Southern Division of American Fisheries Society

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Abstracts

Contributing Session I: Stocking and Regulations

Crappie Stocking in Tennessee: The Blacknose Crappie Experience

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Recent angler surveys conducted by the Tennessee Wildlife Resources Agency (TWRA) have indicated that crappie are the second most popular sportfish in Tennessee reservoirs. However, due to increases in statewide fishing effort and changes in environmental conditions, several of the state's historic crappie fisheries have declined from historic levels. An effort was begun in the early 1980's to identify a strain of crappie that could be easily cultured in the state hatchery system and demonstrated high survival during transport and after stocking. The blacknose race of black crappie was selected since it possessed a natural mark that could be readily identified for recaptured fish when an impoundment was initially stocked. Initial investigations suggested that survival of stocked crappie was low on mainstream impoundments such as Watts Bar Reservoir.

However, TWRA hatchery managers were impressed at the high numbers produced by their blacknose crappie broodstocks and survival in ponds and during transport appeared higher than previous efforts with native black and white crappie. A second blacknose crappie stocking effort in Center Hill Reservoir succeeded in restoring its collapsing crappie fishery. Later attempts to stock crappie in other mainstem and tributary impoundments have also proven successful. At present, the TWRA produces and stocks more than 2 million blacknose crappie annually and demand by the biologists and the public continues to increase. Research currently underway seeks to identify those systems which will be good candidates for future stockings and quantify the impact of supplemental stockings in reservoirs and small impoundments.

Stocking Advanced Fingerling and Subadult Largemouth Bass into Florida Lakes

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Keywords: largemouth bass; stock enhancement; survival; relative weights (W_r); liver disease

Florida Game and Fresh Water Fish Commission biologists have feed trained and raised largemouth bass *Micropterus salmoides* on artificial feeds for stock enhancement studies. The objectives of this study were to determine survival rates and percent contribution of stocked largemouth bass in populations that were stocked. Ten lakes stocked with advanced fingerling (6-13 cm TL) and/or subadult (11-36 cm TL) largemouth bass have been studied since 1994. Stocking rates have varied from 16 bass/ha to 290 bass/ha. Stocked largemouth bass were either microwire-tagged or fin-clipped to differentiate them from wild fish. Stocked largemouth bass appeared to be highly vulnerable to angling in Lake Lawne (63 ha) where a creel survey indicated angler catch rates were 1.26 bass/h for 3 months following stocking. Stocked largemouth bass were less piscivorus than wild fish (within the same size range) during the first month after stocking on two stocked lakes where food habit studies were conducted. Mean relative weights (W_rs) of stocked largemouth bass were significantly lower than wild bass within the same size range. Fifty-four stocked and 36 wild largemouth bass were sampled from 7 different stocked lakes to do liver histologies. Twenty percent of the stocked largemouth bass and 0% of the wild largemouth bass had diseased livers. Survival of stocked largemouth bass ranged from <1% to 34% in 8 study lakes where survival was estimated after 1 year, and survival in 6 of the 8 lakes was <3%. Percent contribution of stocked largemouth bass in electrofishing samples ranged from 3% to 14% after 1 year. We will discuss how factors such as predation, feeding efficiency and disease may have affected survival of hatchery-raised largemouth bass in stocked lakes, and the future direction of this program.

Evaluation of a Pilot Largemouth Bass Micropterus salmoides Stocking Program using Radio Telemetry

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Keywords: largemouth bass, radio telemetry, Ohio River, stocking, embayments

Due to the perceived long-term reduction in the quality of the largemouth bass fishery in the Ohio River, many angling organizations are pressing the West Virginia Department of Natural Resources to stock largemouth bass in the Ohio River. Radio telemetry was used to analyze the success of a pilot largemouth bass (*Micropterus salmoides*) stocking in embayments of the Ohio River. Six adult largemouth bass obtained from a hatchery were implanted with 8-gram radio transmitters. Twenty adult largemouth bass captured through electrofishing and bass tournaments in the Belleville Pool of the Ohio River were fitted with radio transmitters of two percent or less of their body weight. The Belleville Pool is a 70.5-km navigation pool formed by the Belleville Lock and is bordered by the states of Ohio and West Virginia. Due to the size of the Ohio River, stocking sufficient numbers of bass to produce what anglers would perceive, as a "quality" fishery is not feasible. Therefore fish were stocked into smaller embayments of the Ohio River and mortality, habitat preference, and seasonal movement were compared between the wild and stocked fish. In this paper, we discuss and compare these parameters between wild and stocked fish in light of the criteria that for a stocking program to be successful mortality of stocked bass should not be significantly greater than wild bass mortality and stocked bass must contribute to the spawn.

Relative Effectiveness of Stocking Hybrid Striped Bass Fry (Morone saxatilis x Morone chrysops) Versus Fingerlings in Newnans Lake, Florida

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Keywords: hybrid striped bass, stocking density, relative survival, cost effectiveness

Historical stocking rate of hybrid striped bass fingerlings in hypereutrophic Newnans Lake (2800 hectares) was tripled to 64/hectare and fry were stocked at the rate of 179/hectare in April 1996. Fry and fingerlings possessed different genotypes. We assessed the relative effectiveness of stocking fry versus fingerlings and high density stocking to maximize hybrid catch rate. Of 62 hybrid striped bass captured with gillnets, DNA analysis revealed 52 were stocked as reciprocal cross fingerlings and 10 as original cross fry. Relative survival of fingerlings was 12 times greater than fry. Hybrid striped bass harvest and angling effort increased significantly compared to that previously estimated according to creel surveys. Hybrid harvest (14/hectare) was the highest ever documented for a Florida water body and hybrid angling effort accounted for 94% of the total effort. However, overall angler utilization of Newnans Lake failed to increase in response to the improved hybrid fishery. Assuming equal susceptibility to angler catch, the stock to harvest ratio was 5.3 to 1 for fingerlings and 77.2 to 1 for fry. Based on 1991average commercial production costs, the stocking cost to provide for one angler harvested hybrid was similar between fry ($0.70) and fingerlings ($0.80). High density stocking provided an increased hybrid catch rate in a lake that suffers from degraded fishery habitat and has little potential for providing a quality fishery with native fishes.

Effects of a Minimum Length Limit and Daily Creel Reduction on the White Crappie Population Structure and Angler Creel on Arbuckle Reservoir, Oklahoma

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Keywords: crappie; length limit; creel survey; trap net; angler-acceptance

Crappie *Pomoxis* spp. population structure on Arbuckle Reservoir was monitored using fall trap-net samples from 1984-1997. A creel survey was conducted from 1985-1995. A 254-mm length limit/15-fish daily creel regulation was placed on the lake January 1, 1993. Prior to the length limit, the population was characterized as fast-growing and short-lived. Angler harvest steadily improved after the length limit and in the final year of the creel survey, harvest (kg/ha) was higher than in 5 of the 8 years data were collected prior to the length limit. Angler acceptance of the length limit regulation was high. Growth rates remained unchanged following implementation of the length limit. Although no differences in mortality rates could be demonstrated using the trap-net data, size and age structure of the crappie population improved. Based on the data collected, the length limit regulation was deemed a success

Evaluation of a 254-mm Size Limit and Stocking as Management Strategies for Tennessee Reservoir Crappie Fisheries

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Keywords: crappies, size limit, modeling, stocking, oxytetracycline

The Tennessee Wildlife Resources Agency recently implemented a 254-mm size limit on crappie *Pomoxis* spp. fisheries statewide and has stocked up to 1.5 million crappie per year for the past six years. In October 1997 we began investigating the response of reservoir crappie fisheries to the size limit and the efficacy of Tennessee's crappie stocking program. Effects of the size limit on crappie harvest in two Tennessee reservoirs were simulated using a Beverton-Holt equilibrium yield model. Simulations indicated yield in Douglas Reservoir would be increased with a 254-mm limit over a range of conditional natural (CM) and conditional fishing mortality (CF) rates, however, the benefits of the size limit declined as CM increased. Yield in Normandy Reservoir was maximized by the size limit over a wide range of exploitation rates when CM was low (~ 30 %). At higher CM rates (40 - 50%), improvements in yield were only apparent at high exploitation rates (50 - 80%). When CM exceeded 50%, yield was maximized with no size limit. In fall 1997 age-0 black-nosed crappies *P. nigromaculatus* (BNC) were marked with oxytetracycline (OTC) and stocked into Normandy Reservoir. Analysis of otoliths taken from age-1 BNC collected in August 1998 rotenone samples showed marking efficacy to be 98% and stocked crappies represented 90% of age-1 crappies in those rotenone samples. In May 1998 50,000 BNC were OTC- marked and stocked into Old Hickory Reservoir; their contribution to age-0 catch rates in fall 1998 trapnets will be reported.

Contributing Session II: Stream Ecology

Fish Community Patterns in a Northeast Texas Stream

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Keywords: habitat, woody debris, fish assemblage, flow regime, Sulphur River, Texas

This study is designed to provide information about fishes downstream of two proposed reservoir sites on the Sulphur River, Texas. Historic channelization and logging operations appear to have altered the usual longitudinal habitat pattern. The three sites in the upstream reach are straight and deep with a more open canopy than the three sites in the downstream study reach, which are meandering, narrow, and shallower. Pools are the primary mesohabitat type in both reaches, but more riffles occur in the downstream reach. In both reaches, complex microhabitats are dominated by snags, rootwads, and debris dams. Electrofishers, seines, and gillnets are used to sample fish at target discharges within the normal flow regime. Samples to date indicate similar species richness and relative abundances in upstream and downstream sections. However, smallmouth buffalo (*Ictiobus bubalus*) are most abundant in the upstream reach, and red shiners (*Cyprinella lutrensis*) are most abundant in the downstream reach. Results will guide operation of the proposed dams for the purpose of mitigating further alterations to fish communities due to impoundment.

The Effects of Temporal Heterogenety on the Structure of Stream Fish Assemblages within Isolated Pools of the Upper Brazos River, Texas

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Keywords: community structure; environmental variability; fish assemblages; streams; Texas

The Brazos River upstream from Possum Kingdom Reservoir, Texas, is largely intermittent. During summer dry spells, the river consists of a series of isolated pools with varying physical and chemical characteristics. We examined fish assemblage patterns in dry-season pools to examine two hypotheses: (1) that physical and chemical variables within dry-season pools structure species assemblages, (2) species composition and abundance in dry-season pools change in response to changes in environmental factors. We found that species assemblages within dry-season pools were structured by maximum depth, turbidity, salinity, ammonia, and pH levels. Cyprinids had higher relative abundance within deeper pools having higher pH, and turbidity. Whereas shallower dry-season pools having greater salinity, and ammonia levels had higher relative abundance of cyprinodonts ($P < 0.05$). Within pools temperature and conductivity increase through time whereas pH and maximum depth decrease ($P < 0.05$). As these environmental factors change cypinids relative abundance decreases while cyprinodonts increase in relative abundance ($P < 0.05$). Changes in species assemblages within individual pools paralleled those observed among pools on a larger geographic range.

Shifts In Benthic and Fish Community Structure and Recovery Following a Severe Drought in Tennessee

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Keywords: stream drought, fish, benthic invertebrates, disturbance, stream recovery

Seven streams that experienced complete drying during September 1998 will be sampled bimonthly following re-inundation. Data from three previous sampling trips to these streams, during the past two years, will be used to compare the existing community structure to pre-drought conditions and to determine variations in recovery rates. Fish data was obtained using backpack electro-shocking techniques and benthic macroinvertebrates were collected using both quantitative (Hess sampler) and qualitative (D-frame kick net) sampling methods.

Stream Ecosystem Assessment in the Valley and Ridge Province and Eastern Highland Rim of Tennessee Following Bridge Construction/Replacement

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Keywords: bridge construction, environmental impacts, fish communities, water warm streams

The effect of bridge/culvert construction/replacement was studied on 42 streams in two ecoregions of Tennessee. Bridges were placed in three age classes (0-5 years old, 5-10 years old, and 10+ years old), and sampled biannually for two years. Three 100-m long stream reaches were sampled at each bridge with a 50-m buffer zone separating each site. Sites were located upstream from, at, and downstream from bridges. In each 100-m reach, fish communities were sampled by a single pass depletion using a backpack electrofishing unit. Physical and chemical characteristics were measured to correlate with fish community data. Funding was provided by the Tennessee Department of Transportation and the Center for the Management, Utilization, and Protection of Water Resources at Tennessee Technological University.

Eighteen Paired t-tests were conducted to compare richness between upstream and bridge sites; all but one was not significant (Significant test: P = 0.02; Non-significant tests: P = 0.09- 1.00), and only one was significant between the bridge and lower site(Significant test: P = 0.04; Non-significant tests: P = 0.06 - 1.00). Diversity did not differ between bridge and lower sites (18 Paired t-tests, P = 0.06 - 0.95), and only in two diversity tests between upstream and bridge sites(Significant tests: both P = 0.02; Non-significant tests: P = 0.06-0.98). Of the four significant tests, three indicated that richness and/or diversity was greater at bridges than at lower or upper sites. This study does not support the view of some conservation groups that bridge construction has long-term negative impacts on fish communities. However, immediate impacts of bridge construction were not evaluated in this study, and bridges may provide access for activities that are detrimental to fish communities (e.g., gravel dredging).

The Long-Term Influence of Bridge Re-Construction on Benthic Invertebrates in Two Tennessee Ecoregions

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Keywords: benthic, bridge replacement, ecoregions, stream disturbance, rapid bioassessment

Forty two warmwater streams, evenly distributed between the Highland Rim and Ridge and Valley ecoregions of Tennessee, were chosen for a two-year study, to determine what, if any, effects bridge re-construction activities have on benthic invertebrate communities in these ecoregions. Each stream was categorized into one of three age classes, based upon bridge reconstruction completion date, and sampled during spring and fall 1997 and 1998 using a D-frame kick net and a 33-cm diameter Hess sampler. Preliminary results on spatial and temporal variation do not indicate long-term negative impacts on benthic invertebrates following bridge replacement. Two additional streams, which are currently experiencing bridge replacement, are routinely being monitored. The results of this project will help to determine the extent of degradation during bridge replacement and the amount of time necessary for benthic community recovery

Assessment of the Effects of Stream Enhancements on Flame Chub Hemitremia flamea Assemblages in a Newly Constructed Mitigation Stream in West Knoxville, Tennessee

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Keywords: flame chub, altered aquatic ecosystems

A construction operation in west Knoxville, Tennessee required alteration and rerouting of several small spring fed streams into one new stream. These streams historically provided habitat for a rare, spring endemic cyprinid species, the flame chub (*Hemitremia flamea*). Various enhancements have been done to the newly constructed stream to improve its suitability for flame chubs. Riffles, aquatic macrophytes and bed stabilizing river rock were added to reaches of the new stream. Some reaches were left unenhanced. Surveys are to be conducted within enhanced and unenhanced reaches of the new stream and compared to a reference stream, which supports a natural flame chub assemblage. The new stream will be evaluated to assess its ability to support flame chubs. Utilization of the enhanced and unenhanced reaches by the flame chubs will also be examined.

Contributing Session III: Gulf Coast and Caribbean Fisheries

Abundance, Distribution, and Mortality of Young-of-the-Year Spotted Seatrout Cynoscion nebulosus in Three Estuaries Along the Gulf Coast of Florida

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Keywords: *Cynoscion nebulosus*; spotted seatrout; abundance; distribution; mortality

Data gathered during fixed station and random sampling conducted from 1989-1997 were used to examine spatial and temporal patterns in the abundance and size structure of young-of-the-year (YOY) spotted seatrout, *Cynoscion nebulosus*, in three Florida estuaries. Young-of-the-year seatrout first appeared at shallow-water (<1.5 m) seine sites during May-June in Choctawhatchee Bay (Florida Panhandle) and in April-May in Tampa Bay and Charlotte Harbor (both along the southwest Florida peninsula). They were first caught at deep-water (<2.3 m) trawl stations about one to three months after their initial appearance at the shallow-water seine sites. Abundance peaked generally during June-July, declined during July-August, and peaked again during September-October in all bays. Changes in size structure concurrent with changes in abundance suggested that seatrout respond to the high temperatures (>30^{o}C) of mid-summer by moving from shallow-water areas. In Tampa Bay, the probability of capturing YOY seatrout in seines was highest at deep-water, low-salinity sites with bottom vegetation, mud sediments, mangrove stands, and high levels of dissolved oxygen. In Charlotte Harbor, it was highest at deep, low-salinity sites with bottom vegetation. In Choctawhatchee Bay, the probability of capturing YOY seatrout was highest at seine sites with bottom vegetation and mud sediments. Instantaneous total mortality rates, estimated by using an age-length key for the Tampa Bay population, ranged from 0.025 to 0.027/day.

