spotted bass ate more insects. These black bass species partitioned prey resources more so than habitat resources.

GENETIC RELATIONSHIPS OF THE FRESHWATER BLACK BASSES (GENUS *MICROPTERUS)* AS DETERMTNED BY MITOCHONDRTAL DNA ANALYSTS. James *B.* Magee* and Ronald *L.* Johnson, Arkansas State University, Department of Biology, State University, AR 72467.

Geographic isolation and habitat specialization has aided in the evolution of and genetic integrity of the micropterine bass species of North America. Extensive stockings of introduced species into waters previously containing native species has resulted in frequent hybridization and loss of vigor of many natural bass populations. Our goal was to determine the genetic relationships among the freshwater black basses using mitochondrial DNA analysis. Mitochondrial DNA was examined in 15 individuals of each species and subspecies using 15 restriction endonucleases. The smallmouth and spotted basses had the closest genetic similarity, which would be predicted by the numerous reports of hybridization between these two species. No evidence of recent hybridization was observed for the species studied.

FACTORS INFLUENCING BROWN TROUT REPRODUCTIVE SUCCESS IN OZARK TAILWATER RIVERS. Danielle R. Painter* and Thomas J. Kwak, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701

Brown trout, *Salmo trutta,* reproductive success in White River tailwaters is highly variable, resulting in the need for supplemental stocking. A better understanding of physical and biotic factors contributing to reduced survival and variation among tailwaters will facilitate fisheries composed of greater proportions of wild populations to increase the quality ofthe fish and fishery. Fecundity was estimated from 12 female brown trout collected prior to spawning from four sites. Brown trout from one tailwater known for reproductive failure had significantly lower fecundity measures and condition factors than those of three other sites, while there was no difference among other sites with higher reproductive success. Brown trout spawning occurred from October 11 to November 23, 1996, and fry emergence began February 23, 1997. Significant among-site differences were found for spawning and fry microhabitat variables; however, variables-fell within optimal ranges reported in the literature. There were no significant differences in spawning gravel quality or percent fines obtained by freeze-core sampling. Significant differences were found among sites for fry and juvenile density, but not for their size or condition. Interspecific competition and food availability are additional factors that may affect reproductive success. Ozark sculpin, *Cottus hypselurus,* density was highest and benthic invertebrate abundances were lowest at the tailwater known for reproductive failure. Ongoing investigations into trout early life history may reveal additional influential factors to improve trout reproductive success and increase the proportion of wild fish in these systems.

PADDLEFISH MOVEMENTS IN THE KEYSTONE RESERVOIR SYSTEM, OKLAHOMA. Craig Paukert* and William L. Fisher, Oklahoma Cooperative Fish and Wildlife Research Unit, 404 Life Sciences West, Oklahoma State University, Stillwater, Oklahoma 74078.

Paddlefish make extensive movements, particularly during spring spawning migrations, but little is known about their movements during the rest of the year. Paddlefish movements in the Keystone Reservoir system were determined by recaptures during winter and spring gill netting, tag returns by anglers, and ultrasonic telemetry in spring and summer. In winter 1996, 83% of recaptures were tagged and recaptured in the Cimarron River Arm. However, fish tagged and recaptured in winter 1997 showed more variable movement within the reservoir. Gill netting and tag returns from anglers in spring 1997 indicated that paddlefish moved up the Cimarron River at least 67 km, the Arkansas River 176 km to Kaw Dam, and the Salt Fork of the Arkansas River at least 15 km above its confluence with the Arkansas River. They were found in these rivers from 1 March to 16 April. Paddlefish most likely moved out of Keystone Reservoir February 22-24, when flows peaked at 931 m3/s in the Cimarron River and 560 m3/s in the Arkansas River. Only fish > 600 mm were found in the rivers. However, six transmittered males (843 mm - 1000 mm) remained in and made extensive movements within the reservoir during the spring spawning migration. Paddlefish were located back in the reservoir on 10 May; larger fish (> 1000 mm) were located beginning on 16 May. These data along with summer telemetry provide a more complete picture of seasonal movements of paddlefish in a prairie reservoir.

OZARK WATER QUAEITY IN THE NATIONAL PERSPECTIVE. James C. Petersen, U.S. Geological Survey, 401 hardin Road, Little Rock, AR 72211.