Pelagic Fish Distributions on an Artificial Reef System in the Gulf of Mexico

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Keywords: artificial reef, pelagic fish, Gulf of Mexico, distribution, hydroacoustic

Pelagic planktivorous fishes aggregate at artificial reef structures and are known to be an important food resource for some species of piscivorous reef fishes. However, despite their importance little is know about the distribution and persistence of pelagic fishes at artificial reefs. The objective of this study was to collect preliminary data on the distribution of pelagic planktivorous fish and their association and persistence with reefs. We measured the diel distribution, density, and size-structure of fish using a BioSonics 120kHz DT6000 digital hydroacoustic system. Pelagic fish were sampled at two different spatial scales: at a large scale (km) to determine the association of pelagic fishes to reef structures and at a fine scale (m) to determine their persistence on the reefs. Initial analysis indicates that fish appear to have higher densities over the reefs when compared to the surrounding area. Fine scale sampling illustrates a dispersion and reaggregation process occurring from night to day, respectively. Reasons for the increased density and congregation on the reefs have not been determined, but two possible explanations are the reefs provide a common location for fish to find one another, and/or the reefs provide food due to upwelling of benthic organisms around the reefs.

Peripheral Freshwater Fish: Endangered Species of the Tropical Southeastern United States

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Keywords: endangered, tropical, peripheral, freshwater, management

Post-glacial tropical fish invasions of the southeastern U.S., principally to the Florida peninsula have brought a diverse and unique fauna to the region. Among these species are an inter-phyletic euryhaline group that depend on freshwater for spawning and adult habitat, estuaries and the ocean for larval/juvenile habitat and dispersal. These fishes belong to the guild known as tropical peripherals. The guild includes three snook species, *Centropomus* spp., one grunt, *Pomadasys crocro,* the opossum pipefish, Microphis brachyurus lineatus, nine species of sleepers and gobies, eleotridae and gobiidae, and the mountain mullet, *Agonostomus monticola*. The snooks and gobies are of direct fishery value throughout much of the Caribbean, but are not utilized by North Americans. Their existence in the United States is threatened by freshwater habitat destruction and reckless coastal freshwater release through flood control structures. Life history and ecology are discussed. Conservation measures are presented.

Contributing Session IV: Physiology and Disease

Effects of Electrofishing on Catch Efficiency and Injury Rates of Warmwater Fishes

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Keywords: applicability, efficiency, electrofishing, injury, warmwater fishes

Electrofishing is an efficient, frequently used method to sample freshwater fishes in littoral areas of aquatic systems. Fish exposed to electroshock may experience adverse effects such as physiological and behavioral changes, and physical injury. The effect of electrofishing on catch efficiency and injury to fish has been well studied by fish biologists. However, the majority of electrofishing research has focused on salmonids or other coolwater species. Little attention has been given to the incidence of injury in warmwater communities. Also, many studies were not adequate because data collection was designed for other purposes, and comparisons are difficult due to differing gears, techniques, environmental conditions, and fish species. The objectives of this study include the determination of the extent of injuries in warmwater fishes, and the identification of electrofishing procedures that will result in efficient sampling but minimal injury to fish. Experimentation will be performed on bluegill *Lepomis macrochirus*, channel catfish *Ictalurus punctatus*, and largemouth bass *Micropterus salmoides*, fish often targeted with electrofishing. As electrofishing is common practice among those involved in fisheries research, the results of this study will be applicable nationwide. We report findings obtained during the first six months of our research.

Distribution of the Swim Bladder Nematode, Anguillicola crassus, among Chesapeake Bay American Eels, Anguilla rostrata

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Keywords: American eel, Anguillicola, Chesapeake, parasite

An exotic parasite of anguillid species of eels, first noted in a single South Carolina American eel (*Anguilla rostrata*), now appears to be spreading into other regions of eastern North America. Adult stages of the nematode, *Anguillicola crassus*, inhabit the lumen of eel swimbladders, while third and fourth stage juveniles are found in the swim bladder wall. A total of 193 American eels were collected during spring 1998 from four Chesapeake Bay tributaries (the Susquehanna, Chester, and Sassafras rivers, and St. Jerome's Creek) and examined for the presence of juvenile and adult stages *of A. crassus*. Prevalence (% of eels infected) in the four sampling localities ranged from 61-82%, and infection intensity ranged from 0 to 52 worms per eel. Mean intensity (average number of worms per infected eel) in each tributary ranged from 2.9 to 8.9 worms per eel. Fishery scientists should be on the lookout for this potential source of eel debilitation or even mortality.

A Field Test of a Nondestructive Method for Estimation of Fish Proximate Composition

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Keywords: proximate composition, TOBEC, bluegill, regression

Proximate composition (ash, water, protein, and lipid content) is commonly determined in studies of fish physiology, nutrition, and growth, but standard techniques require sacrificing specimens. Here I investigate the field accuracy of a method for nondestructive estimation of fish proximate composition previously used under controlled conditions, total body electrical conductivity (TOBEC). Conductivity is measured noninvasively within a detection chamber by changes in the magnetic field caused by the tissues of the fish. I collected bluegills from two Virginia ponds. Water, lipid, and protein content were measured using standard laboratory methods. I measured TOBEC of each fish at pondside and again in the laboratory. Using laboratory TOBEC and whole-fish variables, predictive regressions ($R^2 > 0.90$) were developed from 63 randomly chosen bluegills and checked with the remaining 21 fish. Under controlled conditions, TOBEC can be used to precisely and accurately predict proximate composition (<6.4% mean error). Regressions developed from pondside TOBEC readings were similar in accuracy (<7.1% mean error). TOBEC is a promising means to nondestructively estimate fish proximate composition in the laboratory, hatchery, or field.

Contributing Session V: Life History

Sexual Dimorphism in Hybognathus placitus from the Brazos River, Texas

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Keywords: sexual dimorphism; plains minnow; fish; Texas

During routine examination of fish collections from several southwest Texas streams, we noted an apparent dimorphism in the length of pectoral and dorsal fins in specimens of plains minnow *Hybognathus placitus*. Although sexual dimorphism in morphological characters other than color and the presence of nuptial tubercles is uncommon in minnows, sexual dimorphism in length of fins (longer in males) has been noted in some species. Here, we present an analysis of this dimorphism and test the hypothesis that plains minnow specimens with longer fins are males. We digitized 16 external morphological landmarks on 62 plains minnows ranging in total length from 7.1 to 8.4 cm. These landmarks were used to generate 21 external length measurements. We used discriminate function analysis to differentiate between males and females based upon 21 measurements. Preliminary identification of males and females was based on dorsal and pectoral fin characteristics. Of the 21 measurements, ten had significant ($P < 0.05$) discriminant coefficients. The first dorsal fin ray had the greatest loading (0.83) followed by the pectoral fin length (0.56). The male plains minnow predominantly have larger heads and peduncle regions whereas the females have larger abdomens. After analyses were complete we verified sex by evisceration of the gonads and histological inspection. Sixty-one of 62 fish were correctly sexed based on pectoral and dorsal fin characters.

Spawning Microhabitat Selection among Guilds of Warmwater Stream Fishes: Adaptation to Bed Movement

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Keywords: stream, microhabitat selection, reproductive guilds, refugia, bed movement

Alterations of sediment dynamics in spawning habitats have been implicated in declines of several stream fishes. For example, increased levels and frequency of bed movement during egg incubation periods may result in reduced reproductive success. Adaptation to bed movement by selection of spawning microhabitat refugia was investigated in the upper Roanoke River, Virginia, a watershed heavily impacted by agriculture and urbanization. Spawning areas of several darters, minnows, and suckers representing 3 reproductive guilds were identified through snorkeling observations. Microhabitat use and availability were measured to investigate habitat selection. Logistic regression analysis indicated that nest spawning darters selected strongly for large particle sizes and low embeddedness. Nest building chubs utilized areas of low embeddedness, low velocity, and relatively laminar flow. Simple lithophilic spawners selected distinct ranges of substrate size, velocity, depth and shear stress. Spawning microhabitat selection in all 3 reproductive guilds has the potential to mitigate for bed turnover in floods. Stability of these spawning microhabitats has also been empirically evaluated with tracer particles and repeated measurements of monumented cross-sections to validate these conclusions.

Reproductive Ecology of the Arkansas River Shiner in the Canadian River, New Mexico and Texas

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Keywords: Arkansas River shiner, gonadosomatic index, reproduction, multiple spawners

We studied the reproductive cycle and spawning requirements of the Arkansas River shiner in the Canadian River, New Mexico and Texas. Males and females were present in equal numbers ($p<0.05$). Oocytes began to increase in diameter and mature in April and ripe ova occurred from May through August. Gonadosomatic indices (GSI) reached a maximum from May through August and were significantly greater ($p<0.05$) than GSIs during September through April. Diameters of mature ova and GSIs did not vary significantly from May through August. These results and the absence of spent fish until late August suggest that individuals were multiple spawners. This is consistent with periodic occurrences of larval fish through the summer. Our results fail to show a relationship between spawning and stream flow as has been suggested by earlier studies. Numbers, but not size, of ova were positively related to total length ($r2=0.63$, $p<0.05$). Mean fecundity was 213.3 ova per fish and total length of 50% maturation of females was estimated at 34 mm.

Effects of Fine Sediment and Gravel Quality on Survival to Emergence of Larval Robust Redhorse Moxostoma robustum

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Keywords: robust redhorse, Catostomidae, sediment, gravel quality, survival to emergence

Robust redhorse are large, riverine catostomids that deposit fertilized eggs in loose gravel. Low larval abundance (<13.4 larvae/1000 m^3) and an absence of juveniles in the Oconee River, Georgia suggest that recent recruitment there has been minimal. Decreased larval survival to emergence (STE) has been implicated as a recruitment constraint. Two experiments were devised to test this hypothesis. In the first, fertilized eggs were incubated in gravel mixtures containing reciprocal ratios of the two most abundant size classes of gravel found in the Oconee. In the second, eggs were placed in representative mixtures containing four levels of percent fine sediment (0, 25, 50, and 75). Larval STE was not related to variation in gravel quality (P = 0.71). However, larval STE was inversely related to percent fine sediment (P < 0.0001). Reductions in STE from treatments containing 25% fine sediment were related to larval entrapment. Reduced gravel permeability in treatments containing ~50% fine sediment depressed dissolved oxygen concentrations to levels that were insufficient (i.e., ~5.0 ppm) for the survival of incubating eggs and larvae. Fine sediment concentrations in the substrates used by spawning robust redhorse in the Oconee range from 25-50% and may limit recruitment in these fish.

Initial Findings in Assessment of Alligator Gar Population in Alabama

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Keywords: alligator gar, life history strategy, metapopulation, spawning periodicity, aging techniques

Age and growth, reproductive biology, and migratory patterns of alligator gar are being utilized in the development of a management plan for Mobile Delta, AL, alligator gar. As of September 1998, a total of 178 alligator gar ranging from 76 cm to 215 cm TL have been collected using multifilament gill nets, floaters, bow and arrow, and hook and line from Alabama, Louisiana, and Mississippi. Female alligator gar were significantly larger in total length, weight, and girth than were males ($p<0.05$). Highest GSI were observed in fall ($\bar{x}$ =7.6+/-4.2) with lowest GSI occurring in summer ($\bar{x}$ =0.9+/-1.5). GSI were similar between males and females in spring and fall. Female summer GSI ($\bar{x}$ =1.6+/-2.1) was significantly greater than male summer GSI ($\bar{x}$ =0.3+/-0.2) ($p<0.05$). Current analyses include radioimmunoassay of plasma samples to determine spawning periodicity, development of aging techniques using otoliths, branchiostegal rays, and scales, fecundity estimates and deployment of radiotags.

Quantifying Smallmouth Bass Movements in Lentic Environments: How Different Techniques Measure Up

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Keywords: smallmouth bass, movement, telemetry, electromyogram, mark-recapture

A variety of techniques are commonly used to monitor the movements of fish. It is generally accepted that mark-recapture studies are biased against the detection of movement, leading many to undertake manual telemetry projects where fish are located at regular sampling intervals. However, this method of data collection may also underestimate fish movements. Fixed telemetry systems consist of a series of continuously scanned antennas and are useful for studying movement patterns of fish on a more continual basis. Fish may also spend a significant amount of time undertaking localized movements on scales that would be difficult to detect using conventional telemetry. Axial musculature activity collected using electromyogram telemetry devices relay information, which when calibrated in a respirometer, can be used to estimate daily movements. Although many of these techniques have been used independently, it was unclear as to how each compares under field conditions. Results on differences in fish movements obtained simultaneously using each of these four data collection techniques will be compared. Field results are based upon observations collected on smallmouth bass (*Micropterus dolomieu*) in an impounded area of Lake Erie during the summer of 1998. The benefits, biases, and limitations of each method, and the consequences of underestimating fish movements and activity will be discussed.

Contributing Session VI: Large River Ecology

The "Flood-Pulse" Concept in Large Temperate Rivers: Modifying a Paradigm

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Keywords: temperate rivers, floodplains, flood-pulse concept, flooding, warmwater fish

The River Continuum Concept (RCC) of the late 1970's has become widely accepted as a conceptual framework for stream ecosystem processes. However, research in tropical and semi-tropical rivers and highly regulated temperate rivers has demonstrated the integral role of seasonal floodplain inundation on the production ecology of fishes. Thus, the "flood-pulse" concept adds a lateral dimension to the RCC by emphasizing the importance of floodplains to fisheries production in large unregulated rivers. Unlike tropical rivers which may flood 4-8 months annually, most large free-flowing temperate rivers such as the Lower Mississippi River are characterized by seasonal climates and at least moderate levels of regulation (levees, dikes) that modify thermal regimes, restrict annual flood duration, and reduce assimilation of terrestrial materials during overflow. Although research in the tropics strongly demonstrates a high dependence of fisheries on seasonal flooding, comparable research in large temperate rivers is lacking. Use of floodplain resources by fishes in these systems has been little studied and the "ecological benefit" afforded fishes by floodplain access is largely speculative except at local scales in a limited number of studies. Temperate river floodplains may function much differently ecologically than those in tropical rivers. Thus, application of "flood pulse" concepts may be misguided without modification or qualification owing to different physical characteristics as compared to tropical rivers.

Turbulent Attraction Flows for Passage of Juvenile Alosids at Dams

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Keywords: hydropower, bypass, turbulence, attraction, FERC

Induction of mild turbulence and increased water velocity in slowly moving water of dam forebays has been proposed to attract downstream-migrating juvenile salmonids in the Pacific Northwest to dam bypasses. Bypasses prevent damages to migrants in hydropower turbines, one of the most vexing problems for hydropower relicensing. The concept may also be applicable to juvenile anadromous alosids (American shad, blueback herring, alewife) in southeastern coastal rivers. Hydraulic concepts for simulating a naturally turbulent stream have been used to attract upstream-migrating adults to ladders and lifts, but not for enhancing the "opportunity for discovery" of fish bypass entrances in dam forebays by downstream migrants. Turbulence can be enhanced near bypass entrances by passive (using existing flow momentum or head directed by vanes) and active (pumped water jets or propellers) methods, which can be tailored to specific locations. Although sound in theory, the concept needs to be tested and evaluated both experimentally and at hydropower sites.

Comparison of Fish Density Estimates in Ohio River Locks using Hydroacoustic and Rotenone Sampling Techniques; Shooting Sish in a Barrel II

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We acoustically surveyed relative fish density at the New Cumberland, Hannibal, and Belleville locks, on the Ohio River, using a Simrad EY 500 echo-sounder coupled with a 120 Khz split-beam transducer. The survey was performed prior to the application of rotenone by West Virginia Division of Natural Resources personal; on 15, 16, and 17 September 1998, respectively. Our intent was to strengthen results of acoustic vs. rotenone density comparisons from two sites the previous year. The 1997 surveys on the Ohio River's Willow Island and Racine locks compared favorably with rotenone assessments. Acoustic estimates ranged from -2% to 13% agreement for total fish abundance. Estimates obtained from three 1998 lock surveys provide additional information on which to test the expected 1:1 relationship between acoustic and rotenone estimates.

Hydrological Factors Limit Primary Production and Fishery Yield in Reservoirs of the Upper Paraná River

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Keywords: reservoirs, South America, primary production, chlorophyll-a, hydrology

Fishery yields in reservoirs of the Upper Paraná River are generally low relative to other South American basins or those in other continents. However, artisanal and commercial fisheries in these reservoirs are very important for local inhabitants, as a source of food and income. The objective of this study was to investigate if primary production is a factor limiting fishery yield in reservoirs of the Upper Parana River, and to identify abiotic conditions potentially stifling primary production. We used a comparative approach wherein various characteristics of 13 reservoirs in the Upper Parana River were compared statistically against 58 reservoirs in the south-central United States. Fishery yield in the 71 study reservoirs was directly related to chlorophyll-a (r^2 = 0.50), and the relation was consistent between Upper Parana River and south-central U.S. reservoirs. In turn, chlorophyll-a was directly related to phosphorus levels, retention time, and reservoir volume, but the relation differed between data sets (R^2 = 0.75). Reservoirs in the Upper Parana River had nutrient concentrations similar or higher than U.S. reservoirs, but lower retention time and larger volume leading to reduced in-reservoir primary production and fishery yield. This is the first time limited fishery yield in the Upper Parana River is shown to be linked to low primary productivity and reservoir hydrological characteristics.

Factors Affecting Fish Passage During Water Release from a Flood Control Reservoir in Mississippi

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Keywords: fish passage, water release, factors, reservoir

Study objectives were to use a conduit net to relate operational and environmental factors with fish passage. Fish passage was inversely correlated ($p<0.05$) with pool elevation and positively correlated with discharge volume and night samples. Fish passage was not significantly correlated ($p>0.15$) with release velocity or water temperature. Regression equations explained 49-68% of the variability in fish passage. Nearly 85% of all fish and 97% of all shad were discharged during December 1993 - February 1994. Gizzard shad, white crappie, black crappie and freshwater drum comprised 78.52%, 15.34%, 1.54% and 1.41% of the total numerical loss, respectively. Fish in the 9 and 10 centimeter groups accounted for 66.37% of the catch while those over 20 centimeters comprised just 2.75%. Tailwater tag recaptures comprised 9.7% of all recaptures and 1.2% of all tagged fish, but tag mortality and tag shedding were not assessed. The tailwater crappie fishery appeared to be dependent on fish passage. These data suggest that fish passage could be reduced by maintaining higher pool elevations during the winter; reducing night time releases and avoiding releases > 1000 cfs during the fall and winter. Negative impacts to the Enid Lake fishery resulting from fish passage were not evident.

Long-Term (1976-1997) Fish Sampling Program for Large Rivers in Oklahoma

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In 1976, the Oklahoma Department of Health, through the Water Quality Service established a fish monitoring program of the rivers and streams in the state. The purpose was to determine if the state was reaching the goals of the Federal Clean Water Act of 1972. The sampling data involves over 1,330 sites and 5,322 collections, 80 of these sites are long-termed sites which are collected 3 times a year. Results shows long-term sampling data is a useful tools to measure changes in the fish communities from environmental factors such as; drought, floods, reservoirs, pollution, and changing in land use patterns. Results from our rivers surveys has been a aid in evaluating the effect of the introduction of exotic sport species, the impact of the biomanipulation of the forage species by transplants of native species and the rate of extinctions of native species.

Contributing Session VII: Black Bass Ecology

Genetic Relationships among Several Species of Freshwater Black Basses (Genus Micropterus) as Determined by Mitochondrial DNA Analysis

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Keywords: *Micropterus*, black bass, mtDNA, biogeography

Geographic isolation and habitat specialization has aided in the evolution of and genetic integrity of the Micropterid bass species of North America. Members of the genus *Micropterus* form a close natural unit with little morphologic and meristic variation. Our goal was to determine the genetic similarity among black bass species using mitochondrial DNA analysis and compare phylogeny to geographic distribution to further understand the divergence of this genus. Mitochondrial DNA was examined in shoal bass (*M*. cf. *coosae),* northern smallmouth bass (*M. dolomieui dolomieui*), Alabama spotted bass (*M. punctulatus henshalli*), northern spotted bass (M. p. punctulatus), northern largemouth bass (*M. salmoides salmoides*), and Guadalupe bass (*M. treculi*) using 15 restriction endonucleases. Phylogenetic relationships were similar to those identified previously by researchers utilizing meristic and allozyme analyses. The largemouth bass had the greatest divergence among the black basses ($p = 0.1989$ to 0.2420). All other species were associated with the spotted bass. The shoal bass and the Guadalupe bass were most similar to the Alabama and northern spotted basses, respectively. The smallmouth was most recently diverged from the spotted bass supporting a recent origin for this species. Further support for recent divergence is provided by frequent hybridization between the smallmouth bass and other Micropterids.

Interannual Variation in Resource Utilization among Three Black Bass Species in an Oklahoma Reservoir

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Keywords: largemouth, smallmouth and spotted bass, habitat and prey overlap

We sampled Skiatook Lake for three black bass species with nighttime electrofishing in spring 1997 and 1998 to assess resource overlap (habitat and prey) among species. Skiatook Lake was stratified into four areas: Bull and Hominy creeks in the upper lake, mid lake, and lower lake. In general, smallmouth and largemouth bass were more abundant throughout the reservoir in 1998 than in 1997, whereas spotted bass abundance remained constant. In 1997, spotted bass abundance exceeded either congener throughout the reservoir, largemouth bass were distributed equally among areas, smallmouth bass were confined to the lower lake. In 1997, spotted bass consumed mostly insects whereas largemouth and smallmouth bass consumed mostly fish. In 1998, species abundances were equal throughout the reservoir except spotted bass exceeded smallmouth bass abundance in Bull Creek. In 1998 spotted bass ate mostly crayfish, largemouth bass ate mostly fish, and smallmouth bass ate mostly insects. In 1997, we found no evidence of habitat and prey overlap in any area of the reservoir. In 1998, however, species exhibited both habitat and prey overlap in the lower lake . If the abundance of these species increases, resource overlap may increase leading to bottlenecks and reduced condition and fitness.

Trophic Interactions of Age-0 Largemouth Bass and Juvenile Bluegill

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Keywords: diet analysis, Schoener's niche overlap index, corrective stocking, stunting, small impoundments

Because piscivores during early ontogenetic stages often have diets similar to their prey, mixed competition/predation interactions may be prevalent in fish communities. We tested whether a mixed competition/predation interaction could occur between largemouth bass and bluegill by measuring their diet similarity in a 3.1-ha impoundment in central Virginia during summer and fall, 1997. We collected age-0 largemouth bass and juvenile bluegill by shoreline seining and electrofishing, and analyzed their stomach contents. Diet similarity was quantified with Schoener's niche overlap index and a bootstrapping technique. Diets did not significantly overlap ($\hat{\alpha} = 0.54$; approximate p-value>0.10). However, most items consumed by largemouth bass also were eaten by bluegill. At the time this study was conducted, the fishery consisted of moderate densities of small largemouth bass ($\overline{CPUE} = 58.11$ hour $^{-1}$; PSD = 30 & RSD-P = 9) and large bluegill ($\overline{CPUE} = 40.26$ hour $^{-1}$; PSD = 67 & RSD-P = 13). At higher densities, bluegill may expand their realized niche due to intraspecific competition and depress available food resources, possibly affecting largemouth bass growth. Due to their diet similarity, we advise stocking largemouth bass already capable of feeding on the smallest size classes of bluegill available when attempting to restore balance to a stunted bluegill impoundment.

Gape Limitation of the Exotic Peacock Cichlid in Florida, Including a Comparison with the Native Largemouth Bass

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Keywords: peacock cichlid, largemouth bass, gape limitation, exotic,

This study determined that gape width of the peacock cichlid, *Cichla ocellaris* (Perciformes: Cichlidae), as indicated by external mouth width, is a good estimator of the maximum size of forage ingested. Gape limitation is important in determining theoretical prey availability to the predator population and is one possible axis of interspecific interaction between co-occurring predators. The peacock cichlid was introduced into South Florida canals by the Florida Game and Fresh Water Fish Commission. The primary biological justification was an unbalanced forage to predator biomass ratio due to an overabundance of exotic species, especially spotted tilapia (*Tilapia mariae*). Regression models of gape width versus length were developed for peacock cichlid and largemouth bass (*Micropterus salmoides*). Peacock cichlid gape limitation estimates were tested by analysis of stomach contents and a laboratory forage experiment. No forage fish body depth exceeded the gape width of the predator in the stomach contents analysis. Three individuals ate bluegill (*Lepomis macrochirus*) slightly exceeding (less than 5 %) estimated gape size in the experiment. Gape width versus total length regression slopes for peacock cichlid and largemouth bass were compared and found statistically different. Peacock cichlid gape was larger below 86 mm TL, while above this length, largemouth bass gape was larger.

A Review of the Relations between Largemouth Bass and Aquatic Plants

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Keywords: largemouth bass, aquatic plants, recruitment, growth, fishing

Conflicts are increasing between management of aquatic plants and largemouth bass *Micropterus salmoides*. Largemouth bass anglers prefer to fish near or in aquatic vegetation and usually demonstrate the greatest opposition to controlling aquatic plants. The invasion and spread of exotic plants particularly hydrilla *Hydrilla verticillata* and Eurasian milfoil *Myriophyllum spicatum* has in some instances created excellent largemouth bass fisheries. Generally, the two rationale support maintaining some plants for managing largemouth bass fisheries and include; 1) that largemouth bass reproduction and early survival is enhance in vegetated habitats that will subsequently produce more adults, and 2) angler catachability of fish is greater in habitats that contain plants. However, excessive levels of aquatic plants can be detrimental to largemouth bass fisheries. Typically, production of young largemouth bass increases with plant coverage, but high densities and competition for food can reduce growth and survival. When plant coverage exceeds 30-40% coverage, growth rates of fish are reduced, body condition declines, and the population is skewed towards greater abundance of smaller individuals. Usually, catch rates by anglers increase with plants, but the size of fish caught declines. The “best science” indicates that 10 to 40% areal coverage of submersed plants may be ideal for largemouth bass fisheries in larger water bodies.

Relation between Plant Coverage and Largemouth Bass Recruitment and Population Characteristics in Lake Seminole, Georgia

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Keywords: largemouth bass, recruitment, population characteristics, aquatic vegetation, Lake Seminole

Population dynamics and recruitment of young-of-year largemouth bass *Micropterus salmoides* in Lake Seminole, Georgia, were evaluated in relation to submersed aquatic vegetation coverage. The introduction and spread of hydrilla *Hydrilla verticillata* has caused conflicts among reservoir users. Fifty to 75% of the surface area of this 13,400 ha reservoir contained aquatic plants during the 1990's. We examined largemouth bass recruitment to age-1 in habitats containing disparate levels (sparse vegetation, mixed native vegetation, and dense hydrilla) of submersed aquatic vegetation coverage and also determined the influence of submersed aquatic vegetation on adult largemouth bass population characteristics. Catch rates of age-0 largemouth bass in 1997 showed no difference between vegetation types, however, in 1998, age-1 catch rates of the 1997 year-class were significantly higher in the mixed native sites than in the dense or sparse sites. Growth rates of adult largemouth bass in Spring Creek, with higher plant coverage (76%), were considerably slower than measured in the Chattahoochee and Flint rivers with lower vegetation coverages (26-32%). Relative weights were also lower in Spring Creek than those of the other two arms. Largemouth bass growth and size structure appear to be affected in the higher submersed vegetated areas, skewing the population towards smaller fish. These results may have implications on future vegetation management in this reservoir.

Contributing Session VIII: Urban and Small Impoundment Fisheries Management

The Success of Grass Carp Confinement and Impact of Aquatic Plant Enclosed Areas of Lake Seminole

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Keywords: grass carp, electrical barrier, radio telemetry, aquatic vegetation, enclosures

We evaluated the success of three types of barriers used to confine grass carp in enclosed embayments of 250 and 350 ha. Our objective was to estimate escape rates of grass carp and to assess the impact of stocking 31 to 35 triploid grass carp (> 304 mm TL) per vegetated hectare on submersed vegetation abundance within these areas. Using radio telemetry, we determined that a funnel weir type barrier and a boatable gate type barrier were ineffective at containing grass carp as evidenced by respective verified annual escape rates of 9% and 23% and maximum potential escape rates of 42% and 35%. Escape rates from the funnel weir enclosure were high enough that grass carp did not reduce vegetation coverage over a two year period. However, a significant vegetation reduction was observed in the boatable gate enclosure. The third barrier type was the same funnel weir retrofitted with an electrical field array positioned within the mouth of the funnel. This design yielded a maximum potential escape rate of 1.2% over a nine month period and thus appears to be effective at confining grass carp. These results may have implications concerning the feasibility of zoning lakes and reservoirs to separate incompatible uses.

Exploring Potential Harvest Regulations in Small Impoundments

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State fishing lakes in western Tennessee provide local citizens ample angling opportunities. These opportunities include fishing for largemouth bass, bluegill, redear sunfish, blue catfish and channel catfish. In an attempt to improve the quality of the largemouth bass fisheries in these small impoundments populations have been assessed using boat-mounted electrofishing collections techniques for the past two years. Data collected included typical length and weight parameters, year class strength and survival estimates, and estimates of angling related mortality. Data were subjected to modeling using the MOCPOP software package. In most systems, it was recommended that either no size limit be imposed or if warranted, a 305 mm minimum size limit be imposed.

Trends In Private Pond Management

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Keywords: pond, private, small impoundments, survey, threadfin shad

Trends in small impoundment management are directly influenced by the desires of pond owners. Pond owner interests were assessed via a mailed questionnaire from October 1, 1998, through December 16, 1998. Survey questions were targeted at obtaining information pertaining to pond owners' management goals and activities related to their goals. Information requests included, but were not limited to, fertilizing and stocking histories, owner estimates of the average size of fish harvested, and angler satisfaction. Other current trends include threadfin shad stocking and reduced stocking rates of largemouth bass. Results from this survey indicate the services and management strategies both private and public pond managers should offer in order to maintain quality pond care.

Virginia Small Lake Population Statistics

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Keywords: largemouth, bluegill, crappie, population structure, population indices

From 1993 to 1997 170 small impoundments (<500 acres) were sampled by electrofishing to determine catch rates and population structural indices (e.g. PSD, Wr) for largemouth bass (*Micropterus salmoides*), bluegill (*Lepomis macrochirus*)and black crappie (*Pomoxis nigromaculatus*) populations. The 25, 50 and 75 percentile values were computed for each parameter. Regional differences were examined. The Coastal Plain had lower cpue's for bass than the Piedmont but higher PSD and RSD-P. Lowest largemouth PSD and RSD-P medians were in the Ridge and Valley Province. The Piedmont had the highest bluegill stock and quality CPUE but minimal differences between the provinces for PSD. Intraspecific correlations were examined; stock and quality cpue, quality and preferred CPUE and PSD and RSD-P were correlated for bluegill and bass respectively. Largemouth bass structural indices were not correlated with any parameter of bluegill catch rates or structural indices. Bluegill populations with a PSD or less than 20 were correlated with largemouth stock and quality cpue. Bluegill and largemouth population structure and catch rates were generally independent of each other.