Surface water, ground water, streambed sediment, biotic tissue, aquatic habitat, and fish communities in the Ozark Plateaus of Missouri, Arkansas, Oklahama, and Kansas generally are of better quality than in most other areas in the United States as indicated by national medians calculated from U.S. Geological Survey National Water-Quality Assessment (NAWQA) Program data. Although exceptions exist, concentrations of analytes usually did not exceed national drinking-water standards or criteria for protection of human health or aquatic life. Indices for nutrients, pesticides, semivolatile and volatile organic compounds, metals, radon, dissolved solids, aquatic habitat, and fish communities for surfacewater and ground-water sampling sites in the Ozark Plateaus were compared to national medians for sites in 19 other NAWQA study areas. Nutrients, metals in streambed sediment, and semivolatile organic compounds in streambed sediment were found at levels greater than the national NAWQA medians primarily at some sites impacted by agriculture, mining, or urbanization. Aquatic habibat was poorer than the national median at a stream site impacted by urbanization and mining. Fish communities were poorer than the national median at some stream sites in agricultural basins. Ground-water quality was most notably poorer than the national medians (for ground water used for drinking water) for nitrate in the Springfield Plateau aquifer. Medians for indices of volatile organic compounds in the Springfield Plateau and unconfined Ozark aquifers and for pesticides in the Springfield Plateau aquifer also exceeded national medians.

LONG TERM CHANGES IN FISH COMMUNITIES OF THE ARKANSAS RIVER IN RELATION TO KAW DAM HYDROPOWER OPERATIONS. Jimmie Pigg and Ken Cunningham . Oklahoma Department of Environmental Quality, 1000 NE 10th, Oklahoma City, OK 73117 and Oklahoma Fishery Research Laboratory, 500 E. Constellation, Norman, OK 730722.

Kaw Dam hydropower operations were initiated in 1990. In an effort to assess the effects of these operations on the fish community of the Arkansas River downstream from Kaw Dam to Keystone Reservoir, long-term sampling data were analyzed and evaluated. This sampling was conducted at two sites from 1977-96 and consisted of taking 20 10-m seine hauls one-three times per year at each site. Fish were preserved in the field ard then enumerated and identified to species in the laboratory. We used correlation procedures to determine differences in non-hydropower and hydropower years for numbers of species collected, total numbers of individuals coliected, and numbers of individuals collected by species. No significant differences were detected for numbers of species collected or total numbers of individuals collected. However, marginal differences were detected in the numbers of cyprinid fishes collected, and these differences may be related to the initiation of hydropower operations. In general, Kaw hydropower operations seem to be having little or no impact on the fish communities of the Arkansas River. However, we recommend that monitoring be continued so that possible future impacts can be evaluated.

PRELIMINARY EXAMINAMON OF VITAMIN C NUTRITION IN GOLDEN SHINERS. Margaret Queathem*, Rebecca Lochmann, Konrad Dabrowski and Regis Moreau, The University of Arkansas at Pine Bluff, Dept. of Aquaculture/Fisheries, Pine Bluff, AR 71611**.**

The role of ascorbic acid in the nutrition of golden shiners *(Notemigonus crysoleucas)* has not been examined. Pathological signs characteristic of ascorbic acid deficiency such as scoliosis, lordosis, and hemorrhages have been reported in golden shiners raised in indoor systems. However, these signs are not specific to ascorbic acid deficiency and the etiology of these signs has not been established. Ascorbic acid is vital for normal structure and function in fish, but not all fish have a dietary requirement for the vitamin. Therefore, a feeding trial was conducted with golden shiners at the University of Arkansas at Pine Bluff (IJAPB) to collect preliminary data. Fish were fed one of four isonitrogenous diets containing either casein and 0 or 250 mg ascorbic acid (Stay C-40) per kg diet, or fish meal and 0 or 250 mg ascorbic acid per kg diet. Diets were formulated at the Ohio State University (OSU) and shipped to UAPB. The experimental system consisted of 11 0-L tanks in a flow-through system containing thirty fish (0.4 g initial weight) in each of three replicate tanks per treatment. Fish were fed at a rate of 5-6% of body weight daily in two feedings. Growth was monitored biweekly. After nine weeks, weight gain of fish fed the diet with fish meal and no supplemental ascorbic acid was significantly lower (p 3D.003) than that of fish fed the other three diets. Growth of fish fed the casein diets with or without ascorbic acid was not statistically different. Although growth of fish fed the casein diets was equal to that of fish fed the fish meal diet with ascorbic acid, the external appearance of the fish fed casein diets was poor compared to that of fish fed supplemented or unsupplemented fish meal diets. Fin erosion, exophthalmia and dermal hemorrhages (but not scoliosis or lordodis) were predominant in fish fed casein diets irrespective of their ascorbic acid content. External pathological signs were virtually nonexisterk~t in fish fed the fish meal diets, although growth of fish fed the

unsupplemented diet was depressed significantly. It is unclear why a pronounced growth effect of dietary ascorbic acid was observed in fish fed fish meal diets but not those fed casein diets. These results suggest that the pathology observed in fish fed casein diets was unrelated to clietary ascorbic acid content. Ascorbic acid analysis of all diets and fish tissues will be conducted at OSU. The results should facilitate interpretation of the preliminarv feeding trial and planning of future experiments.