Mississippi's Community Assistance Program: Opportunities and Problems

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Keywords: urban fishing program, problems, opportunities

The objective of this program is to encourage the development and fisheries management of small community waters for public use by providing, technical advice, and fish. The goal is that conveniently located waters will provide successful fishing experiences (i.e. high catch rates) which will attract new anglers, especially children. Since 1995 we have received 20 inquiries and executed 5 agreements involving 7 ponds totaling 18.2 acres. Reasons for failing to sign agreements include: unsuitable sites, inability to obtain land, funding problems and decreased interest. The period from initial contact to agreement execution has averaged 14 months with a range of 6-21 months. New/renovated waters are stocked with fingerling bass, bluegill and channel catfish at rates recommended for farm ponds and closed to fishing for 2 years. Eight acres are open to fishing with 6.2 acres of new/renovated waters scheduled to open in 1999. Internal (agency) problems include: a narrow objective and goal; low priority; inconsistent funding; and use of fingerlings due to limited hatchery capacity. External (cooperator) problems include: loss of interest after initial contact; lack knowledge/commitment to perform routine management activities and poor communication. The agency should reconsider program goals to emphasize the noncatch benefits these waters provide; increase communication and provide formal training of cooperators.

Urban Fisheries Programs: Can We Afford Them?

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Urban fisheries programs provide fishing opportunities for mobility-impaired anglers, provide healthful recreation, often increase the value of aquatic resources and improve the quality of life in towns and cities, and recruit new anglers. Unfortunately, the angler-recruitment function of urban fisheries has not been evaluated. Most of the benefits gained from urban fisheries accrue to the municipality, yet urban fisheries are usually designed, managed, and funded by state fisheries agencies. Most successful programs rely heavily on stocking catchable- size fish. Licensed (current) anglers rank urban fisheries as low priority management activities and would allocate only a few cents of each license dollar to urban fisheries management. Although the benefits of urban fisheries are many, expansion of urban fisheries programs can substantially drain already-limited staff time, resource management funds, and hatchery production if fisheries management agencies control the programs. I recommend that many urban fisheries programs should be funded, staffed, and managed by municipal government with technical assistance provided by fisheries management agencies and propose a model for effective and enduring urban fisheries programs.

Contributing Session IX: Striped Bass Ecology and Management

Summer Food Habits of Adult Striped Bass Morone saxatilis in the Trout Waters of the Upper Chattahoochee River, Georgia

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Keywords: striped bass, Chattahoochee River, food habits, trout, stomach contents

In the early 1990's, about 200,000 fingerling striped bass were stocked in West Point Lake, Georgia to establish a put-and-take fishery. These fish were stocked at lower-than-normal densities because of the predation threat they pose to the trout fishery in the upper Chattahoochee River. This study was conducted to assess that threat and to make recommendations to Georgia Department of Natural Resources regarding the striped bass and trout stocking programs. Our objectives were to estimate the number of striped bass in the trout waters (via a mark and recapture study) and to determine their food habits. Sixty-two striped bass (range = 534-1066 mm total length) were sampled with a boat-mounted electrofisher and marked with Floy tags. Five fish were recaptured later. Over half the 67 stomachs examined were empty, and the remaining stomachs contained a variety of prey including crayfish, shad, and trout. Crayfish and shad were the most abundant prey; trout were among the least abundant and were in 8% of the stomachs that contained prey. Striped bass predation on trout in the upper Chattahoochee River has been confirmed, but the potential effect(s) to the trout fishery are unknown. These results are preliminary, and data analysis are on going.

Discrimination of White Bass, Striped Bass, and their Hybrids Using Fatty Acid Composition Evaluation Techniques

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Keywords: Morone, biochemical genetic evaluations, fatty acid profiles

Natural hybridization between striped bass (*Morone saxatilis*) and white bass (*M. chrysops*) may be occurring at Cherokee and Norris Reservoirs. Anglers and biologists have noted the presence of *Morone* taxa physically resembling a hybrid (Cherokee bass, striped bass female x white bass male). Standard biochemical genetic analysis evaluations using starch gel electrophoresis, as well as fatty acid evaluations total lipids and fatty acid were conducted for *Morone* taxa in Cherokee, Norris, and Tims Ford reservoirs. Biochemical genetic analysis identified *Morone* hybrids from Cherokee and Norris reservoirs. Fatty acids profiled include linoleic (18:2n-6), linolenic (18:3n-3), arachidonic (20:4n-6), and docosahexaenoic acids (22:6n-3). A seasonal difference was seen in percent total lipids and fatty acids profiled. Principal component analysis (PCA) demonstrated seasonal differences between spring 1997 collection and both spring 1996 and fall 1996 collections for white bass and striped bass collected in Cherokee and Norris Reservoirs. Arachidonic and docosahexaenoic acids usually differed between species; however, PCA revealed no separation between taxa. Discriminant analysis correctly classified taxa ranged from 33% to 100% but dependent upon season fish were collected. No one particular fatty acid continually showed differences between reservoirs. Discriminant analysis correctly classified known *Morone* taxa into reservoir of origin ranged from 57% to 100% dependent upon season.

Effects of Implantation Method on Mortality and Tag Loss in Hybrid Striped Bass

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Keywords: tag implementation, tag loss, hybrid striped bass

Hybrid striped bass (227-455 mm TL) were surgically implanted with dummy transmitters to determine the most effective combination of antenna placement and suture material at high and low temperatures. Following insertion of the dummy tag, the antenna was either left trailing from the incision, or moved away from the incision using the shielded needle technique. The incision was then closed with either absorbable (Dexon) or non-absorbable (silk) suture materials. Three replicates of ten fish of each treatment and ten control fish were held at low (12-16^{o}C) and high (22-28^{o}C) temperatures and individually examined at 7, 30, 60, and 90 days, and at 120 days the experiment was terminated and all surviving fish necropsied. At the lower temperatures, fish suffered no mortality and minimal tag loss independent of treatment. Loss of sutures of both materials was slow (over two thirds of stitches remaining at conclusion of study), although significantly faster for absorbable sutures. At higher temperatures, fish showed no loss of tags or initial (post-surgery) mortality, but all treatments began showing significant mortality after 60 days (over 50% of treated fish), while control fish did not. Over half of absorbable sutures were lost after one month, while over half of non-absorbable sutures were lost by two months. At both temperatures, the antenna and remaining sutures caused irritation. This study indicates that when surgical implantation of transmitters with an external antenna is the preferred attachment method, placement of the antenna away from the incision does not reduce tag loss and either method is effective and results in high transmitter retention at high and low temperatures. The use of absorbable sutures is recommended for tagging as the quicker rate of suture loss reduced foci for inflammation while still allowing the incision to heal completely**.** Post-surgery mortality rates were zero at both temperatures, indicating that for short term studies tagging can be performed at high temperatures, however long term effects of high water temperature on tagged fish may result in high delayed mortality of study fish.

Seasonal Movements and Summer Habitat Requirements of Striped Bass in the Combahee River ,South Carolina

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Keywords: striped bass, thermal tolerance, radio-telemetry, anadromy

The Combahee River is a black-water swamp stream with summer temperatures in excess of 27 C during the summer months. Striped bass were observed in the Combahee River, SC during summer months to determine habitat usage patterns as well as movement. Adult striped bass (n=30) were implanted with radio transmitters and were tracked from March to November, 1998. Telemetry data indicates that adult striped bass utilize upstream areas with a high degree of canopy cover during warm summer months. These areas are 5-10 C cooler than the downstream rice field area of the river. Movements consisted of upstream migrations during the early summer, then localized movement within upstream forested canopy areas during summer, and a return to the lower river during the late fall.

A Multi-Sampling Approach to Assess Striped bass Morone saxatilis Populations and Potential Thermal Refugia in a Pascagoula River Tributary, Black Creek , Mississippi.

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Keywords: striped bass; *Morone saxatilis*; life stages; anadromous; thermal refugia.

Striped bass *Morone saxatilis* populations have declined in coastal river systems of the Gulf of Mexico. Timing and location of striped bass spawning is correlated with temperature (19-24^{0}C), flow, and salinity (< 9ppt). After spawning, striped bass may remain in fresh water, seeking cool water refugia (<27^{0}C) with sufficient dissolved oxygen. The location, characterization, and protection of critical spawning habitat, nursery grounds, and summer refugia for striped bass in coastal river ecosystems are essential to the recovery and management of this anadromous species. Investigations into potential spawning and thermal refuge habitat have been ongoing in the Pascagoula River and its tributaries. Adult bass have been previously captured in Black Creek, a tributary of the Pascagoula River located in Southeast Mississippi. Few data are available on the status of striped bass populations in Black Creek. Our objectives were to investigate availability of habitat in Black Creek and use multi-sampling methods such as beach seines, gill nets, drift nets, and hand seines to target adults, juveniles, larvae and pre-larvae. These samples were conducted at 55 sites along a 30-35 mi reach during May 1998 - October1998. Potential summer refugia was identified in late spring and summer (May-July) with temperatures ranging from 24-31.5 ^{0}C. Our sampling efforts yielded 50 species of fish, however, no striped bass were sampled. We present spatial and temporal relationships of the fishes collected to physicochemical variables along the stream continuum. We conclude that there is available habitat in Black Creek that may provide potential spawning sites and seasonal refugia for striped bass, yet the numbers of striped bass using this tributary appear to be low.

The Collapse and Recovery of the Albemarle Sound/Roanoke River Striped Bass Population: Are We Really There Yet?

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Striped bass (*Morone saxatilis*) in North Carolina were once an important source of food for native Americans, early colonists, and more recently, an important species in commercial and recreational fisheries. Since the advent of commercial fisheries during the colonial era, the Albemarle Sound/Roanoke River striped bass stock has been highly exploited. Intensive commercial and recreational fisheries with few regulations resulted in a peak harvest of 1.3 million pounds during the 1960s, followed by record low levels in the 1980s. Recent catch-at-age analyses indicate rates of fishing mortality (F) may have been as high as 1.8 (83% removal annually) during this period. Concurrent with the decline in landings, reproductive success decreased dramatically. Regulations restricting the harvest of striped bass were begun in the early 1980s and some fishing practices were eliminated altogether. Fishing mortality remained high and not until the late 1980s, when a total allowable catch program was implemented, did F rates begin to decline. Harvest restrictions and management of river flows on the spawning grounds resulted in a dramatic improvement in spawning stock biomass and in 1997, the stock was declared "recovered" by ASMFC. Current data indicate a significant expansion of the stock and increasing representation of older age classes but historical accounts suggest an age structure much different than in our "recovered" stock.

Contributing Session X: Public Outreach

Oklahoma Bass Tournament Economics 101

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Keywords: black bass, bass tournaments, economic survey

A survey of selected Oklahoma black bass tournament organizations was conducted in 1994 to estimate the direct economic impact of these events. The average bass tournament drew 23 two-person teams who spent an average of $4,600 per event on lodging, fuel, food and supplies. The 14 tournaments with over 100 teams and the 36 events with over 50 teams each contributed $640,000 to various local economies. One professional event was estimated at contributing $455,700 to the local economy. The total direct economic impact from bass tournaments in 1995 was estimated at $4.87 million. Tournament permits have increased 42% since 1994 with an estimated 1,700 events in 1998 contributing $6.6 million to the state's economy.

Mortality in Texas Black Bass Fishing Tournaments with an Assessment of the Reliability of Self-Reported Mortality Estimates

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Keywords: black bass, angling mortality, fishing tournaments

We studied self-reported measurements of initial mortality in Texas black bass *Micropterus* spp. fishing tournaments that varied in size and rules of conduct. Self-reported measurements of initial mortality varied by a factor of 30. The lowest initial mortality was reported for paper tournaments (1.1%), in which fish are captured, measured, and immediately released. Initial mortality estimates ranged between 4.7 and 5.4% for big fish, team, and total weight tournaments. The greatest initial mortality (31.8%) was observed in road runner tournaments, in which fish are captured from various lakes, transported overland to a central weigh-in site, and then weighed and released. For total weight tournaments, we also compared self-reported measurements of mortality with those derived from a regression model that predicts initial mortality based on water temperature. Self-reported measurements of initial mortality averaged 5.8% and predicted initial mortality averaged 3.9%. The greatest differences between these estimates occurred in March through June when self-reported mortality was 3-4% greater than predicted mortality. The general agreement between self-reported and predicted estimates of initial mortality suggests that most black bass fishing clubs and tournament sponsors reliably report initial mortality.

Stream Teams, Fisheries, and Habitat

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Keywords: stream teams, habitat, education, stewardship, incentives

In the late 1980's and 1990's, Arkansas Game and Fish Commission biologists conducted statewide stream surveys to evaluate various programs and to obtain baseline data on streams and rivers in Arkansas. Results of this work indicated serious water quality and habitat problems existed on many Arkansas streams, much on private land. In 1996, the Arkansas Game and Fish Commission, along with the USDA Natural Resources Conservation Service, Arkansas Department of Pollution Control and Ecology, and numerous other federal, state, and local agencies and entities began a statewide Stream Team program. The mission of this group was to involve the citizens of Arkansas in stream conservation and water resource issues. Based on the three tenants of education, stewardship, and advocacy, this Stream Team effort was to make the link between fisheries and aquatic science and grass roots volunteer work to improve and/or maintain the quality of Arkansas' water resources. In less than two years, over 191 Stream Teams have signed up statewide and are working on a variety of programs centered around water and watershed conservation. Utilizing volunteer leaders from the Arkansas Cattleman's Association, Sierra Club, various river outfitter groups, and others, Stream Teams now survey streams, collect aquatic invertebrates, sample water quality, conduct litter pick-ups, repair eroded stream banks using Farm Bill program funds, influence state leaders on aquatic issues, and a myriad of other work. Incentives are used to keep this volunteer work force eager to help out.

Response of Anglers to a Differential Harvest Regulation on Three Black Bass Species in an Oklahoma Reservoir

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Keywords: creel survey, anglers specialization, largemouth, smallmouth, spotted bass

We used a two-stage probability roving creel survey in Skiatook Lake, Oklahoma to estimate angler catch, harvest, effort and knowledge about a differential black bass harvest regulation. The regulation, implemented in 1997 because of a large increase in the abundance of the spotted bass allows for the harvest of largemouth and smallmouth bass over 14 inches with a daily creel limit of 6 fish while the daily creel limit for spotted bass is 15 fish of any size. In 1997 all anglers fished 677,377 hours, black bass anglers caught (and harvested) approximately 63,329 (2,703) largemouth bass, 10,470 (0) smallmouth bass, and 46,885 (3,946) spotted bass. Occasional bass anglers were not as well informed of the regulation change as tournament anglers and could not identify spotted bass as well as other bass anglers. Similarly occasional crappie anglers were not as well informed of the regulation change as devoted crappie anglers and, a higher percent of these anglers reported they would keep the bass the caught that day as compared to other crappie anglers. Data from the 1998 creel season are currently being analyzed. Response by anglers to the regulation change seems to be related to the intensity of their fishing effort.

Fishing For Future Anglers

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Keywords: outreach, education

Most fisheries managers in the nation have faced demographic projections of a shrinking client base. Responses to this problem have precipitated an assortment of aquatic and sportfishing promotions designed to recruit new anglers. The Texas Parks & Wildlife Department Inland Fisheries staff has reached over 90,885 youth through 575 youth fishing events since January 1, 1996. In addition, in 1996, a new educational-based fisheries outreach facility, the Texas Freshwater Fisheries Center, opened as an agency-city-private collaboration. The focus of this effort was to provide an educational, entertaining visitor experience which promotes freshwater sport fishing and the enhancement, conservation, and stewardship of aquatic resources in Texas. In addition, the center was designed to generate revenue to defray the cost of operations. In the first two years of operation, the center has had over 150,000 visitors of which 52,000 were school-age youth and generated approximately $650,000.

The ShareLunker Program: A Research, Educational, and Marketing Tool

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Keywords: largemouth bass, angler, sampling, marketing, catch and release

We reviewed data collected through the Texas Parks and Wildlife Departments ShareLunker Program from 1986-1998 to evaluate the benefits of an angler participation program which allowed anglers to loan largemouth bass weighing at least 6.6 kg to the department for spawning, research, catch and release education, and public relations purposes. During the 12-year period, 281 anglers participated in the program providing the department an opportunity to analyze a segment of the states largemouth bass fisheries that could not be studied using traditional sampling methods. Besides spawning these fish and collecting age, length, weight, and genetic data, the program resulted in the marketing of the department's management and culture efforts. Results indicate that carefully designed angler participation programs allow state agencies to collect life history and performance data while providing a program that increased public participation in catch and release fishing of trophy largemouth bass.