TROUT POPULATION RESPONSE AND MICROHABITAT USE OF REHABILITATED HABITAT IN AN OZARK TAILWATER RTVER. Jeffrey W. Quinn* and Thomas J. Kwak, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701.

Habitat rehabilitation was completed following catastrophic flooding in the White River below Beaver Lake Dam using techniques developed in small streams. We evaluated trout response to rehabilitation at reach and microhabitat scales. We estimated trout populations and determined microhabitat use in modified and reference reaches. The ratios of total trout abundance (density and biomass) in the modified reach, relative to that of the reference reach, increased after rehabilitation - evidence that the modified reach supported more fish after rehabilitation. When the population response was stratified by species and size, the greatest positive effects were for rainbow trout and smaller fish (10 - 19.9 cm). Cover increased significantly in the modified reach after rehabilitation, with the majority of additions found at the low-flow, land-water interface. This strategy increased bank stabilization and provided additional cover during high flow, when trout were observed associated with velocity refugia. In summary, we measured increased supportive capacity for trout after rehabilitation that appeared to be associated with the addition of cover, but the pattern varied among trout species and size classes.

PROSPECTS AND ISSUES SURROUNDING DAM REMOVAL AND RESTORATION OF FREE-FLOWING RIVERS. Andrea Radwell* and Thomas J. Kwak, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701

Dams and reservoirs are an important part of the infrastructure of the United States, providing a number of economic and social benefits. Stream and river impoundment, however, has been associated with habitat changes resulting in extirpations and declines in fish and wildlife populations. Given the age and condition of many dams in this country and greater public environmental awareness, there is a growing interest in assessing if benefits of dam removal may outweigh those of dam retention. In some cases, it appears that dam removal and restoration of historical ecological conditions to support native fish populations is a viable alternative. While there have been few documented reports of dam removals in the past, there are currently at least 20 sites in both inland and coastal states where either dam removal has been proposed or assessments are underway to determine if dam removal is feasible. Proposed removal of the Edwards Dam in Maine and Elwha River dams in Washington, as well as detailed assessment underway of the Rodman Dam in Florida, highlight major dam removal issues. Primary factors under consideration include river flow dynamics during and following removal, sediment and nutrient transport, floodplain dynamics, changes in river channel morphology, risk of resuspension of toxins, and potential for restoration of fish populations. Knowledge gained in these reviews and assessments will provide a basis for making decisions regarding dams deemed

to be unsafe or unneeded, as well as those that cause unacceptable environmental damage.

OZARK STREAM FISH ASSEMBLAGES AND BLACK BASS POPULATION DYNAMICS ASSOCIATED WITH WATERSHEDS OF VARYING LAND USE. Ronald D. Rambo* and Thomas J. Kwak, Arkansas Cooperative Fish and Wildlife Research Unit, Department of Biological Sciences, University of Arkansas, Fayetteville, AR 72701.

The effect of watershed land-use patterns on stream fish assemblages is critical information required for effective ecosystem management. We studied the relationship between smallmouth bass abundance and fish assemblages and land use at the watershed scale. Density and biomass of each species were estimated at 11 sites on 8 streams in the Boston Mountain Ecoregion of Arkansas at watershed areas from 3,176 to 7,505 ha. Black bass population parameters and annual production were estimated during May 1996-May 1997. All other fish popuLticns were estimated during summer, 1996. 131ack bass density and biomass averaged 184 fish/ha and 7.8 1rg/ha, respectively, and annual production was highest (3.6 kg/ha) in the watershed with an intermediate proportion of ay,riculture. Total fish density and biomass averaged 19,077 fish/ha and 75.1 kg/ha, respectively. Total fish density and biomass, percent intolerant species, and percent insectivorous cyprinids increased as timber harvest and agriculture increased. Quadratic relationships were detected between smallmouth bass density, biomass, and number of cohorts versus agriculture and forest cover. We hypothesize that at low intensities of agriculture, smallmouth bass are limited by nutrient availability, but at higher intensities structural habitat and flow regime become limiting. Our results suggest differences among fish assemblages associated with varying watershed land use, which may be further explored with manipulative research to establish cause-effect and mechanistic relationships.