Contributing Session XI: Clupeid Ecology

Ecosystem Effects of Omnivorous Fishes in a Southern Reservoir

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Keywords: reservoir fishes, nutrient transport, bioturbation, detritus

Ecosystem effects of three omnivorous fishes, gizzard shad *Dorosoma cepedianum*, smallmouth buffalo *Ictiobus bubalus*, and river carpsucker *Carpiodes carpio* were examined in Lake Texoma (Oklahoma-Texas). Because a large proportion of the total fish biomass in this reservoir (> 50%) is comprised of these fishes, they may potentially play an important role in the functioning of this ecosystem. The objectives of my study were to examine interspecific differences in excretion rates of limiting nutrients (nitrogen and phosphorous) among these fishes. Mean excretion rates by gizzard shad were greatest for both ammonia-N (9.4 Fmol $g^{-1}h^{-1}$) and phosphate-P (0.11 Fmol $g^{-1}h^{-1}$) and least for smallmouth buffalo (ammonia-N 3.1 Fmol $g^{-1}h^{-1}$ and phosphate-P 0.03 Fmol $g^{-1}h^{-1}$). Ratios of N:P were relatively large in comparison to published values for other taxa. Gizzard shad had the lowest mean N:P ratio (90) and river carpsucker the highest (130). Gizzard shad appear to have the greatest potential to make available limiting nutrients, particularly phosphorous. However, the combined excretion of all species is likely to effect primary productivity when external loading from the watershed is low.

Differential Mortality Rates of Two Age-0 Clupeids at Hugo Reservoir, Oklahoma

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Keywords: Dorosoma, otolith, age-0, mortality, weekly cohorts

Larval shad (*Dorosoma* spp.) collections from Hugo Reservoir, Oklahoma in 1995 and 1996 suggested differential morality rates of larval and juvenile gizzard shad (*D. cepedianum*) and threadfin shad (*D. petenence*). The objective of this study was to determine the instantaneous mortality rates and growth rates of weekly cohorts of gizzard shad and threadfin shad and to investigate relationships between mortality and growth to zooplankton abundance. In 1997 trawl samples were collected from Hugo Reservoir with paired 1-m^2-towed nets starting in April and ending in September. Otoliths were removed from five shad of each species per 5-mm length group from each sample. Daily growth rings were counted, spawn dates calculated and fish assigned to respective weekly cohorts. Catch rates (no./m^3) for each cohort were calculated from each sample. Eighteen consecutive weekly cohorts of gizzard shad were identified. Two separate spawns of threadfin shad were found; a spring spawn (April through June) and a late July through early August spawn. Mortality rates of the two threadfin shad spawns will be compared. Age-0 gizzard shad dominated the samples through June and threadfin shad dominated samples from July through September. Age determination is ongoing and mortality and growth rates will be reported at the meeting.

Impact of Trophic Competition Between Larval Gizzard Shad, Alewife, and Sunfish in Claytor Lake, Virginia

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Keywords: gizzard shad, *Dorosoma cepedianum*, trophic competition, ichthyoplankton, forage fish

In many reservoirs gizzard shad *Dorosoma cepedianum* may have negative affects on growth and survival of zooplanktivorous fishes through trophic competition. The intensity of this impact will depend on interspecific overlap in timing of larval zooplanktivory, diet composition, and zooplankton availability. Ichthyoplankton in mesotrophic Claytor Lake, Virginia were sampled in 1997 and 1998 to determine the impact of an introduced population of gizzard shad on resident forage fish and young-of-year sport fish. Sampling in both years indicated that peak densities of larval shad (0.06 fish/m^3), alewives *Alosa pseudoharengus* (0.07 fish/m^3), and sunfish *Lepomis* spp. (0.50 fish/m^3) occur in the limnetic zone from late-June to late-July. However, larval alewives first appear in mid-May while sunfish continue to occur in large numbers through mid-August; larval shad are present from early-June to early-August. All species utilized abundant *Sididae* and *Bosminidae* cladocerans, and copopod nauplii, yet density and composition of zooplankton showed no relationship to density of larval shad. In Claytor Lake, negative trophic impacts between larval shad and other zooplanktivores appears to be minimized by moderate temporal overlap, low shad density, and abundant zooplankton

Are Blueback Herring Distributed Randomly within Desired Habitat During Summer Stratification?

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Keywords: blueback herring, *Alosa*, Thurmond Reservoir, distribution, stratification

Previous work in J. Strom Thurmond reservoir during stratified periods showed that blueback herring were vertically distributed in strata where water temperatures were 18° to 24° C and dissolved oxygen content was $\geq$ 3 ppm. Furthermore, there was evidence that distribution of blueback herring along the longitudinal axis of the reservoir was limited, in some years, by the absence of cool, oxygenated water in the lower half of the reservoir. Previous data were not sufficient to evaluate possible relationships between densities of blueback herring and volume of suitable habitat. From June to September 1998, blueback herring were sampled concurrently with vertical gill-nets and hydro acoustics to determine if densities of blueback herring were constant (within desirable water quality strata) throughout the lake. Alternatively, we wanted to determine if blueback herring distribution during summer stratification was predictable based solely on the distribution of suitable habitat. Lastly, we wanted to evaluate the relationship between the catch rate of blueback herring from gill-nets and the density estimates from mobile hydro acoustics.

Balancing the Books: Predator Demand versus Prey Supply in a Virginia Impoundment

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Keywords: predator-prey interactions, reservoir, bioenergetics, hydroacoustics

The fishery of Smith Mountain Lake, Virginia, is dominated by native largemouth bass and stocked striped bass; both feed primarily on alewife and gizzard shad. Angler pressure to increase striped bass stockings motivated this quantitative assessment of the adequacy of the prey resource to meet increased predator consumption. Predator consumption (current demand) was determined using bioenergetic modeling, while prey production was investigated using hydroacoustic biomass assessment and population simulations; field data on diets and population dynamics were essential inputs. Presently, largemouth bass consume 5 kg/ha of alewife and 9 kg/ha of shad annually, while striped bass utilize 55 and 32 kg/ha of these species, respectively. Hydroacoustic assessment determined average annual August biomass of alewife and shad to be 36 and 67 kg/ha, respectively. Population simulations estimated annual alewife production as 73 kg/ha, while shad production equaled 64 kg/ha. Of this clupeid production, about 90% is currently being utilized by predators, or is morphologically unavailable. Our findings lead us to conclude that increases in striper stockings of 50% will be accompanied by any or all of the following: declines in growth and/or survival of predators, increases in diet breadth of piscivores, decreasing survival with possible increased growth of clupeids.

Assessment of the Potential Benefits of an Illegally Introduced Gizzard Population on Reservoir Sportfishes

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Gizzard shad were illegally introduced into Claytor Lake, Virginia in the late 1980s; this study evaluates their impact on piscivorous sportfishes. We collected piscivores (stocked striped and hybrid striped bass, walleye, and three black bass species) by electrofishing and gillnetting over a 2-yr period (October 1996-September 1998) to describe their seasonal diets and annual growth rates. Age-0 gizzard shad were eaten even by the largest sportfish to the near exclusion of older aged shad. The moronid species most heavily utilized gizzard shad as forage (as much as 65% by weight of stomach contents) especially in late Summer and Fall. During the first Summer, gizzard shad represented only 7% of moronid species diet composition compared to > 50% in the second Summer. The walleye diet included > 30% shad in Fall, 20% in the second summer, but < 5% during the first Summer and Spring. Shad constituted > 20% by weight of largemouth bass diets the first Spring, but < 10% for all three black basses the remainder of the study. A weak 1997 gizzard shad year class followed by a stronger 1998 year class helps explain discrepancies observed gizzard shad utilization between years. Striped bass annual growth rates have improved a average of 12% for ages 1-5 since pre shad years. Walleye growth rates for ages 1 and 2 have improved 25% and 8%, respectively, while black bass growth has declined an average of nearly 20% for ages 1-4.

Special Session: FERC Re-licensing: Perspectives and Issues

FERC Re-Licensing from the FERC Point-of-View

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The Federal Energy Regulatory Commission (the Commission) has the responsibility to regulate all non-federal hydroelectric projects in the United States. The Federal Power Act (FPA) requires licensees of non-federal hydropower projects to obtain a license or exemption from FERC if the project effects lands or waters subject to federal authority. Licenses are issued for terms from 30 to 50 years. Licenses must be best adapted to a comprehensive plan for improving or developing the waterway for beneficial public purposes. Because many of the waterways throughout the United States have already been developed or modified in some way, most licensing activity currently before the Commission involves the relicensing of existing projects constructed or operated under licenses issued many decades ago. The Commission's intent in relicensing these existing hydropower projects is to equitably consider the many competing power and non-power (environmental) interests through the relicensing process. Balancing of competing uses in the relicensing process poses real challenges during this time of deregulation in the electric power industry. The FPA gives statutory authority to state and federal resource agencies in setting mandatory terms and conditions for any license issued.

FERC Re-Licensing and the Federal Land Management Agencies

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Over 290 hydroelectric facilities were licensed and constructed on National Forest system lands with over 180 of these scheduled for re-licensing within the next decade. The Forest Service has mandatory authority to stipulate license articles for licensing these facilities. This work has received priority support and funding and the agency is committed to working cooperatively with other federal and state agencies to identify resource issues. The agency is in support of license conditions that assure protection of resources while allowing some flexibility to licensees and management agencies in hydropower facility operation.

Hydro Licensing: Issues, Concerns and Experiences of Southeastern State Fish and Wildlife Agencies

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Given new status through the passage of the Electric Consumers Protection Act (1986), several state fish and wildlife agencies in the Southeast became active in hydroelectric project licensing during the late 1980's and the 1990's. Issues addressed by these agencies included instream flow, fish entrainment, water quality, recreation, shoreline management, fish passage and reservoir level fluctuation. During the first decade of the new millennium, new licenses will be required for more megawatts of hydroelectric power than during the 1990's decade. How will recent experiences be used to address hydroelectric licensing during the next decade? A survey of issues, concerns and experiences of southeastern state fish and wildlife agencies related to hydroelectric licensing was conducted. The results of this survey and the outlook for licensing activities during the next decade will be presented.

Hydro Licensing from the Owner's Perspective

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Hydroelectric power generation is our nation's chief source of renewable energy, representing 98% of the nation's renewable energy production. There are approximately 2500 non-federal hydroelectric projects subject to licenses issued by the Federal Energy Regulatory Commission (FERC). Between the year 2000 and 2010, approximately 220 of these projects, representing approximately 62% of the licensed capacity, will be re-licensed by the FERC. At relicensing, owners of these projects must deal with a multitude of stakeholders and resource agencies in an effort to balance the many competing demands placed on these hydro resources. These re-licensings also come at a time of unprecedented change within the electric utility industry, as electric companies search for ways to remain competitive in a deregulated market. This presentation will look at the dynamics of the hydro licensing process and the relicensing alternatives available to owners and others involved in this complex process.

FERC Re-Licensing and the Role of Citizen Action Groups

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Since 1992, American Rivers and the 40 other members of the Hydropower Reform Coalition have been engaged in a coordinated effort to ensure that the public maintains its rights and responsibilities within the hydropower licensing process. We continue to constructively participate in more than 75% of the proceedings before the Federal Energy Regulatory Commission providing the Coalition a unique perspective of the broad spectrum of successes and failures. Along with state and federal resource agencies, FERC, the hydropower industry, and interested members of the public, the Coalition has helped to develop and promote a more cooperative and collaborative process. While this process is not applicable in every situation, it does provide a greater opportunity for public participation and potential for better development of science. The Coalition supports and has a number of recommendations for ensuring good process, appropriate science, meaningful public participation, a balance of all user groups, and conservation and restoration of riverine ecosystems.

Consulting In Hydropower Re-License Proceedings or "How to Straddle the Fence and Not Get Caught on the Barbed Wire"

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Since 1990, there has been a distinct rise in the number of hydropower projects that have undergone and are currently in the FERC relicensing process. Due to legislative changes in 1986, when the Electric Consumers Protection Act amended the Federal Power Act, the state and federal agencies have had increased input regarding the protection and enhancement of environmental resources at hydro projects. The legislation and increased participation from resource agencies has changed the relicensing process in that environmental needs are given equal consideration with hydropower generation needs. Both the utilities and the state and federal agencies have wrestled with these changes in trying to maintain or increase their own specific interests. Providing consulting services during this time has been equally challenging. The consultant is frequently placed in the "mediator" role between the disputing parties. For the consultant, this is often referred to as "sitting on the fence" position, where the consultant helps the disputing parties work through the issue before providing their opinion or conclusion on how the issue should be resolved. The consultant must also consider the interests of, non-governmental organizations (NGO) such as the Sierra Club, Trout Unlimited, American Rivers, etc., which are taking a much more active role in hydropower relicensing. It is increasingly important for consultants to use "Team Building" processes to help all parties establish trust for each other early in the relicensing process. Once the Team is formed, they can begin the process of examining the major and minor objectives of both

environmental and hydropower needs. This process will allow the Team to set priorities for each issue to be addressed during relicensing. The consultant must provide innovative ideas for resolving the issues that meet the Team's objectives. The Team must work together to identify the issues that will be easily resolved and those that will require more effort, while working towards resolution at the local level. This negotiation process has proven quicker and more successful in balancing power and environmental needs than the historic section 10(j) process. This Team approach is built into the FERC's new alternative licensing procedures (specifically the Applicant Prepared Environmental Assessment), but it can also be used in the "Traditional" Three-Stage Consultation process. This presentation will address some of the typical issues encountered during relicensing and describe three cases where the Team philosophy was used by federal and state agencies, the hydropower utility, and Kleinschmidt Associates to resolve resource issues. The role of the consultant in each case will be highlighted.

Applicant Prepared Environmental Assessment: Vision, Observation, and Recommendations

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The Office of Hydropower Licensing (OHL) administers the non-Federal hydropower program for the Federal Energy Regulatory Commission (FERC). An OHL alternate licensing process, involving an Applicant Prepared Environmental Assessment (APEA) or third party contractor prepared environmental impact statement, expands participation of the federal and state resource agencies, nongovernmental organizations, and the public in the FERC licensing process and provides them an opportunity to resolve conflicts among developmental and environmental resource interests and accommodate the interests of the participants. After studies are complete, successful teams develop communication patterns that result in cooperative approaches to problem solving. This cooperative approach happens most often when trust is established among team members. The outcome is often a settlement among the team members. This settlement is then proposed as the preferred licensing alternative. When the process is successful, the result is more local control and ownership of the licensing decision, and ongoing local participation during the term of the license. The Commission's commitment to the alternative licensing approach is spelled out in its Order 596, issued October 29, 1997.

Negotiating in the Face of Uncertainty or How to Resolve Conflicts With a Half A Deck.

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It is the usual circumstance that biologists have to negotiate agreements on natural resource issues with less than all of the possible data. This is the norm not the exception and we should not be intimidated by this prospect. There are a number of critical points that one must keep in mind to be successful in negotiating natural resource issues. First, keep in mind that negotiating settlement agreements (SA) is far more preferable to the normal regulatory process. Most regulatory processes are very complicated, take a long time, can be painful, and have significant uncertainty. SA allow for the local solution of problems and reduces the regulatory agencies discretionary decision making, which equals certainty. SA usually provide for a much improved working relationship between the parties allowing one to combine the backgrounds of all parties to solve problems. Thus, negotiating even with less than perfect data is a preferred alternative. To make negotiations work one must: develop working relationships between the parties and among the sides; have each side able to articulate a single position on each issue; understand the management structure of all parties; be able to have the negotiators for all parties must have the authority to make decisions; and must have a willingness to negotiate in good faith among all parties. It is also critical to explore non-traditional solutions; be sure to understand the other side's information completely; and to have technical and legal advice available at all times during the negotiations. The negotiation team must be kept small and negotiations should be done in an informal environment. I strongly recommend developing a conceptual agreement on all issues before writing the full agreement. Finally, develop an understanding of the personalities involved in the negotiations and be sure that the key issues are made very clear from the beginning of the negotiations. If you follow these points, it is possible and likely that you can overcome the gaps in your data and improve public trust resources for long periods of time.