INDUCTION SPAWN]NG OF YAQUI CATFISH. Joshua Reilly* and Rebecca Lochmann, Aquaculture/Fisheries Center, UAPB, P.O. Box 4912, Pine Bluff, AR 71611.

The Yaqui catfish *(Ictalurus pricei) is* a native of the Rio Yaqui Drainage of Chihuahua and Sonora Mexico. Formerly, a resident of the northern headwaters of the Yaqui River, it is now exterpated from the U.S. The Yaqui Catfish has become threatened due to habitat loss by diversion of water, over-grazing, and subsequent erosion, aquifer pumping and hybridization with the non-native Channel Catfish *(Ictalurus punctatus).* Efforts to develop culture techniques and a breeding protocol for the Yaqui Catfish at Dexter National Fish Hatchery and Technology Center, New Mexico, and Uvalde National Fish Hatchery, TX, have met with minimal success thus far. Hormone induction has been successful in some instances with Ovaprim and LHR-Ha, but dosages and other possible variables effecting spawn success have not been experimentally determined. Additionally, due to its status, virtually no published work has focussed on the culture, or nutrition of this species. This paper briefly summarizes the work to date on the Yaqui Catfish, and identifies work that will be undertaken in 1998.

EFFECTS OF INCREASING WATER HARDNESS ON EGG DIAMETER AND HATCH RATES OF *MORONE SPP* EGGS. Steve Spade, Brian Bristow, and Julia Matlock, Oklahoma Department of Wildlife Conservation, Bryon State Fish Hatchery, Rt 1 Box S35, Bryon, OK 73722

Raising total hardness of hatchery well water with calcium chloride was tested to determine the effects on hatch rates and egg diameter of *Morone spp.* eggs. The effects were determined in two experiments. In the first experiments, fertilized eggs from each of 13 fish were divided into two lots. In the control lot, 3, 920,050 eggs were incubated for 48-59 hours in well water (41 mg/L total hardness). In the treatment lot, 4,115,320 eggs were incubated in treated well water (190-200 mg/L total hardness). The treatment eggs hatched at a significantly higher rate (70.3%) than the control eggs (52.9%). the egg diameter of the treatment eggs (2.45 mm) was significantly lower than the control (3.14 mm). In the second experiment, different lengths of treatment times were tested. Fertilized eggs from each of six female striped bass were divided into three lots. In the control lot, 1,788,200 eg~s were incubated in hardened water (190-200 mg/L total hardness) for 48-50 hours. In treatment A, 1,867,600 eggs were incubated for three hours in hardened water and then transferred to soft water (41 mg/L total hardness). In treatment B, 1,809,800 eggs were incubated six hours in hardened water and then transferred to soft water. The control eggs hatched at a significantly higher rate (44.7%) and treatment A (25.3%) or treatment B (31.9%). No significant difference between treatments in final egg size was apparent.

AGE AND GROWTH ANALYSIS OF BLACK AND WHITE CRAPPIE IN FELSENTHAL NATIONAL WILDLIFE REFUGE. Tavaris Spencer* and Steve Lochmann, Aquaculture/Fisheries Center, UAPB, P.O. Box 4912, Pine Bluff, AR 71611.

The Arkansas Crappie Management Plan calls for the use of otoliths for age determination and back-calculation of size-at-age information. When crappie experience variable growth rates from year to year or vary in physiological condition, age determination may be more complex. The presence of cross-overs, split annuli, or checks complicate the aging process. This study allowed the evaluation of growth rates of black and white crappie in Felsenthal National Wildlife Refuge (Crossett, AR) based on year-round trap netting efforts. We determined the time period during which annulus deposition occurs. We also generated a data set of otolith weights to support visual age determinations. Black crappie in Felsenthal grew at a rate similar to crappie from other Arkansas and Tennessee populations. White crappie were somewhat smaller at age than other populations. Otolith weight app `.:rs to be only marginally useful in confirming visual age estimates.

STRUCTURE OF FISH COMMUNITIES AND RELATIONSHIPS TO ENVIRONMENTAL VARIABLES IN THE BLUE RIVER, OKLAHOMA. Chad Stinson*, Sherry McGehee and William J. Stark, Department of Biological Sciences, Southeastern Oklahoma State University, Durant, OK 74701.