Negotiating Hydropower Releases: A Case History from Kaw Reservoir, Oklahoma

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The Oklahoma Department of Wildlife Conservation was party to the review of the Federal Energy Regulatory Commission license for the Oklahoma Municipal Power Authority to produce hydropower at Kaw Reservoir, Oklahoma. Conflicts arose regarding water quality and its effects to stilling basin and downstream fisheries. Following several fish kills, resolution was obtained that specified 1) installation of selective withdrawal plates; 2) installation of a slipstream nozzle; 3) ramping procedures; 4) emergency releases; 5) maintaining Oklahoma water quality standards and; 6) reviewing the plan after one year. We describe the nature and development of this controversy and suggest that anticipating data needs, personnel allocations, training in conflict resolution and developing a communications network are considerations that would benefit natural resource agencies faced with similar situations.

A Watershed Approach to Relicensing: Process and Outcome

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The Menominee River Basin is located in the northeastern part of Wisconsin and the Upper Peninsula of Michigan. The river and its tributaries drain an area of 4,100 square miles. There are 20 Federal Energy Regulatory Commission regulated hydroelectric dams located in this watershed. Eight of these projects, in the upper part of the basin, were due to be relicensed in the 1998-2001 period. The licensee of these projects, Wisconsin Electric Power Company, the resource agencies and two environmental groups reached agreement on all issues associated with relicensing prior to license expiration. This settlement agreement addressed a number of issues that had impacts throughout the basin. These included flow allocation, water quality, entrainment and turbine mortality, land and wildlife management, recreation, dam removal and future dam responsibility. The resource agencies had developed a long-range plan on the fisheries of the Menominee River prior to negotiating this agreement. This plan proved invaluable in directing and prioritizing our issues in the negotiations. A key factor in reaching settlement was that everyone involved took the time to get an understanding of the issues and concerns of the other parties. Tours of all the projects, impacted river sections and impoundments helped accomplish this. In addition, all parties took an active role in the studies conducted prior to licensing. Finally a team made up of the licensee, the resource agencies and the environmental groups will implement the settlement agreement.

Decommissioning Non-Federal Hydroelectric Dams: Procedures and Considerations

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Decommissioning a hydroelectric project regulated by the Federal Energy Regulatory Commission (FERC) has been preferred to continuing the project in some cases. Removal of dams, including non-hydro dams, has been identified as a strategy for restoring habitat and access for fish. Opportunities for decommissioning exist in FERC's relicensing process. The National Environmental Policy Act provides procedures for evaluating decommissioning and dam removal, and for developing an administrative record as a basis for reasoned decision-making. Settlement negotiations have provided a forum for collaboration and agreement on dam removal. Considerations in these processes include affected resources, impacts, benefits, economics, and support. Participants have included dam owners, non-governmental organizations, and state and federal governments. Procedures and considerations from projects are reviewed, including Edwards Dam (ME), Clyde River (VT), and 15-Mile Falls (NH/VT).

Special Session: Norris Reservoir: Fishery Management or Conflict

Formation and Accomplishments of the Norris Reservoir Task Force: A Partnership Approach

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In response to increasing complaints and dissatisfaction by local anglers over the fishing quality on Norris Reservoir, the Norris Reservoir Task Force was formed in January 1992. This interagency task force was composed of state and federal fishery professionals, research staff from two universities and volunteer anglers joined together in a partnership approach to fisheries management in Norris Reservoir. Major issues and concerns perceived by anglers were identified and solutions to selected problems were proposed and implemented. Three major projects were undertaken by the group: (1) a comprehensive baseline reservoir sampling effort involving various agencies and volunteers, (2) a habitat enhancement program that used many volunteers, (3) a comprehensive fishery management plan was developed. Volunteers donated over 7,500 h to these projects while state, federal, and university personnel provided supervision, equipment, and supplies, and coordinated the sampling and work efforts. Working together in these cooperative efforts enabled biologists to gain a better understanding of angler views and concerns and anglers to gain insights into the complexity of reservoir fisheries management.

Partnership Approach to Reservoir Fisheries Management

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Keywords: partnership, fishery management, volunteers

A program wherein state and federal fishery professionals, research staff and students from two universities, and volunteer anglers joined together in a partnership approach to fisheries management in Norris Reservoir, Tennessee. Major issues and concerns perceived by anglers were identified and solutions to selected problems were proposed and implemented. Two major projects were undertaken by the group: (1) a comprehensive baseline reservoir sampling effort involving various agencies and volunteers, and (2) a habitat enhancement program that used many volunteers. Volunteers donated over 6,500 h to these projects while state, federal, and university personnel provided supervision, equipment, and supplies, and coordinated the sampling and work efforts. Working together in these cooperative efforts enabled biologists to gain a better understanding of angler views and concerns and anglers to gain insights into the complexity of reservoir fisheries management.

Human Dimensions in Fishery Management: Norris Reservoir

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Keywords: angler survey, human dimensions, Norris Reservoir

In the early to mid 90's, there was increasing concern expressed by local anglers over the quality of fishing on Norris Reservoir in east Tennessee. Some anglers opposed to stocking striped bass in Norris Reservoir were well organized and quite vocal in their opposition to TWRA's management practices. Because of public concerns about management practices on Norris Reservoir, TWRA asked the Human Dimensions Research Lab in the Department of Forestry, Wildlife and Fisheries at the University of Tennessee to conduct a public opinion survey of TWRA and its management practices in November of 1995.
Participants in the statewide survey were 2,358 individuals, 16 years of age and older, randomly selected across Tennessee. An additional 1,258 participants were randomly selected and interviewed in the 11-county Norris Reservoir area which consists of 11 counties shown by previous surveys to be resident counties for those who fish Norris Reservoir. Using this approach, 249 anglers were randomly contacted in the 11 county area.

Those anglers who indicated that they had stopped fishing Norris Reservoir between 1980 and 1994 were asked the open-ended question "Why did you stop fishing Norris?" Approximately 14% said it was due to "poor quality fishing" and 1.2% said it was because of the striped bass. Nine percent (9%) said they were no longer interested in fishing and 2.2% went elsewhere to fish. The greatest constraint on fishing Norris Reservoir, however, was "time" (37.8%).

The Norris anglers were also asked, "Has the presence of striped bass in Norris Lake caused you to fish Norris Reservoir more, the same, or less?" Although only 1.2% mentioned (on their own) they had stopped fishing Norris because of striped bass, 30% of those familiar with TWRA said that they fished Norris less because of the presence of striped bass. On the other hand, 11% said that they fished Norris Lake more because of striped bass and forty percent (40%) indicated that striped bass had not affected their fishing of the reservoir. Fifty percent (50%) of the Norris anglers familiar with TWRA believe the agency when they say that striped bass prey on non-game fish. Thirty-six percent (36%) believe other people (not TWRA) who say that striped bass prey on game fish. Of those Norris anglers familiar with TWRA, 48% said "Yes" (continue to stock) and 35% said "No" (do not stock striped bass).

Norris Reservoir anglers who said they were somewhat or very familiar with TWRA expressed more dissatisfaction with TWRA's management of fisheries (21.1%) than did other anglers statewide who were familiar with TWRA (7.5%). Nevertheless, 67% of the Norris anglers and 72% of other anglers said they were "very" or "somewhat" satisfied with how TWRA manages the fisheries resources in Tennessee.

As expected, the public opinion survey indicated that there was greater concern about fisheries management in the Norris Reservoir area than in the remainder of the state, but overall, the majority of anglers indicated that they were satisfied with the management of the reservoir.

Food Habits of Adult Predators during Winter Drawdown in Norris Reservoir

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Keywords: food habits, winter reservoir drawdown

Data collection was completed to determine food habits of adult predators (black bass, striped bass, walleye, catfish) during the winter drawdown periods of 1995-96 on Norris Reservoir to see if there was predation on y-o-y game species while they are crowded together. Stomachs from 602 black bass, 85 striped bass, 203 walleye/sauger, and 50 catfish (17 channel/ 33 flathead) were examined for preferred food items. Gut contents indicated clupeids (threadfin/gizzard shad, alewife) and centrarchids (bluegill) were the majority of items ingested by all predator groups. Over 99% of fish eaten by striped bass were alewives and threadfin/gizzard shad; one bluegill was the only other fish identified as a food item. Juvenile crappie were consumed by largemouth and smallmouth bass (2% of all items), sauger (3%), and channel catfish (1%). Crayfish were a substantial item in the diets of black basses.

Utilization of Half-Log Structures as Spawning Sites for Smallmouth Bass in Norris Reservoir

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Keywords: habitat enhancements, spawning structure, smallmouth bass

SCUBA observations were used to evaluate the utilization of half-logs by naturally spawning smallmouth bass. Of the 736 half-logs installed in Norris Reservoir in 1993, 22% of the total (161) logs were evaluated weekly at three different sites from 2 April through 25 June 1996. There were 88 line-transects, each 12.2 m in length, used as controls and positioned in non-structure areas; the transects were located at the same water depths as the half-log structures. Species found utilizing the half-logs for spawning were smallmouth bass, bluegill, black crappie, spotted bass, and largemouth bass. Other species utilizing the half-logs for cover were flathead catfish and common carp. Treatment areas produced an average of 1.9 nests per log whereas the controls produced 0.8 nests per transect, indicating a strong preference for overhead cover for spawning. No smallmouth bass were observed nesting around any of the control transects. In the treatment areas all nests with eggs (61) had a successful hatch. The mean depth at which smallmouth bass nests containing eggs were found was 3.1 m. Half-logs installed on points had a higher percent utilization (45%) for spawning by smallmouth bass than those located in coves (10%).

Recruitment Failure of Walleye in Norris Reservoir, Tennessee

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Keywords: walleye, recruitment failure, alewife

Walleye *Stizostedion vitreum* are an important sportfish in many southeastern reservoirs and large rivers. Norris Reservoir, a large tributary reservoir of the Tennessee River, was historically noted for both riverine and reservoir spawning populations of walleye. Horizontal experimental gill nets have been employed since 1993 to evaluate the reservoir-residing walleye population in Norris Reservoir and to evaluate possible effects of recently introduced alewife *Alosa pseudoharengus* on pelagic fish populations. Sampling was conducted monthly from May through November. Larval fish collections were taken in late-winter and early spring in 1996 and 1997 throughout the system. No larval walleye were collected in either 1996 and 1997, although several other species were noted. Age-0 walleye CPUE (no./net-night) were not significantly different in the Fall 1993 and 1994. No Age-0 walleye have been collected since the Fall 1994. Age-1 CPUE were not significantly different from 1993 through 1995, but no Age-1 walleye have been collected in 1995, 1996 and 1997. Angler creel surveys also indicate that reduced recruitment to the fishery has occurred and the harvest is currently dominated by larger and older individuals. Consequently, it appears walleye have not successfully reproduced in Norris Reservoir since 1994. Concurrent with the reproductive failure of walleye has been a significant increase in the abundance of alewife. Alewife CPUE has increased significantly since 1994 and are now the most abundant clupeid inhabiting the reservoir.

Angler Exploitation of Norris Reservoir's Important Fisheries

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Keywords: angler exploitation, tag retention, walleye, black basses, black crappie, striped bass

Annual angler exploitation is an important consideration when efficiently managing most freshwater fisheries. To determine annual exploitation for largemouth bass, spotted bass, black crappie, striped bass, and walleye in Norris Reservoir, Tennessee a traditional tag-recapture study was conducted over a two-year period. Legal sized individuals were collected with boat-mounted electrofishing equipment and tagged with either Hallprint anchor tags or Hallprint dart tags. Tag retention and tagging related mortality (21-d) for all species except striped bass was determined in experimental hatchery ponds. Nonreporting by anglers was determined by surrogate post cards. A reward of $ 5.00 was offered for both tags and post cards. Tag retention was 100 % for all species evaluated with total tagging-related mortality ranging from 22 % for walleye to 10 % for the black basses. Nonreporting was estimated was 30 % for walleye, 35 % for the black basses, 40 % for striped bass, and 42 % for crappie. Annual exploitation for largemouth bass was 20+/-4 % in 1996 and 14+/-4% in 1997, and 22+/-10 % in 1996 and 17+/-9% in 1997 for spotted bass. Black crappie were the most exploited with annual angler exploitation exceeding 40 % in both years. Striped bass were also heavily exploited with an annual angler exploitation exceeding 30 %. Since 1994, annual exploitation of river-spawning walleye was decreased from 42+/-11% to 14+/-10 %.

Stock Structure of Walleye in Norris Reservoir, Tennessee

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Keywords: walleye, biochemical genetic analysis, fatty acid composition

The stock structure of walleye *Stizostedion vitreum vitreum* in Norris Reservoir, Tennessee is uncertain due to introductions from numerous sources. Since 1994, Tennessee Wildlife Resources Agency has primarily stocked walleye obtained from Greers Ferry Reservoir, Arkansas. Genetic analysis using starch gel electrophoresis and fatty acid analysis using total percent lipids and weight percent fatty acids were used to determine stock structure. Sample sites in Norris Reservoir included the upper Clinch River, upper Powell River, and random reservoir sites. Two secondary study sites, Cherokee Reservoir, Tennessee and Greers Ferry Reservoir, Arkansas, were used as controls for genetic and lipid analysis. Collections were made in March and April of 1997 using standard pulsed DC boat electrofishing and gill-netting techniques. Genetic analysis revealed two polymorphic loci, isocitrate dehydrogenase (IDH) and malate dehydrogenase (MDH). Genetic distinction of the walleye stocks in Norris Reservoir was not possible due to finding northern alleles in the Greers Ferry Reservoir sample. However, fatty acid analysis using linoleic (18:2n-6), linolenic (18:3n-3), arachidonic (20:4n-6), and docosahexaenoic (22:6n-3)

fatty acids provided information about stock structure. Principal component analysis, using weight percent fatty acids and total percent lipids, revealed that Norris Reservoir walleye were not clearly segregated, but overlapped both Cherokee Reservoir and Greers Ferry Reservoir walleye, which were clearly segregated. Quadratic discriminant analysis revealed that 23% of the walleye collected from Norris Reservoir were classified as Greers Ferry Reservoir stock. The majority (70%) of the walleye classified as Greers Ferry stock were age-1 or 2 and 90% were males. Overall, 33% of age-1 and 2 walleye from the Norris Reservoir sample were classified as Greers Ferry Reservoir stock, and 11% of age-3 and up walleye were classified as Greers Ferry Reservoir stock. The walleye classified as Greers Ferry Reservoir stock showed no significant differences in growth, total percent lipids, or relative weight when compared with Norris Reservoir walleye.

Exploring Competition Between Striped Bass and Selected Predatory Fishes in Norris Reservoir: Interspecific Predation

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Keywords: striped bass, predation, reservoirs, bioenergetics, compensatory mortality

Introductions of striped bass *Morone saxatilis* into reservoirs have long been questioned, especially the potential for striped bass to prey upon native game fishes. We investigated the possibility of reduced gamefish survival in Norris Reservoir due to striped bass predation by estimating the number of gamefish consumed and accounting for compensatory mortality responses. Total annual consumption by the striped bass population was estimated using a bioenergetics model. Compensatory mortality was estimated by comparing population abundance in successive years. Striped bass were found to consume only *Lepomis* spp. at a rate of 2.5 kg/ha, representing 6% of the *Lepomis* biomass, and 4% of the striped bass diet. Because mortality of *Lepomis* was highly compensatory, survival was projected to actually increase by 14% as a result of striped bass predation. To simulate the impacts of possible diet shifts by striped bass, other game fishes were modeled to represent increased portions of striped bass consumption. For survival to decrease, we found that *Lepomis* would have to comprise about 50% of striped bass consumption, smallmouth bass *Micropterus dolomieu* 9%; spotted bass *M. punctulatus* 4%; largemouth bass *M. salmoides* 9%; and crappie *Pomoxis* spp. 24%. Our results suggest that predation by striped bass may actually benefit some gamefish populations, although we identified predation on *Lepomis* only.

Exploring Competition Between Striped Bass and Selected Predatory Fishes in Norris Reservoir: Diet Overlap

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Keywords: striped bass, black bass, diet overlap, feeding competition, null models, reservoirs

For competition to occur, two or more species must have to share a food resource, and the resource must be limited in quantity. We measured diet overlap between striped bass *Morone saxatilis* and smallmouth bass *Micropterus dolomieu*, spotted bass *M. punctulatus*, largemouth bass *M. salmoides*, black crappie *Pomoxis nigromaculatus*, sauger *Stizostedion canadense*, and walleye *S. vitreum* to assess if striped bass shared their food with coexisting game fishes in Norris Reservoir. Stomach contents of striped bass and the selected predator species were examined monthly for a 12-month period (N = 3,584 stomachs). Pianka's and Czechanowski's resource overlap indexes (0 = no overlap, 1 = full overlap) were applied to measure diet overlap, and null models used to assess if overlap was more than expected by chance. Diet overlap values ranged from 0 to 0.99, and varied seasonally and between species. Significant diet overlap between striped bass and other game fishes occurred with all species (except largemouth bass), but not in all seasons. Our results indicate that exploitative competition between striped bass and coexisting game fishes is plausible if the prey supply to predator demand ratio is low.

Exploring Competition Between Striped Bass and Selected Predatory Fishes in Norris Reservoir: Prey Supply and Predator Demand

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Keywords: striped bass, prey inadequacy, feeding competition, supply-demand, fish production, bioenergetics, reservoirs

Prey deficiency is generally considered the single most important limitation on gamefish production in southeastern reservoirs; thus, competition for limited forage is likely. We compared prey supply to predator consumptive demand to assess the degree of feeding competition among major game fishes in Norris Reservoir. Prey supply was defined as the biomass plus production of clupeids and lepomids. Predator demand was estimated with bioenergetics models and was partitioned into size-specific demands based on actual prey sizes eaten. The overall mean supply-demand ratio weighted by the importance of prey to the gamefish community was 3.5. Also, we modeled increases and decreases in both supply and demand, to simulate natural fluctuations in prey supply and predator demand. Given fluctuations in both supply and demand from 0.25 to 2 times that of the mean estimates, we observed the supply-demand ratio to range between 0.4 and 28.2. It is difficult at best to associate a supply-demand ratio to competition without additional information on the minimum ratio necessary to sustain predator demand, but given the potential range of supply-demand ratios, it is evident that intensity of competition varies annually. The mean supply-demand ratio, 3.5, may be interpreted as an approximation of what is needed to maintain historical average gamefish biomass and production in Norris Reservoir.

Exploring Competition Between Striped Bass and Selected Predatory Fishes in Norris Reservoir: Dividends of Reduced Striped Bass Stocking

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Keywords: striped bass, stocking, reservoirs, prey inadequacy, supply-demand, fish production, bioenergetics

If density of striped bass in Norris Reservoir is reduced or eliminated through modifications of the stocking program, additional prey would become available to native game fishes. Such release of prey once tied up in striped bass biomass and its maintenance, may partially or entirely be shifted to other predators. An increase in biomass of other predators would be a function of the amount of prey that is released, the efficiency with which that prey is captured, and the efficiency with which the prey is transformed into additional biomass. We simulated reductions in striped bass prey demand by reducing current levels of striped bass biomass by several levels ranging from 0 to 0.75. Capture efficiency was unknown so we modeled several values ranging from 1 to 0.125. A bioenergetics model was used to estimate assimilation efficiency of the native species, as well as total prey demand by the modeled biomass of striped bass. Our results indicated that reducing striped bass biomass would increase supply-demand ratios by as much as 25% if striped bass were removed. Such removal would increase prey supply in the reservoir by an estimated 63.5 kg/ha. This additional supply would increase biomass of native game fish by as much as 12.7 kg/ha, or about 20%, if capture efficiency is 1.0. Nevertheless, it is unrealistic to assume that all the prey released by striped bass would be consumed by other predators, thus smaller increases should be expected.

Special Session: Trout Biology and Management in Southeastern States

Using Test Creel Survey Data in Designing Expansion Creels on North Carolina's Put-and-Take Trout Streams

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Keywords: creel survey design, trout fishery

Put-and-take trout fisheries in North Carolina have not been evaluated since the early 1970s. In the intervening time, stocking frequencies and stocking rates of individual streams have evolved at the discretion of innumerable fishery biologists. Since so little was known about the characteristics of these fisheries, the North Carolina Wildlife Resources Commission conducted pilot creel surveys on 6 streams in 1997. The objective of these surveys was to obtain fishing pressure patterns and angler trip characteristics for use in designing statistically valid and efficient creels in subsequent years. The pilot creel work schedules were subjectively determined with the day of stocking as the beginning of each period. Beginning with the afternoon of each stocking day, morning and afternoon work periods were alternated. Major changes in future put-and-take creel survey designs resulting from this study include: reducing the defined work day by 2 hours, changing the probability of selecting morning and afternoon work periods from 0.5:0.5 to 0.35:0.65, and changing the stratification of work days from weekend days and weekdays to stocking day plus 4 days following and remaining days until the next stocking. These design changes were implemented in 1998 and are expected to improve the precision of the statistical estimators of these creels.

An Assessment of Scales and Otoliths for Aging Rainbow Trout in the Southeast

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Keywords: otolith, scale, rainbow trout, aging, oxytetracycline

Valid age and growth data are necessary for an understanding of the life history of fish, including characteristics such as average growth rates, age at maturity, and average life spans. The age of salmonids is usually assessed by identifying annuli on scales and otoliths. Accurate age determination depends on whether these marks are formed annually. Validation of annuli for rainbow trout in the southern Appalachians has not been reported, but scale and otolith marks have been used widely for aging. This study will attempt to validate otolith and scale marks. Oxytetracycline was used to mark otoliths of visible implant tagged rainbow trout in a mark and recapture study at Sam's Creek, in the Great Smoky Mountains National Park, and Shining Creek, in the Shining Rock Wilderness Area, Haywood County, NC. Fish from all age groups were marked in July and October, 1997 and June, 1998. Some recaptures were harvested in October 1997 and June 1998, with most harvested in October, 1998. Scales were compared with marked otoliths to validate annuli formation and determine time of year that annuli form. The average growth rate for each age group and the relationship of scale and otolith growth to absolute growth was also determined. The data obtained will be available as a baseline for trout age and growth information in the Southeast.

Comparability and Accuracy of Scales and Otoliths for Ageing Wild Brown Trout in Tennessee

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Keywords: brown trout, ageing, otoliths, scales, accuracy

Scales and otoliths were collected from 227 wild brown trout (94-647 mmTL) from 11 Tennessee streams to assess the comparability and accuracy of the two structures for aging these fish. Accuracy was determined by examining scales and otoliths from known-age fish (up to age 5) from five streams. Maximum ages for scales and otoliths were 8 and 12 years, respectively. Overall, there was 74% agreement between corresponding scale and otolith ages (81%, ages 0-5; 21%, older fish). Scale age underestimated otolith age in 68% of cases where the structures did not agree (maximum, 5 years; mean, 1.6 years) and in 98% of disagreements involving age-3 and older fish. Consequently, the regression slope of scale age versus otolith age (0.72) was significantly different ($P < 0.05$) from the hypothetical slope of 1.00. All scale and otolith ages determined for known-age fish were accurate. Additionally, mean absolute ageing error for scales was <1 year through age 5, but usually exceeded a year afterward. Therefore, we conclude that scales are generally reliable for ageing wild brown trout up to age 5. Because growth of individual fish was highly variable (457-508 mm fish were 4-12 years old), length was an unreliable predictor of age for larger specimens.

Relations between Habitat, Water Quality and Trout Biomass in Tennessee Tailwaters

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Keywords: trout, rivers, habitat, GIS, standing crops

Gross habitat features were mapped in the Clinch River, South Fork of the Holston River, Watauga River, and Caney Fork River using GPS receivers and GIS software. These habitat surveys complimented surveys of the fate of trout stocked into each river. Each of these regulated rivers is managed as a put-and-take, or put-grow-and-take fishery for rainbow trout *Oncorhynchus mykiss* and brown trout *Salmo trutta*. The amount of trout habitat in these rivers varied widely, as did the biomass of trout each system supported. Standing stocks of overwintering trout were highest in the South Fork of the Holston River (170 - 232 kg/ha) and lowest in the Caney Fork River (41-74 kg/ha). Not surprisingly, the South Fork of the Holston River had the highest ratio of riffles and runs to pools; whereas, the Caney Fork River had a very low ratio of riffles and runs to pools (1.2 / 1 / 1.85, respectively). Although tentative relations between habitat and carrying capacities in these four tailwaters have been developed, these relations are confounded by the influence of other factors such as minimum flows, frequency of high discharge events, and water quality.

Movement and Activity of Resident and Recently-Stocked Rainbow Trout in the Clinch River Below Norris Dam, TN

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Keywords: trout, radio, telemetry, movement, activity

Approximately 36,000 catchable (>200 mm TL) rainbow trout *Oncorhynchus mykiss* are stocked annually into the Clinch River below Norris Lake, TN, but return rates of these fish are poor. Radio telemetry was used to monitor the movements and activity patterns of resident rainbow trout and rainbow trout recently-stocked into the Clinch River. Resident rainbow trout (N = 20) were collected from the river and implanted with radio transmitters. Hatchery rainbow trout (N = 20) were implanted with radio transmitters and stocked into the river two weeks after implantation. All rainbow trout were located at least once every two weeks during the summer of 1998. Stocked rainbow trout quickly dispersed; of 15 fish that were located 24 h post-stocking, seven moved upstream (mean displacement = 809 m) and eight moved downstream (mean displacement = 1855 m). Stocked rainbow trout disappeared rapidly; there were significantly fewer stocked rainbow trout remaining in the study area then resident rainbow trout 29 d post stocking. Differences in home range size and activity of the two groups were also documented.

Identification of the Factors Necessary for Successful Trout Reproduction in Tennessee Tailwaters

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Keywords: tailwater, trout, reproduction, habitat, fecundity

Tennessee tailwaters are routinely stocked with brown trout *Salmo trutta* and rainbow trout *Oncorhynchus mykiss* to sustain put-and-take and put, grow, and take fisheries. Natural reproduction is known to occur in some Tennessee tailwaters. Natural reproduction can enhance the quality of a fishery and reduce the reliance on hatcheries to maintain a fishery. However, current stocking regimes ignore natural reproduction as a source of population enhancement because the subject is not well researched. The factors which control trout reproduction in Tennessee tailwaters are poorly understood. The objective of this study is to identify the factors necessary for natural reproduction to occur. This study is focusing on four east Tennessee tailwaters; little or no natural reproduction is thought to occur in two rivers (Clinch and Hiwassee), but substantial reproduction has been documented in two other rivers (South Fork of the Holston and Watauga). Complete censuses of spawning activity commenced in October 1998 and will continue through two spawning seasons. In addition to assessing habitat quality, other factors such as fecundity and brood stock size will be investigated.

Influence of Turbidity on the Foraging Success of Brook Trout and Smallmouth Bass

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The impacts of sedimentation on stream habitat and the reproductive potential of fish have received much attention, but information on the effects of sedimentation and suspended solids on the individual is lacking. Brook trout (*Salvelinus fontinalis*) and smallmouth bass (*Micropterus dolomieu*) are top predators in many cold and warm water streams, and their habitats are easily influenced by the land-use practices of man. Individuals of each species were held in an artificial stream channel to test the effects of varying levels of turbidity on reactive distance, probability of prey recognition, and probability of successful foraging attempts. A video camera mounted above the artificial stream channel was used to observe and record feeding behavior. Three individuals of one of the species were tested at a time. This introduced competition between the fish and encouraged a strike by the first individual recognizing the prey. Thus, a measurement of maximum reactive distance could be obtained. Each species was tested at turbidities ranging from 0 to 40 NTU's. Turbidity had a negative effect on the maximum reactive distance of both species with reactive distances at high turbidities being significantly lower than those in clearer water. The proportion of prey items recognized by each species also declined significantly with elevated turbidity, however, once a prey item was recognized, the probability of successfully capture and ingestion of that prey item did not change with turbidity. Encounter rates between predator and prey are a function of reactive distance. Decreased reactive distance in turbid water leads to fewer encounters between predator and prey. This could result in decreased growth rates of fish living in streams that have chronically turbid waters.

Analysis of Mitochondrial DNA Heterogeneity in Maryland Populations of Brook Trout *Salvelinus fontinalis*

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Keywords: brook trout, population genetics, mitochondrial DNA, phylogeny

Mitochondrial DNA (mtDNA) restriction fragment length polymorphisms (RFLP's) from brook trout *Salvelinus fontinalis* collected from 12 stream units in 5 drainages were analyzed to test hypotheses concerning the population genetic structure and divergence of this species. Previous research over the entire range of brook trout indicates a high degree of divergence. These studies have concentrated on samples from the northern (Canadian) and southern (Smoky Mountains) regions of this range while the regions in between, including Maryland, are represented proportionately less in the data. The data from this analysis was compared with previous data to determine clade structure and to speculate on the most likely refugial origin of Maryland brook trout. The data were also used to assess divergence between drainages and stream units. A hypothesis designed to test a possible stream capture event in western Maryland was also investigated using mtDNA RFLP haplotype data from this region.

Importance of Natural Variability in Flow and Temperature for the Continued Coexistance of Two Trout Species: An Individual-based Modeling Approach

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Keywords: individual-based model, coexistence, sympatric populations, population viability, trout

Understanding the biotic and abiotic conditions under which two or more fish species coexist is critical to successful management and accurate assessment of potential impacts. We used an individual-based simulation model of a two-species trout community to evaluate which aspects of the hydrologic and temperature regimes have the greatest impact on the persistence of both species. Various combinations of actual and artificial flow and temperature regimes were used to track the success of the rainbow and brown trout populations during 10- to 20-year simulations. Fairly constant conditions usually allowed one species to dominate, leading to the eventual extinction of the other, but, as environmental variability increased, so did the likelihood of long-term coexistence. We found that the natural temporal variability in temperature and flow and the timing of unpredictable periodic events, such as floods, droughts, and heat waves, temporarily changed the relative advantage of the species, favoring coexistence. Mechanisms by which variation in flow and temperature resulted in differential effects included species-specific differences in optimal temperatures and in timing of spawning. Information of the type derived from this model should be useful for making decisions on stocking strategies and introductions of new species, and for assessing potential impacts of changes in flow and water quality.

Distribution and Status of Introduced Rainbow Trout in Dekalb and Warren Counties, Tennessee

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Keywords: rainbow trout, stocking, habitat use, warmwater streams. distribution

The Tennessee Wildlife Resources Agency (TWRA) has introduced rainbow trout *Oncorhynchus mykiss* into five typically warm water streams in Dekalb and Warren Counties, Tennessee. These introductions are made as frequently as three times annually to support put and take fisheries, but the post-stocking status of these fish has not been evaluated, and any over-summer survival has not been considered significant. However, other studies in these watersheds have reported large rainbow trout (> 400 mm), which suggest that some of these introduced fish are surviving elevated summer water temperatures. Also, rainbow trout have been reported in streams that are tributaries to the stocked streams, indicating that the stocked fish are expanding their distribution. In addition, several fingerling rainbow trout have been collected during the spring months, and TWRA only stocks fingerlings in September, suggesting that natural reproduction may be occurring.

This study will examine the geographic distribution, over-summer survival, age structure, mean length at age, and relative weight of rainbow trout within the two-county region. Electrofishing surveys are being conducted to develop summer and winter distributional maps for trout inhabiting the stream drainages. Global Positioning System coordinates are being obtained for each fish located, and the habitat characteristics of each collection location are being measured to assess habitat variables associated with over-summering trout. All introduced fish are being fin-clipped to assess post-stocking and over-summer survival. Additionally, fin-clipped fingerlings will be used to determine if natural reproduction is occurring, or if the collection of fingerlings during the spring and summer months is due to poor growth of fingerlings stocked during September.