The Blue River Basin is a relative narrow unobstructed river located in southcentral Oklahoma, which supports a diverse assemblage of fishes. An ichthyofaunal survey was conducted to investigate the distribution, community structure, and environmental coorelates of these fish communities. Fifty-five sites were sampled using a variety of gears (seines, gillnets, trapnets, and electrofishing) during the late summer months when presumably fishes would be most

vulnerable. A total of 75 species were collected several of which were previously unreported from the basin. Simultaneous multivariate analysis of species rank-order-abundances and eleven environmental variables indicated that the Blue River fauna consisted of distinctive communities that not surprisingly followed a continuum of replacement that originated in the headwaters and progressed to the confluence with the Red River, OK/TX. Analysis also suggested that hydropower releases from the Denison Dam on Lake Texoma, OK/TX may have had a substantial effect on community structure in the lower portion of the Blue River.

RESPONSE OF TROUT TO LOW D.O. CONDITIONS IN NORFORK TAILWATER. Stan Todd & Tom Bly, Arkansas Game and Fish Commission, lS1 Highway 201 N, Suite B, Mountain Home, AR 72653.

Fall dissolved oxygen concentrations directly below Norfork Dam are frequently below the current state standard of 6.0 ppm and often below 2.0 ppm. Trout health assessments were conducted in late September of 1996 and 1997 to evaluate effects of seasonal low dissolved oxygen conditions. Sample sites were immediately below the dam and approximately 4.5 kilometers downstream. Dissolved oxygen at the downstream site normally remains at or above 6.0 ppm. Health of brown and brook trout were assessed. Both species showed significant decline in health at the dam site compared to the control site in 1997. Only brook trout showed a significant decline (a 0.05) in 1996, however, brown trout were near the significance level (a 0.053). Feeding in both species showed a similar pattern, but, no significant difference was detected in brown trout in 1996. Implications include slowed growth, increased mortality and reduced angling success.

OPTIMIZING THE BENEFICIAL USES OF THE GRAND NEOSHO RIVER BASIN. James R. Triplett, Department of Biology, Pittsburg State University, Pittsburg, KS 66762

HISTORICAL REVIEW OF LARGEMOUTH BASS MTNIMUM LENGTH AND SLOT LIMITS ON LAKE COLUMBIA, ARKANSAS WITH MANAGEMENT IMPLICATIONS. Don Turman and D. Colton Dennis, Arkansas Game and Fish Commission, Fisneries Division, #2 Natural Resources Drive, Little Rock, Arkansas**.**

Lake Columbia is a 1214 ha water municipality reservoir in South-central Arkansas that was impounded in March 1987 and stocked with 75-100 mm (3-4 in) fngerling Florida subspecies largemouth bass *(Micropterus salmoidesfloridanus).* A 300 mm (12 in) minimum length limit was imposed to protect the bass population and insure an adequate spawn. Growth of bass was so rapid that it was necessary to increase the length limit to 375 mm (15 in) on April 1, 1988 in order to protect the bass through their first spawning season. By the Fall of 1989, electrofishing data indicated a large proportion of bass between 225-275 mm (9-11 in). On February 1, 1990 the 375 mm (15 in) minimum length limit was removed and a 325-400 mm (13-16 in) pro~ected slot limit was implemented to reduce the number of 225-275 mm (9-11 in) largemouth bass. By Spring of 1991, the slot limit had successfully reduced the proportion of bass >300 mm (>12 in) and helped shiftthe population into the protected 325-400 mm (13-16 in) slot. By 1992 the bass population had clearly entered the slot and there was evidence of good numbers of bass exceeding 400 mm (16 in). In 1993, composite analyses suggested that largemouth bass <400 mm (16 in) were not above the 1.0 ppm FDA action level for mercury, but largemouth bass >400 mm (16 in) were generally above 1.0 ppm. This new information conflicted with the lake's

current management slot and the Arkansas Health Departments' recommended fish consumption advisory. In January 1994, Lake Columbia was designated a Trophy Bass Lake which required a 400-525 mm (16-21 in) protective slot and a reduced creel of four fish of which only one can be over 525 mm (21 in). The designation as a trophy bass lake with a 400-525 mm (16-21 in) slot allows for the management of a quality bass fishery while also addressing human consumption of largemouth bass. The 400-525 mm (16-21 in) Trophy Bass Slot currently remains in place and has been very successful in allowing for the consumption of bass that are safe to eat while at the same time developing Lake Columbia into an outstanding trophy largemouth bass fishery. The key to achieving management objectives when using minimum length or protective slot limits, is to observe the population carefully and consistently and be able to recognize changes that take place in the population structure so the appropriate changes or corrections in management can be made.