Multiple Electrofishing Removals as a Management Tool For Restoration of Southern Appalachian Brook Trout

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Keywords: trout removal

We evaluated multiple electrofishing removals of rainbow trout *Oncorhynchus mykiss* in one year as a management tool for the restoration of native brook trout *Salvelinus fontinalis* in a small southern Appalachian stream. Six, three-pass depletion removal efforts were conducted between June 1996 and October 1997 using backpack electrofishing gear. After removal 4 (October 1996), 105 native southern Appalachian brook trout of various age-classes were reintroduced into Mannis Branch. No rainbow trout were collected during removal 6, indicating five removals were required to successfully eliminate rainbow trout from Mannis Branch. During the study, 428 rainbow trout were removed from the treatment area. The initial removal collected 296 rainbow trout (70% of total), of which 62 were YOY (21%) and 234 were age-1 (79%) or older. Removals two through five were dominated by YOY rainbow trout (57-83%). The initial two removals successfully eliminated 96% of the reproductively mature adults as well as 86% of the YOY. Surveys conducted in May 1997 indicated adult brook trout successfully spawned initiating re-population of the treatment area. Initial population estimates were compared to the actual catch to assess the accuracy of population estimators. Population estimates from removal one underestimated the actual population size by 30%. It was not until after removal three that the actual number of rainbow trout fell within the population estimate 95% confidence interval for the treatment area. Multiple removals exhibited no negative population level effects on rainbow trout or blacknose dace *Rhynichthys atratulus* in Mannis Branch or a control stream, despite being exposed to six, three-pass depletion electrofishing efforts. Based upon these results, a minimum of two removals conducted per summer should eliminate rainbow trout reproduction and significantly reduce the number of years required to successfully restore a small southern Appalachian stream.

Drought and Flood Effects on Fish Communities in Streams of the Great Smoky Mountains National Park

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Keywords: trout densities, long-term study

Fish populations were observed over a twelve year period in upper and lower sections of a watershed in the Great Smoky Mountains National Park. Several flow regimes were used to determine relationships between fish density and stream discharge. Fish populations in East Prong of Little River were susceptible to extremely high and low water discharges. The greatest changes in density were noted in age-0 trout and small cyprinids during their critical periods of life. Adult trout and larger fish species were not effected. Densities were inversely proportional to mean and peak flows, and number of flow events over 1000 cubic feet per second. Density was effected by a single, extreme flow event (i.e. 1994 flood), however, densities were not effected over a ten year period by single, extreme flow events.

Special Session: Status of Aquaculture in Southeastern States

Winter Pond Production of Rainbow Trout (Oncorhynchus mykiss) and Brook Charr (Salvelinus fontinalis) in Kentucky: A Comparison of Growth Rates

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Keywords: Rainbow Trout, Brook Trout, Pond Production, Comparison

Our study evaluated the growth of rainbow trout and brook charr during the winter in Kentucky. Juvenile rainbow trout (55.1 " 1.5 g) and brook charr (28.9 " 0.4 g) were stocked at a density of 8750 fish/ha into six 0.04-ha ponds to compare winter growth. After 163 days, rainbow trout had significantly higher ($P < 0.05$) individual weights (439.3 g) and total yields (3152 kg/ha) than brook charr (276.8 g and 1854 kg/ha, respectively). Brook charr had higher ($P < 0.01$) percent gain and specific growth rate (856.9% and 1.38%, respectively) than rainbow trout (698.1% and 1.27%, respectively). Differences in growth performance between the two species may have been due to unequal stocking weights. Our results suggest that brook charr are amenable to production conditions and may attain growth rates similar to rainbow trout.

Posters

Movement Rate and Barrier Properties of Riffles: Predicting Movement of Two Cyprinids with an Individual-Based Model

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Keywords: fish, Streams, movement, barriers, model

Movement and dispersal of two Cyprinids (*Notropis boops* and *Campostoma anomalum*) was observed in Brier Creek (Oklahoma) and compared to predicted patterns from an individual-based random walk model. The model was based on data from previous experiments in artificial streams that quantified movement rate across riffles at various levels of current velocity, thalweg depth, riffle length, and levels of predation in pools. One hundred *N. boops* and *C. anomalum* then were marked by subcutaneous injection of acrylic paint, and released in Brier Creek at the point of capture. Over the next 30 days, 17 snorkeling samples were conducted over a 1 km of stream consisting of 10 pools and 9 riffles. During each survey, visual counts were made of all species in each pool, including numbers of marked *N. boops* and *C. anomalum.* The data from the snorkeling surveys were then compared to predicted distributions from the model. Two sets of simulations were run to generate predicted distributions from the model, a null model and a predictive model. The null model assumed all riffles were not effective barriers and had no effect on dispersal. The predictive model accounted for differences in riffle properties (thalweg depth, current velocity, and length) that would make them less permeable. The predictive model was more accurate in predicting marked fish distributions. The majority of marked fish remained in the same pool as they were released, with only a few individuals moving upstream or downstream.

Evaluation of Methods for Establishing Native Aquatic Vegetation in Seven Texas Reservoirs

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Keywords: aquatic plants, aquatic vegetation, native vegetation, habitat, herbivory.

Because many Texas reservoirs are either sparsely vegetated or contain an overabundance of non-native species such as hydrilla (*Hydrilla verticillata*), the Texas Parks and Wildlife Department, Inland Fisheries Division began a new initiative to develop procedures for establishing diverse native plant communities in Texas reservoirs. The objective of the first phase of the initiative is to determine survival and growth of 21 species of native aquatic vegetation planted in 11 different exclosure types (to protect against herbivory) in 7 reservoirs representing a variety of ecological conditions. Two-month survival for emergent species protected by two levels of exclosures (individual tomato cages within cove or shoreline fences) was 90%, followed by 76% for floating-leaved species and 69% for submersed species. Survival was considerably lower without protection from herbivory: 67% for emergent species, 35% for floating-leaved species, and 19% for submersed species.

Effects of Catch and Release on Physiological Responses and Acute Mortality of Striped Bass, Morone saxatilis

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Keywords: respiratory acidosis, metabolic acidosis, striped bass, mortality, catch and release

The Atlantic striped bass *Morone saxatilis* has historically supported some of the most important recreational and commercial fisheries from Maine to North Carolina. Steady declines in the abundance of striped bass, particularly Chesapeake Bay stocks, began in the early 1970=s, primarily due to excessive fishing mortality. This prompted legislative and administrative actions which included catch and release policies that were implemented to offset the impact of angling on a limited fishery. Fish caught by commercial or recreational methods often struggle to the point of complete exhaustion. This can result in severe physiological disturbances and a significant percentage may die from the ordeal. The objective of this study was to determine the effect of angling time on blood pH, HCO_3 -, pCO_2, TCO_2, pO_2, and O_2 saturation. A secondary objective was to monitor mortality of the fish angled at 0-30s, 1 min, 2 min, 3 min, 4 min, and 5 min. The effect of size (< 23@, >23@) on the stress responses and acute mortality was also examined. There was a significant effect ($p<.05$) of angling time on all the blood parameters and acute mortality. There was no significant effect ($p>.05$) of size on the blood parameters and acute mortality. As playing time increased, trends in blood parameters indicated both respiratory and metabolic acidosis.

Using Geographic Information Systems (GIS) as a Fisheries Management Tool in Texas

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Keywords: GIS, GPS, habitat, surveys, mapping

The Inland Fisheries Division of the Texas Parks and Wildlife Department (TPWD) began using Geographic Information Systems (GIS) as a tool to increase the effectiveness of aquatic resource management in August 1994. Before that time, fishery data were only examined in two dimensions since fishery and corresponding environmental data were not available in a digital format. GIS has allowed us to collect data from a variety of sources and layer them for spatial analyses. We are fully integrating GIS into our data management system by creating base maps of our aquatic systems and geo-referencing our routine fish data collection. We overlaid grids on our reservoir maps to facilitate location of our randomly selected fish population survey sites, and geo-referenced all historic fish survey data by identifying site coordinates on grid maps. During field surveys, Global Positioning Systems (GPS) allowed us to collect information directly into electronic databases without transcribing (e.g. lake-wide habitat assessments and pre-impoundment surveys), map previously unavailable features such as reservoir shorelines in fluctuating water bodies, and more quickly and accurately monitor exotic vegetation distribution and coverage. Sharing biological information has become increasingly important. Because our data are available in a standard GIS format, they are easily and frequently used by other natural resource managers.

Evaluation of Stocking Advanced-Size Black Crappie (Pomoxis nigromaculatus) Fingerlings in Florida

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Keywords: black crappie, stocking, micro-wire tag, mortality

We examined the feasibility of mass culturing advanced-size black crappie fingerlings (90-160 mm total length, TL) and assessed the effectiveness of micro-wire tags for marking fingerlings for stocking evaluations. Approximately 142,000 advanced fingerlings were reared in four 0.4-ha ponds during spring-fall 1997. An inverse relationship existed between total length and density of fingerlings in culture ponds (R^2 = 0.93, TL= 155912 + -991(density), $P < 0.01$). We used coded wire tags to mark fish prior to stocking. In January 1998, Lake Jeffords (65 ha) was stocked with wire-tagged fingerlings (315/ha). Mortality was assessed 24 hours after stocking by placing 100 fish into cages located at the lake. Mortality averaged 76%, resulting in an estimated final stocking rate of 76/ha survivors at 24 h after stocking. Conversely, untagged fish stocked into another lake had only 5% mortality after 24 h. Thus, high mortality of tagged fish was likely related to extra handling during the tagging process. Contribution of stocked fingerlings to the population will be assessed during fall 1998.

Aquatic Plant Introduction in Alice City Lake: A Model for Restitution?

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In 1998, the Texas Parks and Wildlife Department initiated a four-year aquatic plant introduction project at Alice City Lake in an attempt to enhance the quality of fish habitat. Funding for plants, materials, and labor are provided by a local entity as negotiated settlement for its role in a public water fish kill. The 288-acre reservoir is shallow and turbid with limited littoral habitat. Largemouth bass and other sunfish populations have historically been in low abundance. Two hundred and seventy-two individual plants of 19 species were planted within wire exclosures in July. Survival and expansion were evaluated after three months to allow planning for 1999 plantings. Emergent plant survival averaged 73%, submersed ~ 48%, and floating-leaved ~ 71%. Survival and expansion varied greatly between species due to herbivory and increases in water level. Species, which demonstrated the greatest potential for establishment and expansion, were water star grass, water willow, softstem bulrush, pickerel weed, white water lily, American pondweed, spatterdock, bulltongue, arrowhead, and square-stem spike rush. These species will be utilized in 1999 plantings. A survey to evaluate use of aquatic plants by small and juvenile fishes is planned. If successful, this project may serve as a model for future fish kill restitution projects.

An Integrated Approach to Managing Aquatic Plants at Lake Jacksonville, Texas

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Keywords: hydrilla control, plant introduction, fish habitat, grass carp, herbicide.

We developed an integrated management plan was developed to control 48 ha of hydrilla (*Hydrilla verticillata*) on Lake Jacksonville, Texas (a 547 ha municipal water-supply reservoir). Our objective was to control a problematic, invasive, exotic plant while increasing coverage and community diversity of native plants for fish habitat. Our plan was to reduce hydrilla biomass with aquatic herbicide, stock a minimal number of grass carp (*Ctenopharyngodon idella*) to control re-sprouting, and introduce a diverse native plant community. Hydrilla was treated with Aquathol K in summer 1997 and 1998 followed by stocking 100 grass carp each year. Following each treatment, native plants representing floating leafed, emergent, and submersed growth forms were planted in protective cages (to limit herbivory). In fall 1998 hydrilla was found only in cages where native plant survival was low. Herbivores appeared to be selectively removing hydrilla from the plant community outside of the cages where it had been observed in summer 1998. Many of the native plant species introduced in 1997 and 1998 have survived and are expanding beyond the protective cages. These preliminary results indicate that an integrated approach has the potential to control hydrilla while promoting diversity of the native plant community.

Introductions of Exotic Species: The Economic Costs

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Keywords: walleye, alewife, economic impact

In southeastern United States reservoirs, alewife *Alosa pseudoharengus* were first introduced into several system to provide a stable forage base. A stable forage have enhanced some reservoir fisheries, but the loss of successful reproduction and recruitment of walleye *Stizostedion vitreum* has also occurred. Accidental introductions of alewife or range expansion have also occurred. One accidental introduction has lead to the recruitment failure of walleye in Norris Reservoir, Tennessee. The concern of losing the fishery resulted in the development of a walleye stocking model, which includes the economic benefits and costs of varying scenarios. No action by the state agency would cost the local economy over one million dollars in lost revenue annually. The stocking of 250,000 fingerlings would cost the agency $ 50,000 annually, but would result in a benefit:cost of $ 6.50:1.00. Increased stocking of walleye to 500,000 annually would result in a benefit:cost ratio of $ 8.75:1.00. The replacement of walleye natural reproduction would require the stocking of 1.2 million fingerling annually at a cost of $ 180,000. Consequently, the accidental introduction of alewife into Norris Reservoir will cost anglers both in loss of fishing opportunities and financially. Input to the local economy may also be affected, thus potentially influencing both employment and tax revenue.

Hatching Periodicity and Growth Rates of Black Crappies and White Crappies in Normandy Reservoir, Tennessee

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Keywords: crappie, hatching periodicity, growth rates

Age-0 black crappies *Pomoxis nigromaculatus* and white crappies *P. annularis* were collected in cove samples from Normandy Reservoir, a 1,307-ha flood control impoundment on the upper Duck River in south-central Tennessee. Three coves were treated with rotenone (1.5 ppm active ingredient) during the first week of August each year. Age-0 crappies were measured and weighed; otoliths were removed for age analysis. In some years fish were subsampled for age analysis. Hatch dates and daily growth rates were determined from the otoliths of age-0 crappies. Crappies hatched as early as April 10 and as late as June 3. Hatch date distribution and length frequencies were unimodal for each species in all years. Peak hatching preceded peak catch of larval crappies in neuston samples by 7-10 d in each year. Growth for both species ranged from 0.4 to 0.8 mm/d and was positively related to hatch date. Crappies hatched earlier and grew slower than largemouth bass and spotted bass collected concurrently in Normandy Reservoir. Unlike largemouth bass, crappies never experienced bimodal hatching distributions; earlier-hatched fish grew at slower rates than later-hatched fish, likely due to warmer water temperatures experienced by later-hatched fish. Compared to largemouth bass, growth and hatching of age-0 crappies appeared to be little affected by spring or summer water-level events.

The Freshwater Mussels of Sulphur Fork Creek and Lower Red River, Tennessee, and Laboratory Transformation of Glochidia.

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The Sulphur Fork Creek/Lower Red River watershed is approximately 74 km long and averages about 29-35 km in width. This was the inaugural mussel survey of this watershed. A total of 347 man-hours were dedicated to research in the summer and fall of 1998 to determine abundance and diversity of living and remnant (shells) species. Mussels were hand-collected by snorkeling, canoeing, walking stream banks and utilizing a Needham bottom scraper. Lower Red River held the highest frequency of living and remnant species. It is interesting to note that living and remnant species encountered in Sulphur Fork Creek were limited to the lower one-fifth of the watershed. Living species encountered were (greatest → least abundant): *Amblema plicata*; *Potamilus alatus*; *Lampsilis ovata; Ptychobranchus fasciolaris*; *Cyclonaias tuberculata*; *Tritogonia verrucosa*; *Elliptio crassidens*; *Lampsilis fasciola*; *Lasmigona costata*; *Quadrula cylindrica*; and *Fusconaia flava*. Remnant species encountered were (living excluded): *Cumberlandia monodonta*; *Toxolasma lividus*; *Villosa iris*; *Elliptio dilatatus*; and *Obovaria subrotunda*. Furthermore, a variety of host fish species, other than those associated with surveyed mussel species, were observed. This paper also focuses on employing laboratory transformation to culture *Megalonaias nervosa*. Future studies will concentrate on re-establishing threatened native species using this transformation process, and the relocation of living mussels at different locations.